ESCUELA DE DOCTORADO
INTERNACIONAL DE LA USC

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Tesis doctoral

A GLOBAL PERSPECTIVE OF THE HEALTH SYSTEMS AND THEIR RELATIONSHIP WITH THE ECONOMY

Santiago de Compostela, 2023

PD en Desarrollo Regional e Integración Económica

DOCTORAL THESIS

A GLOBAL PERSPECTIVE OF THE HEALTH SYSTEMS AND THEIR RELATIONSHIP WITH THE ECONOMY

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INTERNATIONAL PHD SCHOOL OF THE UNIVERSITY OF SANTIAGO DE COMPOSTELA
PHD PROGRAMME IN "DESARROLLO REGIONAL E INTEGRACIÓN ECONÓMICA"

THIS THESIS IS INCLUDED IN THE PROJECT "SUSTAINABILITY OF THE HEALTH SYSTEM IN KAZAKHSTAN", IN THE FRAMEWORK OF INDUSTRIAL DOCTORATES PROGRAMME, CO-FINANCED BY THE AGENCIA ESTATAL DE INVESTIGACIÓN FROM THE MINISTRY OF SCIENCE AND INNOVATION OF SPAIN"

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RESUMEN

La pandemia del COVID-19 ha sido la demostración definitiva de la importancia crucial de la salud para la población mundial y la necesidad de contar con sistemas sanitarios eficientes que permitan garantizar y mejorar la salud de la población. También ha puesto de manifiesto la importancia que puede llegar a tener la salud en la economía, tanto a nivel nacional como internacional.

Estudiar conjuntamente ambos enfoques permite identificar las posibilidades de mejora del sistema y también conocer las implicaciones económicas de posibles medidas o inversiones a realizar en el sector.

Nuestro objetivo es contribuir a este análisis conjunto, aportando nuevos enfoques y resultados. Este estudio, desarrolla una evaluación del desempeño para 75 países, calculando la mortalidad prevenible y tratable para todos ellos. El cálculo se realiza desagregando ambos tipos de mortalidad y se obtienen resultados detallados para 12 causas o grupos de enfermedades diferentes. También se han identificado diferentes clusters y subclusters de países en función de esta distribución de mortalidad prevenible y tratable. Los resultados obtenidos nos muestran una importante heterogeneidad entre países y también ofrecen información interesante desde el punto de vista del benchmarking, en cuanto al diseño de políticas o medidas relacionadas con la salud a través de la prevención y el tratamiento.

Desde el punto de vista de la toma de decisiones, el análisis macroeconómico del sector como parte de la economía de cada país tiene una especial relevancia ya que nos permite conocer sus interrelaciones con el resto de la economía, más allá de la tradicional visión del sector como generador de gasto público. Partiendo del análisis Input-Output, y previa desagregación del sector se ha estudiado su tecnología de producción para un total de 41 países y se han identificado tipologías de producción a nivel internacional. Los resultados nos muestran que también existe heterogeneidad en cuanto a su forma de producir salud, unas diferencias que son

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todavía mayores si comparamos el origen doméstico o importado de los inputs del sector, en cada caso.

Teniendo en cuenta estos resultados internacionales se ha realizado un estudio más en profundidad de Kazajistán y sus regiones como ejemplo de caso de estudio y aplicación de los resultados, tratando de analizar las diferencias regionales e identificar los principales factores que subyacen en ellas. Su elevado nivel de mortalidad evitable respecto a la media de la OECD, y su actual proceso de reformas, convierten al país en un candidato para el cuál este tipo de estudio resulta especialmente interesante.

Al calcular los indicadores de mortalidad evitable a nivel regional se han observado importantes disparidades regionales tanto en cuantía como en distribución por causas de muerte. Estos datos apoyan una futura toma de decisiones adaptadas al contexto de cada región de cara a mejorar de forma específica el desempeño del sistema de salud y las prioridades de cada región. Desde el punto de vista de la tecnología de producción del sector, destaca el elevado peso de las actividades financieras y de seguros, así como del consumo farmacéutico. También se ha regionalizado la tabla Input-Output nacional para evaluar las interrelaciones del sector en las diferentes economías regionales.

Tanto los resultados obtenidos a nivel internacional como los resultados obtenidos para Kazajistán permiten profundizar en el impacto de los sistemas sanitarios y en la identificación de los puntos clave sobre los que actuar para la mejora de su desempeño. Además, también permiten conocer el papel del sector desde el punto macroeconómico y contribuir a la toma de decisiones sobre posibles inversiones futuras.

Como resultado, esta tesis proporcionará información de referencia para futuras decisiones sobre política sanitaria en los países considerados y, en particular en Kazajistán y sus regiones.

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RESUMO

A pandemia do COVID-19 foi a demostración definitiva da importancia crucial da saúde para a poboación mundial e a necesidade de contar con sistemas sanitarios eficientes que permitan garantir e mellorar a saúde da poboación. Tamén puxo de manifesto a importancia que pode chegar a ter a saúde na economía, tanto a nivel nacional como internacional.

Estudar conxuntamente ambos os enfoques permite identificar as posibilidades de mellora do sistema e tamén coñecer as implicacións económicas de posibles medidas ou investimentos a realizar no sector.

O noso obxectivo é contribuír a esta análise conxunta, achegando novos enfoques e resultados. Este estudo, desenvolve unha avaliación do desempeño para 75 países, calculando a mortalidade previble e tratable para todos eles. O cálculo realízase desagregando ambos tipos de mortalidade e obtéñense resultados detallados para 12 causas ou grupos de enfermidades diferentes. Tamén se identificaron diferentes clústers e subclústers de países en función desta distribución de mortalidade previble e tratable. Os resultados obtidos móstrannos unha importante heteroxeneidade entre países e tamén ofrecen información interesante desde o punto de vista do benchmarking, en canto ao deseño de políticas ou medidas relacionadas coa saúde a través da prevención e o tratamento.

Desde o punto de vista da toma de decisións, a análise macroeconómica do sector como parte da economía de cada país ten unha especial relevancia xa que nos permite coñecer as súas interrelacións co resto da economía, máis aló da tradicional visión do sector como xerador de gasto público. Partindo da análise Input-Output, e previa desagregación do sector, estudouse a súa tecnoloxía de produción para un total de 41 países e identificáronse diferentes tipoloxías de produción a nivel internacional. Os resultados móstrannos que tamén existe heteroxeneidade en canto á súa forma de producir saúde, unhas diferenzas que son aínda maiores se comparamos a orixe doméstica ou importada dos inputs do sector, en cada caso.

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Partindo destes resultados internacionais, realizouse un estudo máis en profundidade de Kazakhstan e as súas rexións como exemplo de caso de estudo e aplicación dos resultados, tratando de analizar as diferenzas rexionais e identificar os principais factores que subxacen nelas. O seu elevado nivel de mortalidade evitable respecto á media da OECD, e o seu actual proceso de reformas, converten ao país nun candidato para o cal este tipo de estudo resulta especialmente interesante.

Ao calcular os indicadores de mortalidade evitable a nivel rexional observáronse importantes disparidades rexionais, tanto en contía como en distribución por causas de morte. Estes datos apoian unha futura toma de decisións adaptadas ao contexto de cada rexión para mellorar de forma específica o desempeño do sistema de saúde e as prioridades de cada rexión. Desde o punto de vista da tecnoloxía de produción do sector, destaca o elevado peso das actividades financeiras e de seguros, así como do consumo farmacéutico. Tamén se rexionalizou a táboa Input-Output nacional para avaliar as interrelacións do sector nas diferentes economías rexionais.

Tanto os resultados obtidos a nivel internacional como os resultados obtidos para Kazakhstan permiten afondar no impacto dos sistemas sanitarios e na identificación dos puntos crave sobre os que actuar para a mellora do seu desempeño. Ademais, tamén permiten coñecer o papel do sector desde o punto macroeconómico e contribuír á toma de decisións sobre posibles investimentos futuros.

Como resultado, esta tese proporcionará información de referencia para futuras decisións sobre política sanitaria nos países considerados e, en particular en Kazakhstan e as súas rexións.

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ABSTRACT

The COVID-19 pandemic has been the definitive demonstration of the crucial importance of health for the world population and the need to have efficient health systems that guarantee and improve the health of the population. It has also highlighted the importance that health can have in the economy, both nationally and internationally.

Studying both approaches together makes it possible to identify the possibilities for improving the system and also to know the economic implications of possible measures or investments to be made in the sector.

Our objective is to contribute to this joint analysis, providing new approaches and results. This study develops a performance evaluation for 75 countries, calculating preventable and treatable mortality for all of them. The calculation is made by disaggregating both types of mortality, obtaining detailed results for 12 different causes or groups of diseases. Different clusters and subclusters of countries have also been identified based on this distribution of preventable and treatable mortality. The results obtained show us an important heterogeneity between countries and also offer interesting information from the point of view of benchmarking, in terms of the design of policies or measures related to health through prevention and treatment.

From the point of view of decision-making, the macroeconomic analysis of the sector as part of the economy of each country is of special relevance since it allows us to know its interrelationships with the rest of the economy, beyond the traditional vision of the sector. as a generator of public spending. Based on the Input-Output analysis, and after disaggregating the sector, its production technology has been studied for a total of 41 countries and international production typologies have been identified. The results show us that there is also heterogeneity in terms of the way in which health is produced, differences that are even greater if we compare the domestic or imported origin of the sector's inputs, in each case.

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Taking into account these international results, a more in-depth study of Kazakhstan and its regions has been developed, as an example of a case study and application of the results, trying to analyze the regional differences and identify the main factors that underlie them. Its high level of avoidable mortality compared to the OECD average, and its current reform process, make the country a candidate for which this type of study is especially interesting.

When calculating the indicators of preventable mortality at the regional level, significant regional disparities have been observed, both in quantity and in distribution by cause of death. These data support future decision-making adapted to the context of each region to specifically improve the performance of the health system and the priorities of each region. From the point of view of the sector's production technology, the high weight of financial and insurance activities, as well as pharmaceutical consumption, stands out. The national Input-Output table has also been regionalized to assess the interrelationships of the sector in the different regional economies.

Both the results obtained at the international level and the results obtained for Kazakhstan allow us to go further into the impact of health systems and identify the key points on which to act to improve their performance. In addition, they also allow us to know the role of the sector from a macroeconomic point of view and contribute to decision-making on possible future investments.

As a result, this thesis will provide reference information for future health policy decisions in the considered countries and, in particular, in Kazakhstan and its regions.

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ABBREVIATIONS

ACRONYM	NAME
AFLQ	AUGMENTED FLEGG´S LOCATION QUOTIENT
AGGR	AGGREGATED SECTOR
CIHI	CANADIAN INSTITUTE FOR HEALTH INFORMATION
CILQ	CROSS-INDUSTRY LOCATION QUOTIENT
COVID-19	CORONAVIRUS DISEASE 2019
DISAGGR	DISAGGREGATED SECTOR
DOMIMP	DOMESTIC AND IMPORTS INPUT-OUTPUT TABLES
EU	EUROPEAN UNION
EUROSTAT	STATISTICAL OFFICE OF THE EUROPEAN COMMUNITIES
GDP	GROSS DOMESTIC PRODUCT
GVA	GROSS VALUE ADDED
GVC	GLOBAL VALUE CHAIN
HCS/HS/HH	HEALTH CARE SYSTEMS / HEALTH SECTOR / HUMAN HEALTH ACTIVITIES
HHSS	HUMAN HEALTH AND SOCIAL SERVICES SECTOR (AGGREGATED)
HEM	HYPOTHETICAL EXTRACTION METHOD
HSPA	HEALTH SYSTEM PERFORMANCE ASSESSMENT
ICD-10	INTERNATIONAL CLASSIFICATION OF DISEASES. VERSION 10
IOT	INPUT – OUTPUT TABLE
LQ	LOCATION QUOTIENTS
OECD	ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
ONS	OFFICE FOR NATIONAL STATISTICS OF UNITED KINGDOM
PC	PER CAPITA
PPP	PURCHASING POWER PARITY
SNA	SYSTEM OF NATIONAL ACCOUNTS
SS	SOCIAL SERVICES SECTOR/ SOCIAL SERVICES ACTIVITIES
SUTs	SUPPLY AND USE TABLES
SYMM	SYMMETRIC INPUT-OUTPUT TABLES
TTL	TOTAL INPUT-OUTPUT TABLES
UHC	UNIVERSAL HEALTH COVERAGE
UN	UNITED NATIONS
UNICEF	UNITED NATIONS INTERNATIONAL CHILDREN'S EMERGENCY FUND
UNSTAT	UNITED NATIONS STATISTICS DIVISION
WHO	WORLD HEALTH ORGANIZATION
WIOD	WORLD INPUT-OUTPUT DATABASE

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ACRONYM	COUNTRY
ARG	ARGENTINA
ARM	ARMENIA
AUS	AUSTRALIA
AUT	AUSTRIA
BRB	BARBADOS
BLR	BELARUS
BEL	BELGIUM
BRA	BRASIL
BRN	BRUNEI DARUSSALAM
BGR	BULGARIA
CAN	CANADA
CHL	CHILE
CHN	CHINA
COL	COLOMBIA
CRI	COSTA RICA
HRV	CROATIA
CUB	CUBA
CYP	CYPRUS
CZE	CZECH REPUBLIC
DEU	GERMANY
DNK	DENMARK
DOM	DOMINICAN REPUBLIC
ECU	ECUADOR
SLV	EL SALVADOR
EST	ESTONIA
FIN	FINLAND
FRA	FRANCE
GEO	GEORGIA
GRC	GREECE
GTM	GUATEMALA
HKG	HONG KONG SAR
HND	HONDURAS
HUN	HUNGARY
IDN	INDONESIA
IRL	IRELAND
ISR	ISRAEL
ITA	ITALY
JAM	JAMAICA
JPN	JAPAN
JOR	JORDAN
KAZ	KAZAKHSTAN
KOR	KOREA (REPUBLIC OF)

ACRONYM	COUNTRY
KWT	KUWAIT
KGZ	KYRGYZSTAN
LBN	LEBANON
LTU	LITHUANIA
LVA	LATVIA
LUX	LUXEMBOURG
MLT	MALTA
MUS	MAURITIUS
MEX	MEXICO
MDA	MOLDOVA (REPUBLIC OF)
MNG	MONGOLIA
MAR	MOROCCO
NLD	NETHERLANDS
NZL	NEW ZEALAND
NIC	NICARAGUA
NOR	NORWAY
OMN	OMAN
PRY	PARAGUAY
PER	PERU
POL	POLAND
PRT	PORTUGAL
PRI	PUERTO RICO
REU	RÉUNION
ROU	ROMANIA
LCA	SAINT LUCIA
SRB	SERBIA
SVK	SLOVAKIA
SVN	SLOVENIA
ESP	SPAIN
LKA	SRI LANKA
SUR	SURINAME
SWE	SWEEDEN
CHE	SWITZERLAND
THA	THAILAND
TUN	TUNISIA
TUR	TURKEY
TWN	TAIWAN
GBR	UNITED KINGDOM
USA	UNITED STATES OF AMERICA
URY	URUGUAY
VEN	VENEZUELA

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FUNDING

This thesis has been developed in the framework of Industrial Doctorates Programme, co-financed by the Agencia Estatal de Investigación from the Ministry of Science and Innovation of Spain”. It is included in the project “Sustainability of the Health System in Kazakhstan”, developed by the company AYeconomics Research Centre, S.L.

María del Carmen Vilariño López has developed her doctoral thesis in the company Ayeconomics Research Centre, S.L. between december of 2019 and July of 2023 with the support of the company.

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INTRODUCTION

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I. BACKGROUND

<u>The role of Health and Health Care Systems for the people, the society and the economy</u>

To define the role of Health and Health Care Systems, first, it is necessary to define what is Health and what are Health Systems. The Alma Ata Declaration (WHO-PAHO-UNICEF, 1978) establishes that "health, which is a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity, is a fundamental human right and that the attainment of the highest possible level of health is a most important world-wide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector". It also emphasizes the need to reduce inequalities in the health status of people between countries and within each country.

According to the World Health Organization, the Health Systems were defined in the *World Health Report 2000 Health Systems: Improving Performance* (WHO, 2000), and they comprise "all the organizations, institutions and resources that are devoted to producing health actions. A health action is defined as any effort, whether in personal health care, public health services or through intersectoral initiatives, whose primary purpose is to improve health". Therefore, health depends on health systems and how they produce their health actions.

Health systems are crucial around the world due to their direct relationship with the population's health, well-being as well as their growing role in the economy. The main objective of health systems is to improve the health of the population. However, its importance from the economic point of view is increasing and being widely recognized in the literature.

Traditionally the health sector has been analysed from a spending generation point of view. However, recently different studies and institutions have put forward the idea that, in addition to its fundamental role in the health of the population, it is a key sector in the economy with important potential for job creation and, more generally, economic growth (Boyce and Brown, 2019b). The COVID-19 pandemic has been the definitive proof of the existence of that relationship and its magnitude.

This crisis has been the most important global shock in health and economic terms in the last century. According to the recent report *World health statistics 2023: Monitoring Health for the Sustainable Development Goals* (World Health Organization, 2023), the pandemic caused 14.9

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million excess deaths worldwide between 2020 and 2021, amounting to 336.8 million years of life lost.

But it also paralyzed the economy global economy to a great extent, representing an unprecedented disruption. The policy measures taken to contain the transmission of the virus, such as lockdowns, mobility restrictions, safety protocols, and the overall increase in health expenditure, had a clear economic translation. The contraction of both supply and demand affected, directly and indirectly, a vast majority of countries; reaching limits not seen in either of the World Wars or in the Great Recession of the 1930s (World Bank, 2022). These challenges deepened existing social inequalities given the international differences in resources and policies to fight the spread of the virus, and the added difficulties faced by developing countries.

The recent crisis caused by COVID-19 has revealed the indisputable and strong dependence that the national and global economies have on the health factor. We could say that if health is "sick", the economy is "sick". The observed relationship between health outcomes, how that outcome is produced and the economy makes it crucial to understand in depth how different health systems are connected to the rest of the economy and to evaluate their performance, comparing them internationally, in order to have a frame of reference that guides public policy-making.

Figure 1 summarizes the main framework presented in this thesis. Countries differ in the set of resources they allocate to the health sector that serve as inputs to produce health for their citizens. The number of beds/doctors, size of the hospitals or overall expenditure present great heterogeneity worldwide. Provided this, it is not surprising that there is also heterogeneity in health outcomes. Figures on life expectancy range from around 55 years in the poorest African countries to over 80 years in most European ones. However, the relationship between health systems inputs and outputs does not hold perfectly: in some cases, countries with similar health expenditure levels exhibit rather different results. The main hypothesis of this thesis is that the production technology of health services explains, at least partially, these striking deviations.

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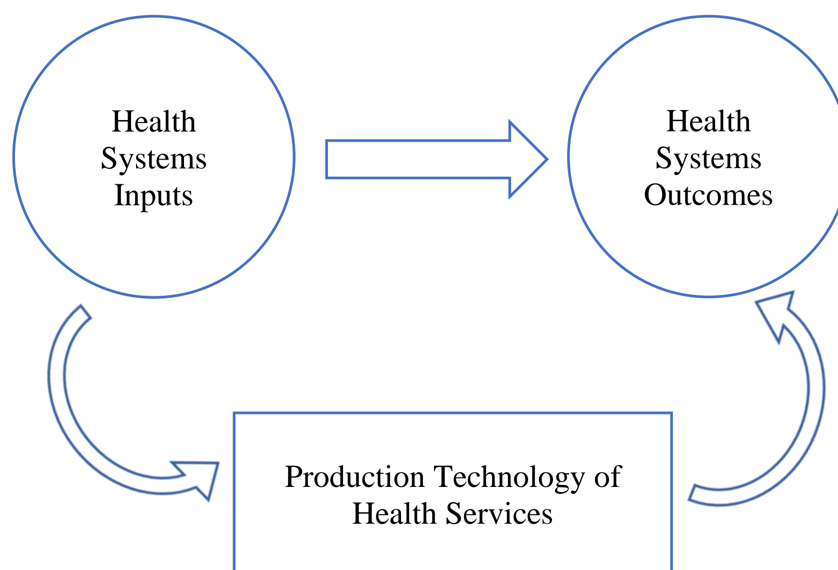
Figure 1. Analysis framework



Source: Own elaboration

Heterogeneity of the health systems at international level

Health systems present important differences internationally. At the institutional level, there are 4 traditional models based on institutional and financing aspects[1]:

- Beveridge model: the government manages the provision of health and, for this purpose, it has an item in the state budget that is financed through taxes on all citizens. This is the case of Australia, the United Kingdom, the Nordic countries, Ireland or some countries in the south of Europe such as Spain, Portugal or Italy.
- Bismark model: companies and workers pay fees that feed a mandatory insurance fund that covers everyone, even those who do not contribute. It is the state that guarantees benefits. This is the model of most of the countries of the European Union, Switzerland, Turkey, Mexico or Japan.
- The National Health Insurance: it is a combination of the two previous systems. Payments are made by the government through a mandatory insurance, although the providers are private. Some countries in Asia use this model, such as the Republic of Korea, Indonesia or Taiwan. It is also the model applied in Canada.

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[1] The appendix 1 includes a table detailing the model for some countries around the world

- Liberal model or private insurance (out-of-pocket payments): the most common in poor or underdeveloped countries. In this case, the providers are private, and the health services are paid directly by the users. Countries such as the United States, China, or Kazakhstan have systems mainly based on this model.

Beyond the basic model presented by each country, if we compare the data on the resources used and the health results obtained in each country, we find significant differences between countries, that is, significant heterogeneity in a sector that provides the most important good of a society, health.

According to the OECD data[2], if we compare the Current Health Expenditure (CHE) in terms of percentage of the GDP and in terms of expenditure per capita in purchasing power parity, we will find again important differences between the same countries. So, USA has a CHEpc of $11.859 and Mexico $1.227.

Figure 2 illustrates the differences in health expenditure between OECD countries, both in terms of per capita spending and in terms of percentage of GDP. This heterogeneity is evident in both indicators. The United States presents values well above the rest of the countries, with a total of $11,859 per capita compared to the $1,227 of its neighbouring country Mexico, which presents the lowest amount. They are followed by Switzerland ($7,179, which represents 61% of spending in the United States), Germany ($6,939), Norway ($6,582) and the Netherlands ($6,180). The OECD average stands at 4,278 euros per capita. The countries closest to that average in 2020 are New Zealand ($4,469), Finland ($4,605), Iceland ($4,620), Japan ($4,666), the Czech Republic ($3,805), Italy ($3,747) and Spain ($3,718). The furthest away are Mexico ($1,227, 29% of the OECD average), Turkey ($1,305), Colombia ($1,336) and Costa Rica ($1,618), all of them with values below $2,000 per capita, far below 40% of the OECD average.

Regarding the weight of current health expenditure (CHE) with respect to GDP, we can find, again, important differences between countries. The OECD average is 9.7% and, in this case, the differences between countries range from 18.8% in the USA to 4.6% in Turkey, which in this case presents a value of less than Mexico. However, in this case some countries significantly change their relative position with respect to the one they present in per capita spending. This is

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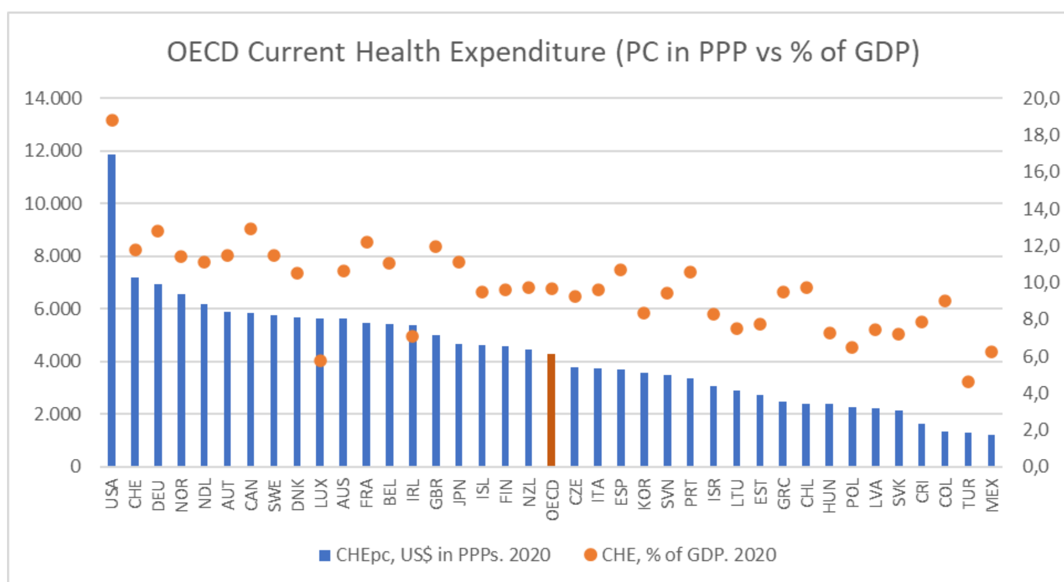
[2] http://stats.oecd.org/Index.aspx?DataSetCode=SHA

the case of countries such as Luxembourg or Ireland that go from occupying the 10th and 14th positions, in terms of per capita spending in the group of countries, to being among the lowest positions in the table (38 and 35 respectively with percentages of spending out of the GDP of 5.8% and 7.1%) given its high GDP per capita that dilutes the weight of health spending in the total amount of its income. In other countries, the opposite happens. The most significant case is Chile, which in terms of health spending per capita occupies position 31 in the OECD as a whole, while in terms of spending as a percentage of GDP it is in position 17. Other countries that present this behaviour are Colombia (position 37 compared to 26) and Spain and the United Kingdom, which rose 10 positions, with a percentage of GDP of 10.7% and 12%, respectively. This tells us that beyond the figure for health spending in each country, the effort that this spending represents in the economy as a whole can differ significantly in each case.

Figure 2. Current health expenditure (pc in PPP vs % of GDP)



Own elaboration. Data source: OECD Health Statistics 2022. http://stats.oecd.org/Index.aspx?DataSetCode=SHA

If we now analyse the variation in per capita spending between 2000 and 2020, we find that, in general terms, the positions of the countries in the spending ranking do not vary substantially.

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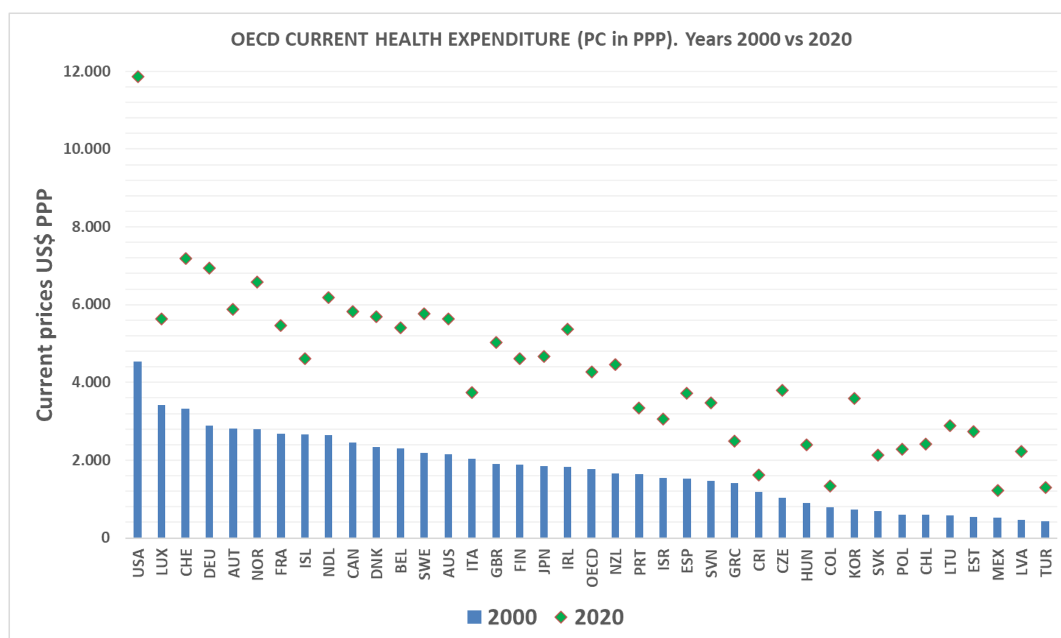
Figure 3. Current health Expenditure per capita in purchasing power parity. Year 2000 vs year 2020



Own elaboration. Data source: OECD Health Statistics 2022. In the case of Colombia and Costa Rica the comparison was done between 2011 (oldest data available) and 2020. http://stats.oecd.org/Index.aspx?DataSetCode=SHA.

Some countries such as Costa Rica, Iceland, Luxembourg, Italy or Colombia vary their position in the table (between 7 and 9 positions), as a consequence of having lower spending compared to the rest of the OECD countries (in the case of Colombia and Costa Rica we are comparing the year 2011 and the year 2020 because we do not have previous data for this indicator in the database). However, all of them remain above the average, with the exception of Italy, which, in this time interval, has gone from spending above the OECD average to having a value below it. Other countries such as the Czech Republic, Estonia, Lithuania or Korea have considerably increased their position in the table (7 positions each) although they all remain below the OECD average.

It should be noted that, although the Covid-19 crisis has motivated an increase in health expenditure, moderated and relative, given that it has been accompanied by the growth of other items of public spending as a result of the need to support households and businesses during the crisis (OECD/European Union, 2020).

If we see other key data, such as those shown in the following table , the significant disparities between countries in important system resources such as hospital beds, doctors or household financing through the out-of-pocket are reaffirmed:

Table 1. Additional indicators of the OECD health care systems.

Indicators (2019)	Min.	Max.	Dif.	Dif.%
Out-of-Pocket expenditure pc (USA $)	67	2.445	2.378	3549 %
Hospital beds (per 1.000 inh.)	1.0	12.8	11.8	1180 %
Doctors (per 1.000 inh.)	1.9	6.2	4.3	226%

Own elaboration. Data source: OECD Health Statistics 2022.
http://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_STAT

These indicators reflect important resources of the health systems. So, the out-of-pocket expenditure[3] reflects the private efforts of the households to pay the health services by themselves. It is used to complement the compulsory coverage in order to cover each person's healthcare expenses. This expense depends on the funding system of each country, but it is especially relevant in the poorest countries. In them, the lesser development of health systems with a public organization means that this type of spending is the main source of health financing. This implies access conditioned by purchasing power and by a private offer with a higher burden of business interest. As can be seen in table 1, although compulsory government schemes predominate in the OECD as means of financing, there are also countries with a strong out-of-pocket expenditure that generate significant disparities within the OECD itself.

If we analyze other inputs such as the hospital beds, once again huge differences between countries can be seen. This indicator is directly related to the average hospital stay indicator and both have been decreasing over the years. However, Covid-19 has highlighted the need to have this type of resource in the face of eventual health situations in a fast and flexible manner. If we look at the table again, it shows us important differences within the OECD.

Another important input to facilitate access and health care is the sufficient number of doctors and specialists who can cover the needs of the entire territory of a country. It should be noted that both the availability of doctors and their distribution, generally more deficient in rural areas, means that the lack of them is causing problems both in the European Union and in the OECD. If we analyze the health workforce through the number of doctors per 1,000 inhabitants in each country, the differences in the OECD are smaller, but the figures are still overwhelming and make us think of very different care capacities depending on the case.

The previous data are referred to the resources to produce health, but they do not include indicators about health outcomes, the most important objective of the health systems. As

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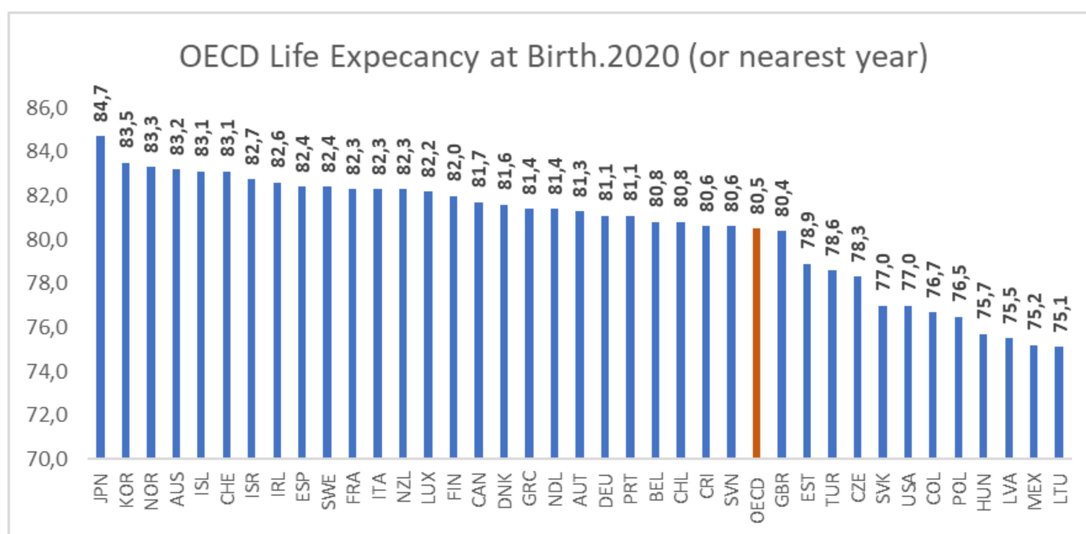
Joumard et al., (2010) point out, it is essential to evaluate the performance or efficiency of health systems in terms of outcomes, that is, what final health results are achieved with each health system, its inputs and outputs. intermediates.
Traditionally one of the most used indicators to measure the performance of the health systems was the life expectancy at birth (LE). In Figure 4, based on OECD Health Statistics, we can appreciate important differences between countries in this indicator. The results show differences in 2020 of 9.6 years between Japan (84,7 years) and Lithuania (75,1 years). The OECD mean is 80,5 years. Even, in the European Union, that difference is 7. 5 years (Ireland 82.6 vs Lithuania 75.1).

Analyzing both figures together, it can be seen that there is no coincidence between the countries with the highest spending and those that obtain better results in terms of life expectancy.

Figure 4. Life Expectancy at birth in the OECD countries. Year 2020 (or nearest)



Own elaboration. Data source: OECD Health Statistics 2022.
http://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_STAT

If both graphs are compared, a low correlation between life expectancy and the expenditure indicators analyzed can be deduced. In fact, the correlation coefficient is equal to 0.39 if we compare life expectancy with per capita national spending and 0.32 if we compare it with spending as % of GDP.

The disparity in health results and spending, as well as the differences in resources or the way of financing health, lead us to the need to propose a study that delves into the underlying causes

and the similarities and differences between health systems. The figures about expenditure show us a clear heterogeneity of expenditure between countries within the OECD and also a certain stability in terms of the position they maintain with respect to this group of countries over the years based on that expenditure.

On the other hand, if we analyze indicators of resources involved in the production of health, as important as hospital beds per 1,000 inhabitants or doctors per 1,000 inhabitants. There are overwhelming differences within the OECD related to the way of producing health. These data, undoubtedly suggest the importance of deepening the comparative analysis between the way of producing health and the outcomes obtained, in each case, to try to identify which factors may be creating those differences between countries.

To assess the performance of health systems, it is important to measure the final health results or outcomes. There are other measures of intermediate resources or outputs from health systems, but they can lead us to wrong conclusions about the efficiency of health systems. In other words, the fact that a System is efficient in the management of a certain resource or output from the system (expenditure, time spent in the hospital, for example), does not have to imply better health or a reduction in premature mortality. of the population, which are the final objectives of a health system.

But measuring the performance of health systems in terms of health is not an easy task. The difficulty arises when defining measures or indicators that reflect all the dimensions of health and the socioeconomic factors that condition it. Another major problem is often the existing data limitations for many countries and regions.

For this reason, various indirect indicators have been used in the literature to try to approximate the final health results or outcomes of health systems, such as life expectancy or mortality rates. Despite their wide use, these indicators have the disadvantage that they reflect many factors and only some of them can be attributed to the interventions of the health systems (Nolte and McKee, 2004). For this reason, alternative indicators have been sought, more related to health performance.

Rustein et al., (1976) developed the concept of preventable mortality, which is defined as "deaths that should not occur in the presence of timely and effective medical care." This concept

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arises with the aim of being able to more accurately assess the performance of health systems by measuring premature mortality due to causes or diseases susceptible to prevention or treatment, with the aim of being able to design measures that reduce these indicators and improve the results of health. The concept of avoidable mortality (equivalent to the sum of preventable mortality and treatable mortality) has been widely used by researchers and institutions for the evaluation and monitoring of the performance of health systems, such as Mackenbach et al., (1988), Tobias and Jackson, (2001), Nolte and McKee, (2011) AMIEHS European Project (Hoffmann et al., 2013), and institutions as European Commision, (2020).

The OECD and Eurostat have recently updated the calculation methodology of these indicators (OECD and Eurostat, 2019) describing the set of diseases or causes of mortality that are considered preventable or treatable whose definition includes:

- Preventable mortality: Causes of death that can be avoided primarily through effective public health interventions and primary prevention (ie, before the onset of disease/injury, to reduce incidence).

- Treatable mortality: Causes of death that can be prevented primarily through timely and effective health care interventions, including secondary prevention and treatment (ie, after disease onset, to reduce mortality).

The concept of treatable mortality can be used as a proxy indicator to measure the effectiveness of the health system on health outcomes. It reflects the rate for those specific causes of mortality directly related to the interventions of the health system through treatment and secondary and tertiary prevention[4]. It offers more specific information in this regard than crude mortality rates.

Preventable mortality is also a very interesting indicator to complete the analysis of the performance of the health system and offer information for health policy and tend to offer information more linked to primary care activities. However, several specific causes of mortality included in this rate depend on factors that are outside the reach of health systems (related to national health promotion or primary prevention policies), for example, accidental

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injuries, suicides, alcohol and tobacco. consumption, pollution, etc. The next figure shows our scheme of calculation of the avoidable mortality indicators:

Figure 5. Scheme of calculation of avoidable mortality indicators

Source: Own elaboration

ese rates are calculated based on the age limit of 75 years, the age that is taken as a reference to classify a death as premature according to the lowest values of life expectancy of the member states of the EU and the OECD and using the coding by cause of death according to the International Classification of Diseases (ICD-10) of the World Health Organization (WHO). It should also be noted that the classification of diseases or causes of mortality as preventable or treatable has been the subject of various reviews over the years, such as those carried out by (Nolte and McKee, 2011), (Eurostat, 2014a), ONS, (2016) and Canadian Institute for Health Information, (2012). This methodology has recently been jointly updated by the OECD and Eurostat.

Many important elements of an earlier Eurostat list of preventable mortality have been retained in the new joint OECD and Eurostat, (2019) lists that were adopted at the end of 20, including general definitions, selection of many causes of death, and the general age threshold. However, there are also some important improvements, including a mutually exclusive assignment of causes of death into preventable and treatable categories and a greater emphasis on preventable causes of death.

It should be noted that these indicators also have the advantage of being able to be calculated from registration data that exists in all countries (instead of other valuations based on estimates or on surveys and subjective criteria of satisfaction or perception).

Although the OECD publishes preventable mortality indicators for its member countries (38 countries), in the thesis we have expanded this calculation and in Chapter 1 the results of preventable and treatable mortality are shown for a group of 75 countries.

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Based on the lists published by the OECD and Eurostat and the WHO mortality database, the mortality data corresponding to the two types of causes separately have been taken for each country. Once these preventable and treatable mortality rates (per 100,000 inhabitants) are obtained, they are applied to a reference population structure (OECD 2010) to get standardized and comparable rates between countries. This standardization contributes to improving the comparability of the data between countries, by eliminating the possible effects on mortality, derived from the age structure of the population of each country.

These results offer us, for each country, not only the preventable and treatable mortality rates for each country but their breakdown by large groups of diseases or causes of death (cardiovascular, cancer, respiratory diseases, infectious diseases, accidents, etc.). This information and its comparison at an international level are especially valuable when it comes to identifying the priority areas of action for each health system and the types of measures and resources that could be necessary or convenient to improve these results.

It should be noted that, currently, the indicators of avoidable mortality are the reference indicators to measure the performance of health systems in the European Union, as recently established by the European Commission, (2020)

The heterogeneity in both inputs and outcomes by health systems at the international level justifies the need to delve into the origin of these differences and their effects.

Economic importance of health systems

We found diverse evidence based on the economic importance of health and health systems. In this paper, we focus on its importance from a macroeconomic point of view. In the first part of this introduction was established as the Covid-19 pandemic has reinforced this evidence from the point of view of the effects of the crisis (lockdowns, and from the point of view of the measures adopted.

(Jagrič et al., 2020) have recently analyzed the importance of the health sector in 19 European countries and have verified that, in addition to its importance in the health and well-being of the population, it generates positive effects in their respective national economies. These effects occur in terms of added value, employment and household income, especially when compared with other sectors and they consider that it can be an important instrument of economic policy.

Health systems are characterized by being a sector that generates high added value and whose indirect and induced effects are particularly relevant as it is a highly skilled sector that generates high average wages. Other works confirm this evidence, based on the analysis of forward and backward linkages, such as Gutiérrez-Hernández and Abásolo-Alessón, (2021). Boyce and Brown, (2019a), in a report developed for the World Health Organisation, highlight the importance of the health sector for a stable and functioning economy. They highlight its clear positive impact on the other sectors of the economy, by generating quality employment, acting as a buyer of goods and services, and its ability to reduce inequalities and social exclusion. The report shows, through case studies, the value and robustness of the input output methodology as an impact analysis tool applied to the health sector. It shows the results of an impact analysis for 19 countries and according to them, on average, one additional euro spent in the health sector would result in 1.4 € of greater output in the national economies, accounting for direct and indirect effects, and 2.7 € considering the induced effects.

To introduce this work we have calculated the weight of the sector in some national economies of the OECD. Based on the model of Wassily Leontief, (1941), the Hypothetical Extraction Method (HEM) (Dietzenbacher et al., 1993) considers the hypothetical situation in which a certain industry or sector is extracted, virtually, from the economy (not being operational) and offers us the results of this scenario in the input-output tables. Extracting the sector (the coefficients of the sector are replaced by zeros in matrix A and in the Final Demand matrix), it is possible to quantify how much the total output of an n-sector economy would decrease. Therefore, the difference between the initial output $\left(\boldsymbol{x}_j = (\boldsymbol{I} - \boldsymbol{A}_j)^{-1}\boldsymbol{f}_j\right)$ and the output in the extraction scenario $\left(\bar{\boldsymbol{x}}_j = (\boldsymbol{I} - \bar{\boldsymbol{A}}_j)^{-1}\bar{\boldsymbol{f}}_j\right)$ of the sector would indicate the effect that this sector has on the output of an economy and also on its respective sectors. Figure 6 reflects the weight of the health sector in each economy, that is, how much the output of an economy would fall if the sector ceased to exist (it is expressed in negative terms). It has been calculated using the hypothetical extraction method has been used for its calculation.

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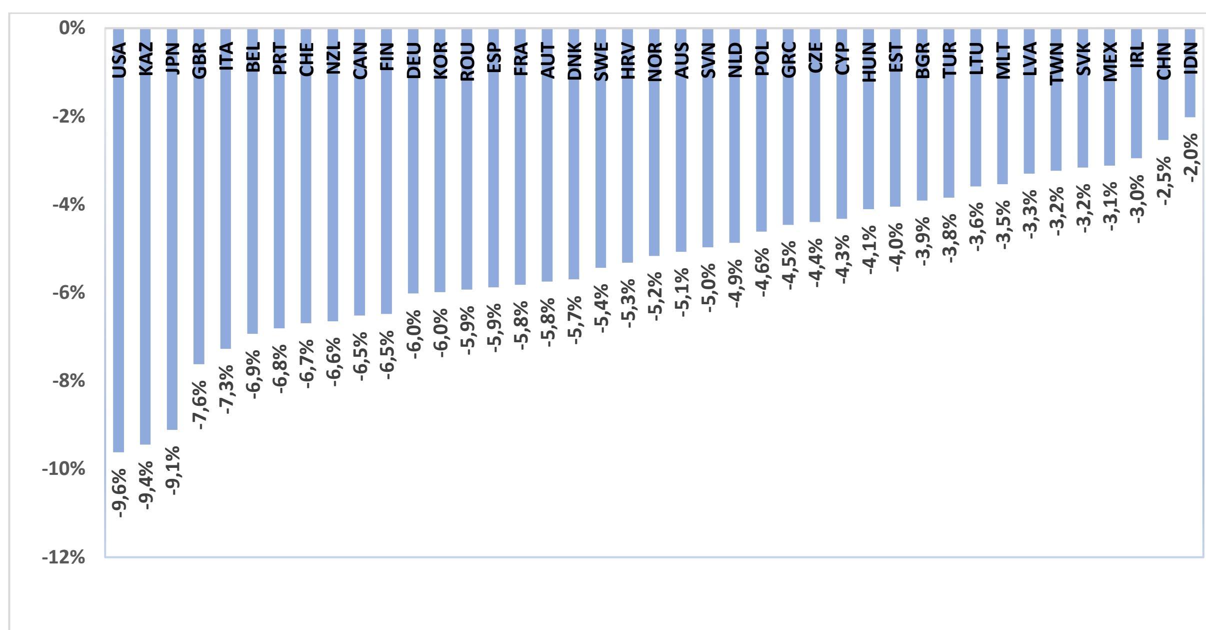
Figure 6. Output decrease with HEM of the human health sector (86) in the OECD countries



Source: Own elaborations using the OECD input-output database

The results show how this sector means between 9,6% of the United States economy and 2% for Indonesia, among the economies considered.

II. Motivation and objetives

This research arises from the common interest of the doctoral candidate and the company Ayeconomics Research Center, S.L., to delve into the study and comparison of the performance of health systems from a health perspective and also from a macroeconomic point of view, given the importance of combining both visions in an attempt to contribute advances in the methodology of evaluation of health systems. For this, a methodological approach has been proposed, including both types of results at an international level. The study is completed with a specific analysis for Kazakhstan, based on the particular situation of the Kazakh health system, whose results in terms of health are below the OECD average and which is in a transition stage from a Semashko health system type that the country try to restructure. Kazakhstan is one of the target markets of Ayeconomics Research Centre, S.L.

In the literature, there are different classifications and comparisons of health systems. Traditionally, the main classifications of these systems are made based on legal, institutional, financing models, etc. (Ferreira and Tavares, 2018) summarize some of these classifications and the criteria used in each of them. However, few studies contemplate the identification of

typologies of health systems based on other production variables and health outcomes. Some recent works have started this path and have oriented their analysis to the need to offer information to health systems on the benchmarking possibilities that can be found at an international level. (Reibling et al., 2019) has developed a cluster analysis that follows this line, combining the comparative-institutional classification with other variables such as indicators on supply, public-private mix, and institutional access regulations from earlier typologies with information on primary care orientation and performance management in prevention and quality of care.

Demonstrated the heterogeneity between the different production systems and taking into account that their objective is common and the most important for a society, we must deepen the study of how health is produced and what results are obtained in each case in order to facilitate the identification of improvement strategies in each country. We will try to answer some questions related to the macroeconomic role of health systems and their performance in terms of health.

In this sense, in this introduction, various examples of works have been described that address the macroeconomic importance of health systems at an international level. We have also verified significant heterogeneity between OECD countries in terms of inputs used and results obtained in terms of health. In this context, aspects have been emerging that we will try to develop in the different chapters of the thesis.

The first question we ask ourselves is: how to measure the outcomes of healthcare systems at the country level? Can it be done in a homogeneous way that we can relate to the different functions of a healthcare system? The objective is not only to have a measure of performance that can be compared but also to provide relevant information for future improvements in healthcare systems. In this sense, avoidable mortality indicators have been chosen, both preventable and treatable, and disaggregated for 12 large groups of diseases. This classification allows us to identify similarities and differences that health systems present in terms of their performance by type of disease. In addition, it also makes it possible to identify which are the critical points by disease groups, to see their position at an international level, for each of them, and helps to identify possible measures to adopt for their improvement.

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We have identified the indicators of preventable and treatable mortality and their distribution by 12 causes of death for a total of 75 countries. To our knowledge, this is the first time that these calculations have been done for this number of countries[5].

The problem with the international comparison is the differences in multiple socioeconomic factors that can condition the health outcomes in each country. In this sense, how can contribute the information of this comparison to the improvement of the health systems included in the study? Based on previous studies about benchmarking and the comparison of health systems, we have applied a cluster analysis. This methodology allows us to identify similarities between countries based on their level of avoidable mortality and the distribution by causes of death. The definition of clusters offers key information for the countries. It is a starting point to analyse the differences and identify the causes for the different results in some cases.

Once identified the results in health in each case, which are the production technology of the health sector in each country? How does each country produce health? and what is the effect of this production technology on the whole economy from the macroeconomic point of view? To answer to this we have applied the methodology that relate a sector with the rest of the economy, the input-output analysis using the OECD database. Previously, we have disaggregated the sector Human Health Activities form the sector Social Services to know its specific effect in the economy using, adittionally, information of the recently published OECD Supply and Use database (OECD, 2020b) and also the information of the WIOD database[6] (WIOD, 2016),(Timmer et al., 2015) to complete the disaggregation for 9 countries.

Once again, we have considered essential to use cluster analysis to facilitate the comparison between groups of countries that are as similar and homogeneous as possible to each other, to promote benchmarking and the identification of the most appropriate policies and measures for each context. It has been developed the identification of typologies of health systems based on their production structure from the Input-Output analysis and the total symmetric matrices published by the OECD. Also, the dentification of typologies of health systems based on the

[5] The OECD publish the total avoidable and preventable mortality data for the 38 countries integrated in the institution.

[6] Accoroing with the database, World Input-Output Tables and underlying data, covering 43 countries, and a model for the rest of the world for the period 2000-2014. Data for 56 sectors are classified according to the International Standard Industrial Classification revision 4 (ISIC Rev. 4). The tables adhere to the 2008 version of the SNA.

matrix of domestic Output and Imports to deepen the origin of this technology and the possible implications from the point of view of health policy decisions.

Once the performance and the productive structure have been analysed separately, can any relationship between the two be identified? Can it be concluded that a certain form of production also entails a certain avoidable mortality due to types of disease? To respond to this, a joint analysis of the typologies found based on the health results and based on the production technology of the countries considered has been proposed. This analysis can show us if we can identify benchmarking possibilities, among countries with similar structures, to improve results in terms of health and contribute to health policy decisions. Also, contribute to the permanent evaluation framework of health systems at the international level with new approaches.

Within the set of countries considered, Kazakhstan presents highly differentiated results in terms of health outcomes and productive structure. In your case, what would be the implications of this type of study for this country at a regional level?. To answer this question, a specific study has been carried out for Kazakhstan, analysing its position at the international level based on the criteria described above and expanding these calculations at the regional level to contribute to public policy decision-making by the policymakers. The table for Kazakhstan has also been regionalized for the first time to analyze the weight and interrelationships of its health sector by region.

Which would be the final result of this work, the main objective. The main objective is to offer a new methodology for the analysis of health systems and identification of typologies at an international level based on the relationship between their productive structure, from the macroeconomic point of view, and their performance in terms of outcomes, measured in this case in terms of avoidable mortality. Also, identify benchmarking possibilities between countries based on this relationship and contributes to the macroeconomic assessment framework for the health systems.

III. METHODOLOGY

This section describes the main methodologies applied in the thesis to develop the objectives proposed.

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Input-output framework

For the analysis of the productive structure of the health sector, we use the input-output model developed by Wassily Leontief, which shows the interdependencies between the different sectors of the economy. In the model, it is considered that each sector is both a producer and a consumer.

The Input-Output tables show in their rows how the production value of each industry (goods) is distributed to all other industries and to other non-producing end users (final demand). The table represents the elements of the Input-Output matrix and the interrelations between the sectors (Miller & Blair, 2009). Each column reflects the consumption of each industry or sector (inputs), of the other sectors, to carry out their own production process. The last column of the table 2 reflects the gross production of each sector (sales), while the last row reflects the total purchases of each sector, plus the added value generated by each sector, that is, the output generated by each sector.

Table 2. Symmetric Input-Output Tables Scheme. Total Matrix of Interindustry Flows

but		BUYING SECTORS					FINAL DEMAND	TOT. OUTPUT (X_i)
		S1	**…**	**Sj**	**…**	**Sn**		
SELLING SECTORS	**S1**	Z_{11}	…	Z_{1j}	…	Z_{1n}	f_1	X_1
	…	…	…	…	…	…	…	…
	Si	Z_{i1}	…	Z_{ij}	…	Z_{in}	f_i	X_i
		…	…	…	…	…	…	…
	Sn	Z_{n1}	…	Z_{nj}	…	Z_{nn}	f_n	Xn
VALUE ADDED		VA_1	…	VA_3	…	VA_5		
TOT. OUTPUT (X_j)		X_1	…	X_j	…	Xn	Fn	$\sum X_i=\sum X_j$

Source: Own elaboration

Where:

- S: Sectors of the economy (1, …, n)
- X: Total output (production) of the economy
- X_j: Total output (production) of the sector j
- Z_i: Interindustry sales by sector i
- F_i: Total final demand for sectoral production that integrates household consumption, government spending, investment and exports)

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The row sum of interindustry exchanges and final demand components must be equal to an industry's total output. For the whole economy, total output production must be equal to the total output employments.

Table 3. Symmetric Input-Output Tables Scheme. Domestic Flows and Imports (DOMIMP)

			BUYING SECTORS					FINAL DEMAND				TOT. OUTPUT (X_i)
			S1	…	Sj	…	Sn	Dom. Demand	Cross-border exports	Direct purchases non residents	Direct purchases abroad	
SELLING SECTORS	DOMESTIC	S1	Z_{11}	…	Z_{1j}	…	Z_{1n}	f_1				X_1
		…	…	…	…	…	…	…				…
		Si	Z_{i1}	…	Z_{ij}	…	Z_{in}	f_i				X_i
			…	…	…	…	…	…				…
		Sn	Z_{n1}	…	Z_{nj}	…	Z_{nn}	f_n				Xn
	IMPORTS	S1	Z_{11}^m	…	Z_{1j}^m	…	Z_{1n}^m	f_1^m				X_1^m
		…	…	…	…	…	…	…				…
		Si	Z_{i1}^m	…	Z_{ij}^m	…	Z_{in}^m	f_i^m				X_i^m
			…	…	…	…	…	…				…
		Sn	Z_{n1}^m	…	Z_{nj}^m	…	Z_{nn}^m	f_n^m				X_n^m
	VALUE ADDED		VA_1	…	VAj	…	VAn					
	TOT. OUTPUT (X_j)		X_1		X_j		Xn	Fn				$\sum X_i = \sum X_j$

Source: Own elaboration

The Leontief model can be expressed by distinguishing, within the production of each sector, the part of that production that is generated within the economy itself and the part that is obtained through imports from other countries. The table 3 show the intersectoral flows detailing both origin (see Table 3).

Disaggregation of the Health sector and the social services sector

Considering the importance of comparability of data from our study, the symmetric tables of the OECD have been used in the input-output analysis (both total and domestic +imports) as they offer the most recent homogenized tables and for a greater number of imports. countries at present.

In the OECD tables, the health sector (86) appears aggregated with the social services sector 87T88). However, the OECD has recently published Supply and Use tables (SUTs) for most of these countries and this has allowed us to see that the weight of both sectors differs greatly between countries, given that, unlike the symmetric tables, both sectors are disaggregated.

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Through a correlation analysis of each of the sectors by country, we have been able to contrast the need to disaggregate the health sector and analyse its effects separately.

Although throughout the thesis this information is developed in greater detail, it should be noted that, in order to carry out this disaggregation, we have had to identify the individual weight of each of the sectors for each country. For this we have started from the data available in the tables of USE and destination of the OECD (year 2018 or nearest) for those countries for which they are published and in the remaining cases we have resorted to the supply and use tables of the WIOD database (year 2014). Despite the difference in the year of publication of both databases, we have integrated the information from both, because we consider that changes in the productive structure, in general, are not usually significant in such a short period of time.

Using the methodology published by the OECD and Eurostat for this purpose, we have transformed the SUTS into symmetric tables and we have obtained the weights of the health sector and the social services sector for each country. These weights have been used to multiply them in the symmetric matrix by the aggregate sector of each country and thus calculate the rows and columns of both sectors separately.

Based on the information available, it has finally been possible to complete this process for a total of 41 countries, being, to our knowledge, the first time that this breakdown has been obtained for this set of countries. For our knowledge is the first time that this disaggregation is developed for all these countries.

The cluster analysis applied to the Health Systems. An approach for the benchmarking

Applied to our study, the clustering is a methodology that allows us to identify and classify, based on the information available, clusters of countries at an international level. In this way, the countries that make up each cluster will be as similar as possible to each other and as different as possible from the members of the other clusters. That is, it allows us to group the countries with homogeneity criteria, measuring the divergence between them by calculating the distance between them. There are several formulas to measure these distances, although the most common is the Euclidean distance:

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$$d(x,y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2}$$

Thus, given the study countries, for which a series of variables are available, the distance between them gives us an idea of how close or far these countries are depending on how different their values are for the variables considered. Distance measurements must always satisfy the properties of non-negativity and symmetry:

$$d(x,y) \geq 0 \quad \& \quad d(x,y) = d(y,x)$$

There are several clustering methods. In our case, we have opted for the K-means method, which is a direct iterative procedure through which, after defining some initial clusters with a certain location or centroid, in each iteration each observation is assigned to the closest cluster. Once assigned, the centroids are recalculated, and the process is repeated until the centroids do not change. The choice of this method is based in the previous utilization and validation in previous studies of the health systems by authors as Reibling et al., (2019) and (Lotrič Dolinar et al., 2019).

These methods have allowed us to identify groups of countries similar to each other in terms of avoidable mortality and productive structure. We believe that this information can be very useful so that countries can see their international position from a macroeconomic perspective and even identify strengths and weaknesses and possible improvement strategies.

All of this, without prejudice to the necessary adaptation of all this information to the context (socioeconomic, environmental, etc.) of each country.

The 2DLQ method.

To regionalize the Input-Output table of Kazakhstan we have applied a method derived from the location coefficients. These types of methods allow the generation of regional tables in a consistent and robust way but at an affordable cost. The Simple Location Quotient (SLQ) is the most common approach, which compares the relative weight of a given industry sector in a region with its relative weight in the country as a whole.

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Pereira-López et al., (2020) propose a new approach (2DLQ) based on the performance of bidimensional location quotients for constructing input–output tables. This method uses sectoral degrees of specialization at the sub-territorial level (by rows) with an alternative formulation that excludes the sub-territorial effect size at global level.

IV. RESEARCH STRUCTURE

The chapter 1 develops the analysis of the avoidable mortality indicators for 75 countries. Applying a two-stage cluster analysis, country clusters were firstly identified based on total preventable and treatable mortality indicators for each country. In the second step of the cluster analysis, new subclusters have been identified within each cluster from step 1, now based on the distribution of this preventable and treatable mortality by disease group.

This has allowed us to see, for countries with similar levels of preventable and treatable mortality, which are more similar to each other when comparing the causes of mortality for each of them.

In chapter 2**,** after disaggregating the health sector from the social services sector, it has been possible to identify again different clusters and typologies of health systems, but in this case, based on the production structure of the sector, that is, on its technology. of input-output production. Once again, a two-stage cluster analysis has been applied with the aim of classifying the countries in the most useful way possible for the objectives of the thesis. In this way, first 2 clusters based on the production technology extracted from the total symmetric IO table have been identified. Subsequently, in the second step, new subclusters have been identified based on the production structure of each country but broken down into the domestic part and imports. This new grouping of countries has allowed us to identify those with the greatest affinity in terms of the origin of their inputs and their relationship with the domestic economy of their country.

In the Chapter 3 we specifically analyse the case of Kazakhstan, as it is a country with a differentiated behaviour in terms of health outcomes and also in terms of productive structure. For this, the IO table of Kazakhstan has been regionalized for the first time and the production structure of the health sector for each region has been analysed. In addition, following the study scheme proposed in the thesis, the indicators of preventable and treatable mortality at the regional level have been calculated to compare them with the results of the productive structure in each case.

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V. RESEARCH CONTRIBUTIONS

The first contribution of this work is the international comparison of the outcomes of the healthcare systems for 75 countries in terms of avoidable mortality indicators**.** It allows for first time, the identification of conglomerates of countries that have a similar performance, not only in terms of preventable mortality through prevention and treatment, but also in terms of how this mortality is distributed according to the large groups of diseases in order to know their relative position. Identification of benchmarking possibilities. In this sense, the results obtained constitute an interesting contribution to the extent that they make it possible to identify benchmarking possibilities between countries and to relate these results with the measures to be adopted for their improvement through prevention and treatment. The OECD publish these indicators for its members, 38 countries. Our study increases the number of countries with these control indicators to 75 countries, almost the double that the published by the OECD.

Additionally, our analysis, disaggregating the avoidable mortality by preventable and treatable causes of death, offer specific information about the performance of each country by type of causes of death.

Combining this information with the input-output analysis for the disaggregated sector offers us an important overview about the way to produce health and the origin of the inputs to do it. All this information is crucial to assess the performance by causes of death and to identify the dependence of the sector respect other sectors in the domestic economy and the dependence of the imports too.

The results allow us to study the relationship between avoidable mortality (preventable and treatable) and the production structure of the health sector for a total of 41 countries. This has allowed us to confirm the heterogeneity of the countries both in terms of avoidable mortality and in terms of productive structure and the need to compare and identify typologies at the international level.

We have developed the regionalization of the table of Kazakhstan and the obtaining, for the first time, of the indicators of preventable and treatable mortality by groups of diseases for each region. Joint analysis about the outcomes and the production structure of the sector provides specific results for Kazakhstan and their regions to facilitate decision-making by policymakers.

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CHAPTER 1

The impact of the Health Care Systems in terms of outcomes. International analysis based in Avoidable Mortality Indicators

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1.1 INTRODUCTION

Although, evaluating health systems was already a key issue in the literature, it is the Covid-19 international crisis that fosters the health system (HS) performance as a priority on the political agendas and as the main interest of the societies. In this context, policymakers need to assess the quality of their HS based on its results, i.e., evaluating the HS outcomes. Therefore, to improve HS performance they need to identify the priority areas of intervention, allowing them to focus on the HS main deficiencies to improve health quality in a more effective way, also preparing HS for facing future challenges such as the increase in chronic diseases, appearance of new infectious diseases or the population aging.

As Joumard et al., (2010) point out, the most practical and effective way to increase HS efficiency is to borrow the most appropriate elements from other similar HS, i.e., to find benchmarking countries. Additionally, it must be considered that HS can have good performance for a particular illness (area of intervention) and be really bad on others or to only perform really well in a particular type of intervention (ej. hospital or primary care). In fact, the distribution of causes of death is key for the country benchmarking since countries with the same mortality rate can have very different mortality structures, and vice versa (Lotrič Dolinar et al., 2019).

For this reason, the objective of this chapter is to develop a system to identify the priority areas for intervention that countries should target based on avoidable mortality indicators, distinguishing the mortality rates for 12 groups of preventable and treatable causes according the methodology of OECD and Eurostat, (2019). At the same time, this work aims to provide a new international classification of health systems based on performance measured through these indicators. This approach creates conglomerates of countries also with the same level of HS performance but with different distributions of avoidable mortality by the types of preventable and treatable illness that can be used as benchmarking approach for decision makers.

To identify types of healthcare systems based on their performance in terms of outcomes, we have applied the methodology of OECD and Eurostat, (2019) and, additionally, a two-step

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cluster analysis to classify countries with a similar distribution of preventable and treatable mortality by illness within the same level of avoidable mortality, i.e., global HS performance.

Most of the literature on HS classifications, which can be useful for identifying benchmarking countries, are mainly based on HS institutional aspects, financing and HS outputs such as medical activities, number of patients or hospital discharges, forgetting about health outcomes, i.e., what it is directly linked to HS main objective: population health. Ferreira et al., (2018) mentions some of these previous classifications and the criteria used. Recent works have applied clustering methods for the classification of health systems and the approximation of benchmarking possibilities between countries as Reibling et al., (2019). They do not use health outcomes as the criteria to identify the clusters, although they have included some variables related to the performance of primary care as a control. The work of Lotrič Dolinar et al., (2019) includes standardized indicators of mortality from different causes of disease, although it only considers 3 large groups of diseases: neoplasms, diseases of the circulatory system and diseases of the respiratory system. More recently, Ivankova et al., (2021) tried to analyze the association between health spending, economic prosperity, and the performance of health systems. To do this, they performed a cluster analysis based on economic indicators (health spending and GDP) and also on indicators of treatable mortality, although it only includes those derived from diseases of the circulatory system and endocrine, nutritional and metabolic diseases.

The contribution of this work is the creation of a new benchmark system that allows countries (i) to identify the areas of intervention or priorities they should target by focusing on the illness with preventable and/or treatable mortality higher than other countries with similar levels of HS performance (similar levels of avoidable mortality). (ii) to identify if their needs for intervention are more severe in the primary care (high preventable mortality) or hospital (high treatable mortality) and (iii) to identify the countries with a similar level of HS performance that are performing better preventing or treating this illness to use them as a good benchmark to search for solutions. These clusters provide additional information on health systems and their effectiveness in prevention and treatment. They allow us to identify urgent points of improvement for each country, offering policymakers support for the adoption of public policies. Moreover, to develop this system we have calculated the avoidable indicators distinguishing by treatable and preventable mortality for a total of 75 countries, 37 countries additional to those published in the report Health at Glance (OECD, 2021a).

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In the following section a review of the literature on this subject is developed and the methodology applied is detailed in point 1.3. The results obtained and the discussion about them are described below in section 1.4. Finally, the section 1.5 show the conclusions of this chapter.

As a summary of the results obtained, indicate that a total of 3 clusters of countries have been identified based on their total level of preventable mortality and 10 subclusters based on the distribution of mortality according to the different preventable and treatable causes. The similarities and differences between them offer an important starting point for the benchmarking based in health outcomes and focused in specific intervention areas.

1.2 Literature review

Starting from the 1960s, a wide range of papers have classified health systems, aiming to analyze and compare the performance of healthcare systems in order to give new insights for effective health policies. Ferreira et al., (2018) review some of these classifications, such as those proposed by Field, (1973), Wendt, (2009), EU, (2012) or Böhm et al., (2013) which have used criteria related to financing, regulations, provision, or other institutional aspects (governance, etc.). In addition, to institutional perspective (supply, public-private mix, access regulation, primary care orientation) Reibling et al., (2019) introduce some health outcomes indicators to classify Health Systems. These outcomes indicators such as asthma and chronic obstructive pulmonary disease, congestive heart failure and hypertension, diabetes as well as 30-day mortality after hospital admission per one hundred hospital discharges, acute myocardial infarction, hemorrhagic stroke and ischemic stroke) were included as control variables and not as the main classification criteria.

However, as Joumard et al., (2010) highlights HS performance should be measured in terms of outcomes because they are the main objective of the HS. Lotrič Dolinar et al., (2019) which have developed HS classifications based exclusively on outcomes; in this case, they use age-standardized mortality rate by cause of death, gender, and age group. They argue that ”when making cross-country comparison, which can provide new ideas for effective health and demographic policies, it is important to consider both the mortality rate and the distribution of causes of death because countries with the same mortality rate can have very different mortality structures, and vice versa” and they prove that this classification is much more useful for

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identifying effective policies than classifications using other health outcomes indicators such as life expectancy at birth.

In this sense, an appropriate outcome indicator that accounts for national differences in age structure is key to evaluating HS performance. Life expectancy indicators and crude mortality rates have been widely used in the literature to measure the performance of health systems. However, they have the disadvantage that their results cannot be directly attributed to healthcare interventions. Some indicators such as disability-adjusted life years (DALYs) or years of healthy life lost due to disability (YLDs) adjust the indicators for the time lived in states of less than full health and account for better HS performance than life expectancy. However, interpreting YLDs and DALYs can be challenging, and they can have comparability issues that would invalidate the benchmarks based on them. They are compiled based on sources of information that present some variability between countries, as well as methodological difficulties such as spatial smoothness that may affect their interpretation and comparability (European Commision, 2020).

Considering the difficulty of addressing all the health dimensions with a single indicator, in this study have been selected the indicators of avoidable mortality, as a measure of outcomes of the health systems and as sensitive indicators of their effectiveness. Allin and Grignon, (2014) consider the avoidable mortality as a tested indicator to assess the quality of the health systems and they highlight that the distinction between preventable and treatable causes of mortality is especially useful to decide the more effective interventions and evaluate the impact of the health policies. They highlight that the limitations attributed to these indicators do not exclude their validity, but rather that they must be applied and interpreted taking into account the context of the study.

Avoidable mortality is defined as “deaths that should not occur in the presence of timely and effective medical care”. It was developed in the 70s [12] and widely used by researchers and institutions for the evaluation and monitoring of the performance of health systems. Indicators of avoidable mortality allow us to assess and monitor the effectiveness and performance of health systems and medical care based on the objective of avoiding premature mortality (OECD, 2019), through effective public health and primary prevention interventions, i.e., before the onset of diseases/injuries, to reduce the incidence or the timely and effective health care interventions, including secondary prevention, detecting the disease and preventing its

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development and the treatment and the rehabilitation in each case, i.e. after the onset of diseases, to reduce case-fatality. Thus, treatable causes of death reflect those specific causes directly related to the health system interventions through the treatment and secondary and tertiary prevention, while preventable causes of death are related to primary prevention, i.e., when the disease has not yet appeared.

Thus, avoidable indicators separating between preventable and treatable mortality by cause of death give additionally information and ideas to police makers than the analysis and classification of Lotrič Dolinar et al., (2019). By adding these types of indicators, we can approximate HS performance of primary care (preventable) and hospital care (treatable).

Several studies have used this type of indicator to study the performance of health systems. This is the case of Nolte and McKee, (2011) with their study of trends in amenable mortality in 16 high-income countries. In 2018, Karanikolos et al., (2018) analized trends in amenable and other mortality in the EU since 2000, across 28 EU countries to study the effects of global financial crisis and its aftermath impact upon the performance of the HS.

Petrie et al., (2015) propose a new health indicator: Realization of Conditional Potential Life Years (RCPLY) that accounts for avoidable mortality and the available resources across countries. Although, it is a really interesting proposal, this indicator is not considering the distribution of causes of death, which is one of the main aims of this paper.

1.3 METHODOLOGY AND DATA

1.3.1 THE CALCULATION OF THE AVOIDABLE MORTALITY INDICATORS

The Avoidable mortality rates ((t_a) are calculated as age-standardized death rates for the list of causes of death classified as avoidable (preventable and/or treatable):

$$t_a = \sum \frac{P_{ej}}{P_e} * t_j$$

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i.e., crude mortality rates (tj) weighted by standardized population, (Pej) rate of each age group j (j = 1,…,n), where "n" is the number of age groups considered. When we standardize death rates by age groups, we are taking into account the differences in age structures of the populations across countries and time, allowing an adequate comparison of results (OECD and Eurostat, 2019). It should be noted that life expectancy and age structures are really different across the countries that are considered in this paper. For example, the life expectancy at birth is 68 years in Mongolia and 84 in Japan (World Health Organization, 2022), and in several causes of death the probability of dying increases with the age.

Pe is the total standardized population and $t_j = \frac{c_j}{P_j}$. is the specific rate of the j_{th}, being cj the number of death cases in the jth age group j=1,…,n. Pj is the standard population of the j_{th} group.

To identify the causes of death that are preventable or/and treatable, i.e. avoidable, we use the list jointly developed by OECD and Eurostat, (2019). They are based in previous lists taken as a reference for the determination of specific causes of mortality as preventable and/or treatable (for example, Nolte and McKee, (2011), Eurostat, (2014), Office for National Statistics, (2016) and Canadian Institute for Health Information, (2012). The list is defined under the following assumptions:

- The age limit considered for calculating preventable or treatable mortality rates is less than 75 years. This reference age for considering a dead as premature is based on the lowest values of life expectancy in the EU and OECD member states.
- The attribution of causes of death to the category of preventable or treatable mortality is based on the criterion of whether it is predominantly prevention or healthcare interventions that can reduce these causes of death.
- Causes of death that can be largely prevented and also treated once they have occurred are attributed to the preventable category.
- Causes of death should generally not be split as partially preventable and treatable given the lack of evidence to do so accurately and systematically, except where there is no strong evidence of dominant position, in which case a 50%-50% allocation was used.

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• There is no double counting of the same causes of death between the two lists.

• Causes of death representing a very small number of deaths are excluded to keep the lists as concise as possible.

Data

Avoidable indicators, both treatable and preventable disaggregated by groups of causes of death are calculated based on the information from the mortality database of the World Health Organization (WHO, 2022b) using the list 104 of causes (detailed) from the revisions of the International Classification of Diseases, ICD-10 (WHO, 2010). The following considerations have been taken into account (OECD and Eurostat, 2019):

• WHO only publishes medically certified deaths. Diagnoses on causes of death by lay people are not included.

• Following the OECD and Eurostat recommendations, only deaths up to 74 years of age have been considered.

• The year of reference is 2017; i.e., most recent year that most of the countries have data available. For those countries without data available in 2017, we use the latest year published in the WHO Mortality Database (updated in February 2022).

• WHO database offers mortality data disaggregated by sex, and this would enrich the results. However, we have aggregated them since population data by sex was not available for all countries.

• Yearly data for the population between 0 and 4 years was not available either; for this reason, we have to proceed to aggregate the group 0-4 years.

• We have used the total population data published by United Nations Population Division (UNSTAT, 2017) by countries and age groups. The population considered to calculate them are residents who die inside or outside their country of origin.

• To standardize, we have applied the OECD 2010 Standard Population (OECD, 2021b) measured by 100.000 inhabitants.

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• Missing values in most of the countries on the sample on cases of death related to pregnancy, childbirth, and the perinatal period force us to aggregate them with causes related to congenital malformations.

• The pool of countries remaining is 75, presenting most of the big regions of the world. The list of countries appears in the Table 1. This list includes those countries that present mortality data by five-year groups in accordance with list 104 of the ICD-10 classification, to apply the Eurostat/OECD methodology with the appropriate level of disaggregation. Those countries that presented a preventable or treatable mortality rate equal to zero have not been included, considering that it is not possible, which makes us think of possible methodological discrepancies in the registration of mortality by death causes that should be studied in depth.

1.3.2 THE TWO-STAGES CLUSTER ANALYSIS

In the absence of a standard and perfect method for classifying health systems, cluster analysis has become one of the methods used to define typologies and analyze their characteristics and results. The application of this methodology has allowed us to identify the groups of countries that are closer in terms of avoidable mortality in levels (distinguishing between preventable and treatable) and within each of this clusters we identify a set of subclusters based on the similarities for the distribution for preventable and treatable mortality by causes of diseases.

To identify groups of countries with similar health sector performance at aggregate level but with important differences by type of illness, we performed a cluster analysis which was developed in two steps:

1 First step: We apply the cluster analysis based on the total rates of treatable and preventable indicators. Thus, on this step we will get groups of countries with similar levels of avoidable mortality. Once we have comparable groups of countries in terms of levels of avoidable mortality, we attempt to identify subclusters with similar distribution by causes of death among them in a second step.

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2 Second step: For each of the cluster that we get in the first step, we run again a separate cluster analysis, this time based on the main groups of causes of death both in preventable and treatable causes of death. The groups of diseases proposed by the OECD/Eurostat lists are: infectious, cancer, endocrine and metabolic, diseases derived from the systems nervous, circulatory, respiratory, digestive and genitourinary, diseases derived from the pregnancy, childbirth and perinatal period, diseases due to congenital malformations, due to adverse effects of medical and surgical care, due to injuries and due to alcohol and drugs.

Since we want to identify groups of countries with different distributions of causes of death when the aggregate performance is similar, we need to standardize the indicators to avoid the effect of a greater weight of some causes of mortality that they have by construction (for example, some groups of illness include a large number of causes of deaths). The standardization of each indicator will do based on:

$$S = (x - x_{min})(x_{max} - x_{min})$$

Similar to Reibling et al., (2019) or Lotrič Dolinar et al., (2019), we apply two different clustering methods to assess the robustness of the results and cluster consistency:

a) **The K-Means method** attempts to create groups as homogeneous as possible within the members and heterogeneous from other groups by minimizing the squared of the standard Euclidean (L2) distance between each unit (x) and the centroid (ci):

$$MIN_{SSE} = \sum_{j=1}^{k} \sum_{x \in c_i} L_2(c_i, x)^2$$

b) **Hierarchical Agglomerative Clustering** based on the Ward linkage method (HW) create each group as homogeneous as possible by minimizing intra-Cluster variability, and incorporating into each cluster those observations that generate a smaller increase in the mean of the quadratic distance (SS) of each element from the centroid, in an ascending (agglomerative) way:

$$SS_{12} = (SS_1 + SS_2)$$

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To obtain the optimal number of clusters for both techniques, we apply the Calinski – Harabasz pseudo-F Index Stopping-rule, CH(K), (Calĩnski and Harabasz, 1974):

$$CH(K) = \frac{SS_B}{SS_W} * \frac{N-k}{k-1}$$

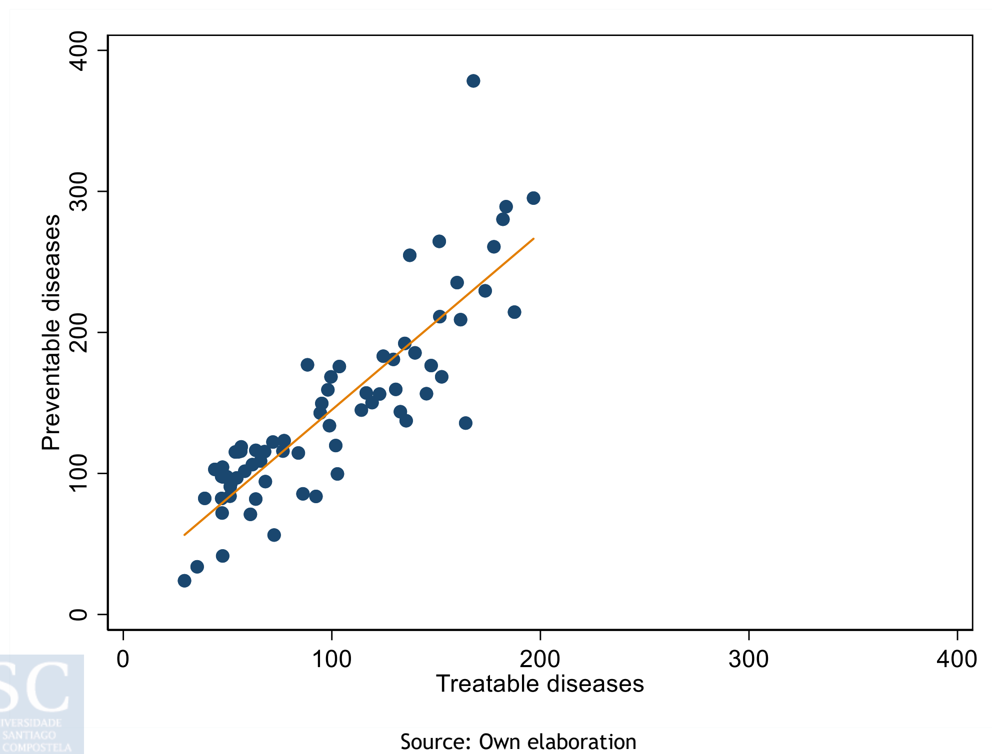
being K the number of clusters, N the number of observations (83 countries), SS_W the intra-cluster variation (within the cluster), and SSB s the inter-cluster variation (between clusters).

1.4 Results and discussion

1.4.1 Results

Data about global preventable and treatable rates by country is displayed in Figure 7 (detailed data in the Table 4 in the appendices of the chapter). In general, we can observe a high correlation between preventable and treatable ratios; i.e. those countries with a high number of preventable deaths also show a high number of treatable deaths.

Figure 7. Deaths due to Preventable and Treatable Diseases by Country (per 100.000 inhabitants)



Source: Own elaboration

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Additionally, there are important differences in levels of preventable and treatable mortality between countries going from ratios below 100 to ratios over 300. Countries with the highest ratios are Mongolia, Kyrgyzstan, Belarus or the Republic of Moldova.

The international Clusters and Subclusters of Health Care Systems

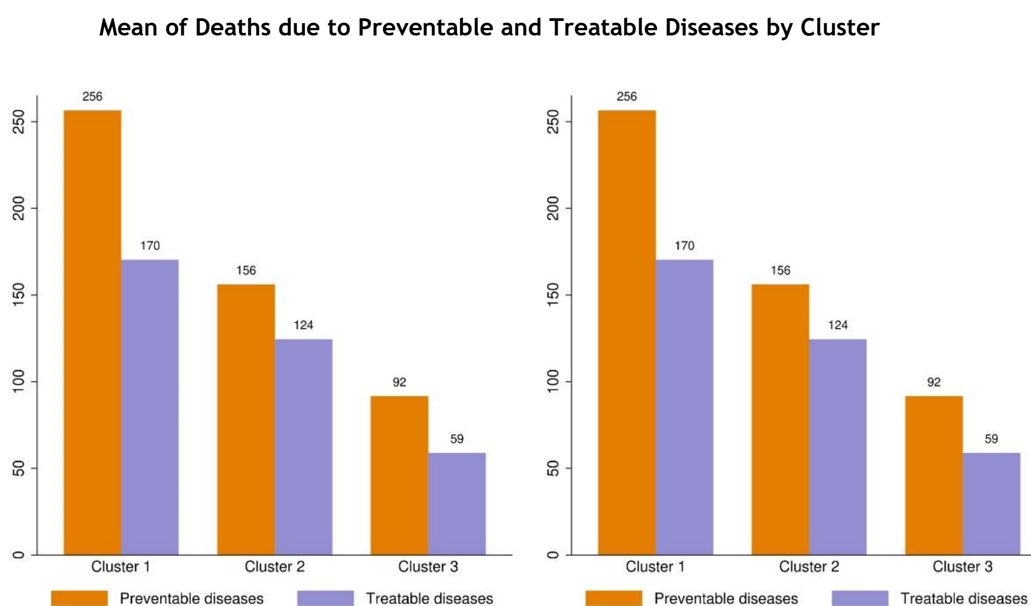
As we have described in the methodology, the cluster analysis has been performed in 2 stages. In the first step, we group the countries according to their levels of preventable and treatable mortality ratios. Following the Calinski-Harabasz Stopping-rule, the optimal number of clusters is 3 using both K-Means and Hierarchical Clustering Methods.

Clusters analysis results from both methodologies are robust: only 1 country (Jordan) would change their position between clusters classifications, proving the robustness of the results.

As we can see in Figure 8, on average, there are important differences between the 3 clusters in terms of deaths due to preventable and treatable diseases.

Figure 8. Cluster Analysis-First Step (Hierarchical Wards and K-Means Methods).

Mean of Deaths due to Preventable and Treatable Diseases by Cluster



Source: Own elaboration

Cluster 1 includes those countries with larger values of deaths due to treatable and preventable diseases, in particular, when we refer to preventable diseases. Among other, this group of

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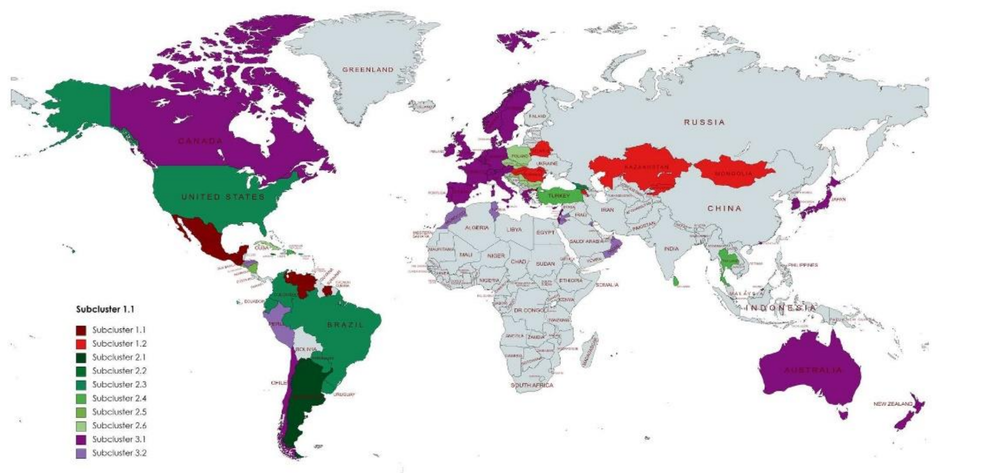
countries includes post-Soviet Union countries and some countries from Latin-America (See Table 2).

On the other hand, on average cluster 3 shows a lowest values of preventable and treatable mortality with values under 100 by 100.000 inhabitants. These countries include European countries, Australia, New Zealand, Japan and some North of African countries among other (See Table 1). Between these two groups of countries are cluster 2, including those countries which don't show the lowest nor the highest values in terms of preventable and treatable mortality. Some of the countries included in cluster 2 are from Latin-America, East European countries, United States, among others (See Table 1). As we have mentioned before, results stand with both clusters methodologies, confirming the robustness of the results.

In the second step, we sub-divide the first conglomerates taking into account the type of illness within the clusters of the first step. We can see the results in the map, in the Figure 9:

Figure 9. Second - Stage Cluster Analysis. Map of Countries by Subcluster



Source: Own elaboration

Applying the second stage to the clusters, it would come up 10 subclusters. Each of them is integrated by the countries showed by the Table 5 (appendices of the chapter).

Within Cluster 1, the one with the highest mortality levels of the 3 Clusters obtained within the first step, diseases of the circulatory system are the ones with the highest mortality rates, both from the point of view of preventable and treatable pathologies, followed by diseases related to cancer (see Figure 10). In the case of subcluster 1.2, mortality rates are more widely distributed

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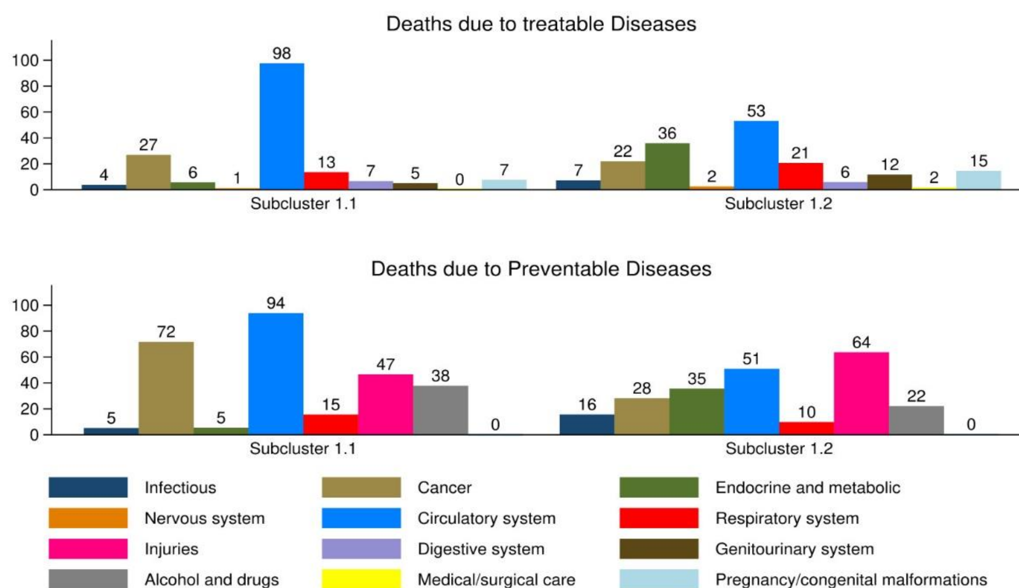
among the different causes of death, highlighting mortality due to treatable diseases of the circulatory system and preventable diseases related to injuries.

Figure 10. Cluster Analysis-Second Stage (Hierarchical Wards Method). Mean of Deaths due to Main Groups of Preventable and Treatable Diseases. Cluster 1. Optimal Sub-clusters: 2



Source: Own elaboration

Among the treatable causes of mortality, circulatory diseases are the first cause in the 2 subclusters followed by the cancer and the endocrine and metabolic diseases. In the subcluster 1.1, the diseases of the circulatory system have a much higher mortality than other causes (3 times greater than the next cause, which is cancer).

The subcluster 1.2 is characterized by a more uniform distribution of mortality from different causes, being the first again, the diseases of the circulatory system, followed by endocrine and metabolic diseases, cancer and diseases of the respiratory system.

As for deaths from preventable diseases, those derived from the circulatory system predominate again, followed by accidents, cancer and deaths from alcohol and drugs. In the subcluster 1.1 highlight the mortality due to circulatory system diseases and the cancer, but it presents an important mortality due to injuries and alcohol and drugs. In the subcluster 1.2, the most important cause of preventable mortality are the injuries followed by the circulatory system diseases and the endocrine and metabolic diseases.

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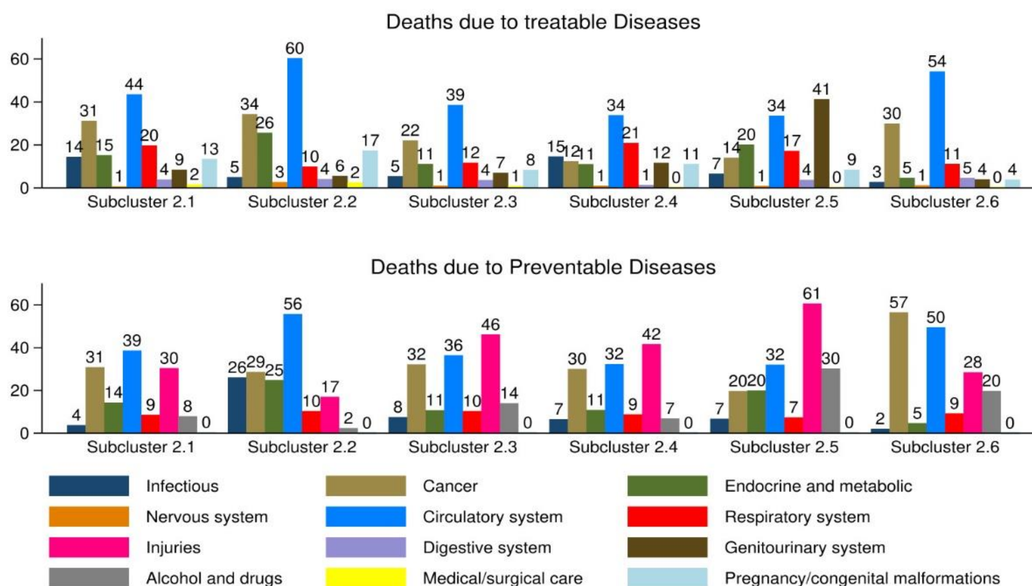
The cluster 2 presents 6 optimal subclusters Figure 11. In all of them, those related to the circulatory system clearly highlight as the main causes of treatable mortality, with the exception of subcluster 2.5, where they are surpassed by mortality related to diseases of the genitourinary system.

Figure 11. Cluster Analysis-Second Stage (Hierarchical Wards Method). Mean of Deaths due to Main Groups of Preventable and Treatable Diseases. Cluster 2. Optimal Sub-clusters: 6.



Source: Own elaboration

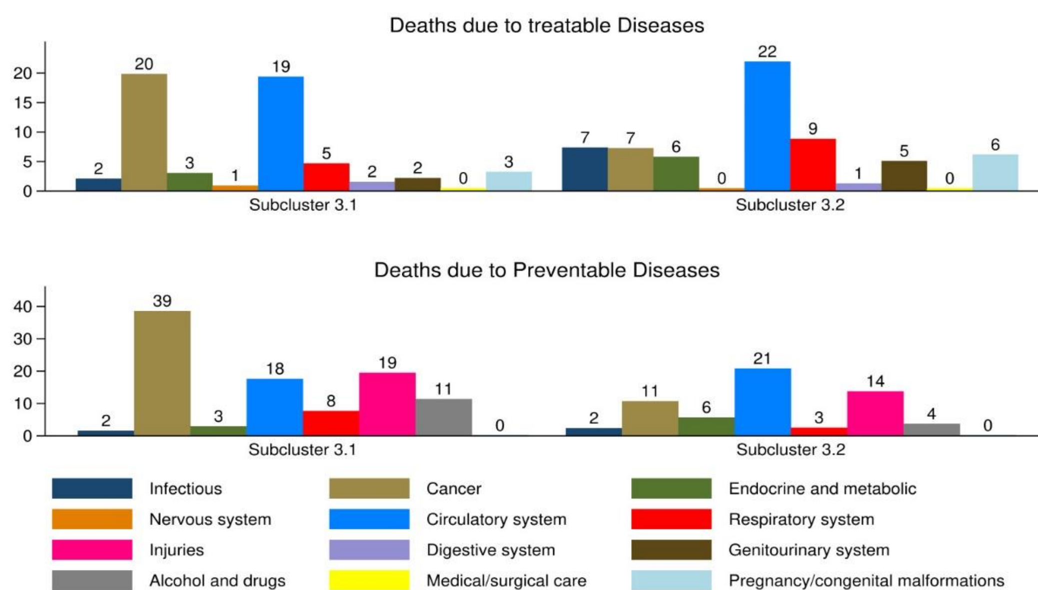
The third leading cause of death is cancer-related diseases. Regarding deaths due to preventable causes, the circulatory system diseases predominate in subclusters 2.1 and 2.2, being surpassed in subclusters 2.3, 2.4 and 2.5 by injuries, with a particularly high value in the case of subcluster 2.5. In cluster 2.6, cancer is the leading cause of preventable death.

Regarding the total standardized mortality rates, subcluster 2.2 is the one with the highest mortality rates due to treatable causes and 2.6 is the one with the highest preventable mortality rate. The cluster 3 includes 2 subclusters (Figure 12). When analyzing them, we see that in cluster 3.1, the causes of mortality related to diseases of the circulatory system and cancer stand out almost equally. For its part, in group 3.2, deaths from diseases of the circulatory system clearly predominate, followed by diseases related to the respiratory system.

In relation to preventable diseases, in cluster 3.1, it highlights mortality related to different types of cancer, while in cluster 3.2, mortality derived from diseases of the circulatory system predominates again, followed by deaths due to injuries. As we have mentioned before, in general

terms for preventable and treatable mortality rates, they are also really correlated by type of illness, i.e., countries reporting high ratios of treatable deaths in particular diseases also show high level of preventable deaths for the same diseases.

Figure 12. Cluster Analysis-Second Stage (Hierarchical Wards Method). Mean of Deaths due to Main Groups of Preventable and Treatable Diseases. Cluster3. Optimal Sub-clusters: 2.



Source: Own elaboration

1.4.2 DISCUSSION

As a result of the two-stage cluster analysis, countries are grouped into subclusters with similar distribution of treatable and preventable mortality rates by illness within a larger cluster of countries with similar total level of preventable and treatable mortality rates (first step cluster). Since avoidable mortality indicators approximate the effectiveness of the health system, this classification allows countries to use as reference countries that perform better than them in particular types of illness within a similar level of health system performance on average (i.e., other subclusters within the same cluster in step 1), or to target countries similar illness distribution but with a much better health system performance on average (i.e., comparing subclusters from different cluster in step 1). In this section we present some examples, without being exhaustive, about how subclusters can be used to identify priority areas of intervention and benchmarking countries for searching for solutions.

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Subclusters 1.1 and 1.2 as part of cluster 1 are the ones showing the lowest effectiveness of the health system analyses, i.e., countries belonging to these clusters have extremely high mortality rates for a number of groups of pathologies, both, preventable and treatable: infectious diseases, endocrine and metabolic diseases, respiratory diseases, preventable injuries, treatable digestive system diseases. There is also a high mortality rate from adverse effects of medical or surgical care and diseases related to pregnancy or congenital malformations. Mainly consisting of Latin American and Caribbean countries, subcluster 1.1 has the highest preventable and treatable mortality from pregnancy-related diseases and congenital malformations.

Subcluster 1.2 relative to subcluster 1.1 shows higher mortality from respiratory diseases both preventable and treatable. One of the causes that may be behind this high number of mortalities by respiratory diseases is air pollution due to primary reliance on solid fuels for cooking and heating (World Health Organization, 2017) and a low level of urbanization (World Bank, 2017).

Household combustion of solid fuels may also have adverse effects on pregnancy outcomes (Santos, 2018), which is noteworthy considering the high mortality rates from pregnancy-related diseases in SubCluster 1.2 countries.

The countries in SubCluster 1.1 and SubCluster 1.2 are characterized by abnormally high mortality rates from preventable diseases related with alcohol and drugs compared with the rest of sub-clusters, and from circulatory system diseases, both preventable and treatable, even when compared to subcluster 1.2 countries. Indeed, according to The World Bank, (2015), the countries of this group, except for Armenia and Uzbekistan, had higher than average per capita alcohol consumption in 2015 (the latest available data before 2017), while indicators for Belarus (12 liters), Republic of Moldova (11.9), Romania (11.6), Hungary (11.6) and Mongolia (11) were among the top 30 countries. Although there were many European countries with bigger levels of per capita consumption, including Czech Republic (14.3), Germany (13.1), France (12.6) and Ireland (12.5), researchers argue that types of beverage consumed and drinking patterns play an important role, too [28]. According to WHO Global Health Observatory (Global Change Data Lab, 2016a), countries in subcluster 1.2 usually consume spirits as a primary beverage type, with Kyrgyzstan (86.2%), Armenia (82.3%), Uzbekistan (56.9%), Mongolia (54,5%) and Belarus (49%) having significant shares of spirit beverages in total alcohol consumption. Strongly linked with the risk of ischemic heart disease [30], irregular binge drinking pattern accounts for high mortality from circulatory diseases in these countries. Mostly composed of Post-Soviet and Soviet

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influence countries, spontaneous heavy drinking (traditionally vodka) is common for this group (Popova et al., 2007), (Pajak and Kozela, 2011). Romania and Hungary, for example had more than half of the adult drinkers who had heavy episodic drinking in past 30 days, while in Mongolia, Kyrgyzstan, Republic of Moldova and Armenia that number was between 40% and 50% (Global Change Data Lab, 2016c).

Another factor to explain the level of cardiovascular disease mortality in these countries may be psychosocial one. Pointing to a strong correlation between wealth psychosocial stress (depression, anxiety, low social position, poor job conditions) may lead to higher mortality from circulatory system diseases (Pajak and Kozela, 2011), (Kopp et al., 2007). Psychosocial factors may also explain high level of mortality from preventable cancer diseases in SubCluster 1.1 countries (Thacker et al., 2007).

We can start identifying illnesses where each sub-cluster underperforms within cluster 2. If we compare subcluster 2.1 with the rest of the subclusters, we can see that countries from Subcluster 2.1 (together with subcluster 2.2 that took part of the subcluster 2.1 in some robustness checks with a different sample of countries) have higher mortality rates among treatable group of diseases, caused the pregnancy and congenital malformations diseases being more than 3 times higher than the average of subcluster 2.6 (reference subcluster in this case). Among the main preventable causes of adverse pregnancy outcomes, the researchers note teenage pregnancy andshort inter-pregnancy intervals (Swaminathan et al., n.d.), (Mignini et al., 2015), (Hosny et al., 2017).

In fact, according to The World Bank data for 2017 on average countries from subcluster 2.1 and 2.2 shows adolescent fertility rate, i.e. births per woman aged 15-19 (e.g. Argentina - 62.8, Barbados- 33.55, St Luc´ıa - 40.54, Jamaica - 52.8) significantly higher than countries in Subcluster 2.6 with the extremely low adolescent fertility rates (e.g. Croatia - 8.7, Poland - 10.5, Czech Republic - 12.0, Serbia - 14.7) as well as lowest preventable mortality from pregnancy.

Subcluster 2.3 and 2.4 show a similar pattern by pathology mortality rate both for preventable and treatable and they have been grouping in the same subcluster in one of the robustness checks done. These subclusters are quite on the average and they are not performing worse than all the others in any cluster neither the benchmark for any of illness, with the exception of the circulatory system, both treatable and preventable where they perform quite well. Anyway, we can still

identify their key points of intervention, such as preventing injuries in subcluster 2.3 and treating respiratory diseases in subcluster 2.4. Namely, relatively high levels of deaths from injuries in subcluster 2.3 countries may have been caused by long-distance travels leading to higher numbers of automobile deaths in large countries such as the United States and Brazil (Baker et al., 2018).

Clearly, the main point that health systems should address in Subcluster 2.5 is the treatment of diseases related with the genitourinary system. In fact, this group of countries have extremely high mortality rates from treatable diseases of the genitourinary system, higher than any other subcluster, both from its same cluster (step 1) or from any other cluster that performs worse in average terms.

There is a considerable amount of research on causes of the chronic kidney disease in the Caribbean countries. Those studies argue that the main determinants of the kidney disease in El Salvador and Nicaragua may be environmental and job-related exposure to chemicals, heat and physical workload in agriculture (Navarro et al., 2015), (Anastario et al., 2020), (Ramírez, 2013).

The subcluster 2.6 shows similar levels of treatable mortality rates to cluster 3, i.e. the cluster performing in average terms, and it's the preventable mortality which sets them within cluster 2 countries. Additionally, it is the best in coping with Infectious, Endocrine & metabolic and Pregnancy & congenital malformations diseases being 3-4 times lower than the rest of subclusters of its group and with similar values to sub-clusters that performs better in average term. However, these groups of countries have high rates of mortality from cancer and circulatory system diseases, both preventable and treatable. In particular, preventable mortality linked with cancer is much higher in subcluster 2.6 than the rest of the subclusters with similar levels of effectiveness (cluster 1). Although, there are a lot of types of cancer and we should check which have the higher mortality, one of the cancers that can be preventable is the one related with smoking. In fact, according to the WHO data for 2016 (Global Change Data Lab, 2016a), all countries in the subcluster - Serbia (41,2% of the adult population), Bulgaria (40.1%), Croatia (36.3%), Slovakia (32.1%), Czech Republic (31.9%), Poland (27.4%) and Cuba (28.6%) - are marked by relatively large proportions of adult smokers compared with data with countries from subcluster 2.4 and 2.5 (Dominican Republic - 10.1%, Sri Lanka-23.3%, Thailand - 23.6%, Turkey - 29.8%, El Salvador - 13.3%). Additionally, it should also be noted that all of the countries, except for Croatia and Cuba, are among the top 30 with high alcohol consumption per capita (Global Change Data Lab, 2018), which is positively correlated with the risk of cardiovascular diseases (CVD). However,

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unlike SubCluster 2.2 countries with higher mortality from CVD, countries in Subcluster 2.1 may be distinguished by the predominant consumption of low-alcohol beverages (beer, wine) and regular moderate drinking (instead of binge drinking).

Countries in subcluster 3.1 and 3.2, belonging to cluster 3 in step 1, are the ones showing a better health system performance for both preventable and treatable diseases and injuries, as we have shown in the results section. Subcluster 3.1 is represented by a large number of countries; most of them are developed nations of Central and Western Europe, East Asia and the Commonwealth, and 23 of 27 are OECD members. These countries are characterized by more favorable socioeconomic conditions and quality of the healthcare. However, they show 2-4 times higher values of preventable and treatable cancer diseases mortality than in subcluster 3.2. They perform worse than subcluster 3.2 and similar to other subclusters in cancer pathology, both in treatable and preventable. One of the reasons, can be that these countries are able to detect a higher number of cancers that before where not treated. Actually, there may be inconsistencies in cross-country data on avoidable mortality because of differences and peculiarities in diagnostic practices and coding of causes of death. The problem is exacerbated by the difficulty of identifying a single underlying cause of death for people who suffer from several chronic conditions, especially among the elderly (Kossarova et al., 2012).

On the other hand, Subcluster 3.2 consists mainly of high- and middle-income Arab countries (except for Honduras and Peru). In contrast with subcluster 3.2, these countries have remarkably low mortality rates from alcohol- and drug-related illnesses, which can be primarily attributed to the strong influence of Islamic culture. Still, attention must be drawn on the relatively high mortality rate from endocrine and metabolic disease and deaths related to pregnancy and congenital malformations, which researchers have recently linked to obesity, especially among women (Jahan, 2016). According to 2016 WHO data (Global Change Data Lab, 2016b), Kuwait (37.9%), Oman (27%), Tunisia (26.9%) and Morocco (26.1%) were among the top 50 countries with the greatest share of adults who are obese.

Note that part of the interventions to avoid mortality, in particular related with prevention may be linked with policies outside of the health system. The factor outside health sector linked with the weak correlation of health care inputs is the reason why some researchers have challenged the viability of using avoidable mortality indicators as a proxy for healthcare quality (Mackenbach et al., 1988) (Kunst et al., 1988), such as reducing poverty, water access, reducing pollution, etc.

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We should note, however, that most of the variables used in those studies to explain the level of avoidable mortality, including healthcare expenditure, number of medical personnel or hospital beds, are quantitative indicators and do not reflect the quality of care (Kossarova et al., 2012). Additionally, we are using the indicators to identify urgent point of intervention and not only as a general measure of effectiveness or quality of health system.

We are aware that big countries such as China, India, Russia or regions such as Sub-Saharan African and South-East Asian countries are not present in the analysis due to data availability. However, we consider that this would not affect the validity of the results, since based on the preliminary results from a pool of 110 countries just 3 countries change subcluster. For the results in this paper, we drop the countries reporting 0 in the mortality rate of in some groups of illness assuming that their data may be compromised.

Considering the above-mentioned limitations, along with low availability of comparable data across countries, the concept of avoidable mortality offers an important starting point to analyze the performance of healthcare systems. Used under scrupulous consideration of those limitations, research based on avoidable mortality may help identifying weak healthcare provision areas and reform priorities (Joumard et al., 2010).

Although these are preliminary explanations of the underlying factors, this analysis provides the first clues to their identification and may help formulate adequate health policies at the state level. Further study of the functional significance of these associations is required to be able to develop evidence-based policies, although is out of the scope of this paper.

1.5 CONCLUSIONS

A proper performance of the health system is essential for archiving a good health status and well-being of the population, and as a result, a sustainable economic growth throughout the increase of healthy workers productivity. The cluster analysis can provide benchmarking possibilities by identifying different causes of death distributions within countries with similar levels of avoidable mortality providing transferrable lessons to health managers and policy makers.

Our approach based on avoidable mortality indicators, both preventable and treatable, uses a two-step cluster analysis to identify countries with similar distributions of avoidable mortality (second step identification) within cluster of countries with similar performance in terms of health (first

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step identification). In this process, we are able to identify other subclusters with similar level of global health system effectiveness but with a different pattern of illness, and this can be used as a benchmark to identify and improve the areas that need it the most.

Based on study results, countries were grouped into 3 clusters based on total avoidable mortality data (first step):

- Cluster 1 with some countries of Latin America (Mexico, Venezuela, etc.), Central Asia and East Europe (Kazakhstan, Belarus Hungary, etc.) has an extremely high level of avoidable mortality, both in preventable and treatable.

- Cluster 3 with European countries, Australia, New Zealand, Japan and some North of African countries among other show the lowest levels of aggregate preventable and treatable mortality rates.

- Cluster 2 with most of Latin America countries, United States of America and some of Balkans (Serbia, Croatia) and East Europe (Bulgaria, Czechia, Poland, Slovakia) is characterized by a medium level of avoidable mortality rates between cluster 1 and cluster 3.

Each of these clusters was divided in subclusters in the second step with similar distributions of causes of death trying to find benchmarking possibilities for the other subclusters within the same cluster level in step 1. Thus, cluster 1 is divided in two subclusters that can use each other as a reference for some points of intervention: subcluster 1.1 with the highest level of preventable and treatable mortality of circulatory and cancer diseases among all subclusters and subcluster 1.2 that, even if it presents a more uniform distribution of cause of death, has a much higher level of endocrine and metabolic diseases both preventable and treatable and of treatable respiratory mortality rates than cluster 1.1.

This will be the primary point of intervention of each subcluster that can search for effective policy ideas in the neighbor subcluster: checking treatments and procedures of Health Systems, particularly, on hospital care when it refers to a high level of treatable mortality relative to the other subcluster and prevention policies within and outside of the HS when it refers to preventable mortality.

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In a similar way, cluster 2 is divided in 6 subclusters that can be used as a benchmark for each other. In this case, subcluster 2.1 and subcluster 2.2 shows 3 times higher than the average of subcluster 2.6 (reference subcluster in this case) treatable mortality caused by the pregnancy and congenital malformations diseases. Thus, it is also important to ensure that pregnant women receive the necessary medical care and support during pregnancy and childbirth to avoid high mortality rates and subcluster 2.6 can be a reference for these countries. Cluster 2.6 can also act as a reference of the key point of intervention of subcluster 2.5, i.e., the treatment of diseases related with the genitourinary system. Although, subcluster 2.6 performs better than the rest subcluster within cluster 2, showing similar pattern to countries in cluster 3, still can find important points of intervention and benchmarking since it presents higher values of cancer diseases that other subclusters and like values of in cluster 1. Other points of intervention are preventable injuries in subcluster 2.3 and treatable respiratory illness in subcluster 2.4 acting subcluster 2.2 since it performs better.

Finally, cluster 3 is divided in 2 subclusters that can also act as references of each other: subcluster 3.1 composed mainly by western European countries with high level of cancer, both treatable and preventable and subcluster 3.2 includes mainly of high- and middle- income Arab countries showing a very low level of mortality from alcohol. The explanation can be that alcohol consumption is generally prohibited in Islamic countries. However, the cluster demonstrates a relatively high mortality rate from endocrine and metabolic diseases and deaths related to pregnancy and congenital malformations.

This approach offers an important overview of the health systems performance at international level. It allows to identify and compare the priority areas in terms of avoidable mortality, preventable and treatable. This information is the starting point to find effective solutions to avoid the preventable mortality through primary prevention and other public health measures and the treatable mortality through the timely and effective health care interventions, treatment and secondary prevention.

Cluster results can be used to identify key health problems and needs in a particular population or region, and to prioritize policy efforts accordingly. Additionally, the study provides distinct subgroups of countries that can be used to identify best practices and evidence-based approaches for each illness in preventable and treatable. Thus, countries grouped in subclusters within the same cluster (first step) can exchange benchmark policies and measures in successfully coping

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with particular diseases and learn from each other's experiences in order to improve their own healthcare systems. As a result, research findings can be an important source of evidence for policymakers in shaping policy recommendations. However, a detailed analysis evaluating the policies and intervention by illnesses in each cluster to identify the most promising approaches and to assess their impact on health outcomes, is out of the scope of this paper.

Although we are aware that measuring or evaluating the performance of health systems requires a more complex analysis, we believe that the analysis of the indicators of avoidable mortality, both preventable and treatable, offers important starting information, since the classification based on the causes of death offers a key insight into the results of the system. This is the first step before introducing different socio-economic variables that can affect health outcomes and can contribute to differences between countries to more precisely assess the health sector performance.

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APPENDICES TO CHAPTER I

Table 4. Deaths due to preventable and treatable diseases by country (per 100.000 inh.)

Deaths due to Preventable and Treatable Diseases by Country. Year:2017 or nearest)					
Country [1]	Preventable	Treatable	Country	Preventable	Treatable
Argentina	137	136	Kyrgyzstan	295	197
Armenia	209	162	Lebanon	42	48
Australia	98	48	Luxembourg	97	54
Austria	115	55	Malta	94	68
Barbados	110	164	Mauritius	214	188
Belarus	289	184	Mexico	211	152
Belgium	115	54	Mongolia	378	168
Brazil	192	135	Morocco	24	29
Brunei Darussalam	136	164	Netherlands	98	50
Bulgaria	177	148	New Zealand	106	62
Canada	116	56	Nicaragua	169	153
Chile	123	77	Norway	98	47
Hong Kong SAR	82	64	Oman	56	72
Colombia	143	94	Paraguay	160	131
Costa Rica	115	84	Peru	86	86
Croatia	176	104	Poland	168	100
Cuba	183	125	Portugal	109	66
Cyprus	72	47	Puerto Rico	145	114
Czechia	150	95	Republic of Korea	103	44
Denmark	119	57	Republic of Moldova	280	182
Dominican Rep.	144	133	Romania	235	160
Ecuador	134	99	Réunion	122	72
El Salvador	186	140	Saint Lucia	157	145
France	104	48	Serbia	157	117
Georgia	150	119	Slovakia	181	130
Germany	116	64	Spain	91	51
Greece	116	77	Sri Lanka	129	114
Guatemala	229	174	Suriname	211	182
Honduras	34	35	Sweden	93	52
Hungary	255	137	Switzerland	82	39
Ireland	102	58	Thailand	156	123
Israel	71	61	Tunisia	34	35
Italy	84	51	Turkey	120	102
Jamaica	165	167	United Kingdom	115	68
Japan	82	47	USA	177	88
Jordan	100	103	Uruguay	159	98
Kazakhstan	265	152	Venezuela	261	178
Kuwait	84	92			

[1] The lists of reference are the 104 (ICD10 4 (detailed) character list). The countries that publish their data according to the list 103 are excluded of the analysis. The data year of reference is 2017, i.e., most recent year that most of the countries have data available. For those countries without data available in 2017, we use the latest year published in the WHO database. The exceptions are Barbados (2013), Honduras (2013), Jamaica (2014), Sri Lanka (2014), Suriname (2014), Saint Lucia (2015), Serbia (2015), France (2016), Mongolia (2016), Morocco (2016), New Zealand (2016), Norway (2016), Réunion (2016), Venezuela (2016), Belarus (2018), Kazakhstan (2018), Ireland (2018), Turkey (2019).

Source: Own elaboration

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Table 5. Cluster Analysis - Stage 2. Countries by cluster and subcluster

Cluster 1	Cluster 2	Cluster 3
(1.1) Guatemala	(2.1) Argentina	(3.1) Australia
(1.1) Mauritius	(2.1) Barbados	(3.1) Austria
(1.1) Mexico	(2.1) Brunei Darussalam	(3.1) Belgium
(1.1) Suriname	(2.1) Saint Lucia	(3.1) Canada
(1.1) Venezuela	(2.2) Jamaica	(3.1) Chile
(1.2) Armenia	(2.3) Brazil	(3.1) Hong Kong SAR
(1.2) Belarus	(2.3) Colombia	(3.1) Costa Rica
(1.2) Hungary	(2.3) Ecuador	(3.1) Cyprus
(1.2) Kazakhstan	(2.3) Georgia	(3.1) Denmark
(1.2) Kyrgyzstan	(2.3) Paraguay	(3.1) France
(1.2) Mongolia	(2.3) Puerto Rico	(3.1) Germany
(1.2) Republic of Moldova	(2.3) USA	(3.1) Greece
(1.2) Romania	(2.3) Uruguay	(3.1) Ireland
	(2.4) Dominican Republic	(3.1) Israel
	(2.4) Sri Lanka	(3.1) Italy
	(2.4) Thailand	(3.1) Japan
	(2.4) Turkey	(3.1) Lebanon
	(2.5) El Salvador	(3.1) Luxembourg
	(2.5) Nicaragua	(3.1) Malta
	(2.6) Bulgaria	(3.1) Netherlands
	(2.6) Croatia	(3.1) New Zealand
	(2.6) Cuba	(3.1) Norway
	(2.6) Czechia	(3.1) Portugal
	(2.6) Poland	(3.1) Republic of Korea
	(2.6) Serbia	(3.1) Réunion
	(2.6) Slovakia	(3.1) Spain
		(3.1) Sweeden
		(3.1) Switzerland
		(3.1) United Kingdom
		(3.2) Honduras
		(3.2) Jordan
		(3.2) Kuwait
		(3.2) Morocco
		(3.2) Oman
		(3.2) Peru
		(3.2) Tunisia
(1.1) - Subcluster 1.1 (1.2) - Subcluster 1.2	(2.1) - Subcluster 2.1 (2.2) - Subcluster 2.2 (2.3) - Subcluster 2.3 (2.4) - Subcluster 2.4 (2.5) - Subcluster 2.5 (2.6) - Subcluster 2.6	(3.1) - Subcluster 3.1 (3.2) - Subcluster 3.2

Source: Own elaboration

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CHAPTER 2

International comparison of Health Care Systems based in their productive structure

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2.2 Introduction

The heterogeneity of health systems at the international level implies different ways of producing health, which is the main objective of the sector and constitutes the most important right for the population.

To translate policies and resources into better performance at the national and international level, especially considering the effects of globalization, it is essential to have information and evaluation systems that allow the identification of the key areas on which to act, the strategies to be developed and the necessary resources, to develop the smart investments needed in the long term. A recent publication of the World Health Organization (WHO, 2022) offers a conceptual framework for the health system performance assessment based on 4 dimensions: structure (inputs), process, outputs, and results. In this sense, we consider crucial to offer studies that strengthen this evaluation framework, considering aspects as important as the macroeconomic results of health systems in relation to their productive structure, sectoral interdependencies, as well as the economic implications of the sector for the whole economy. It is expected that the study of these dimensions will allow a better understanding of health systems and priority areas of intervention.

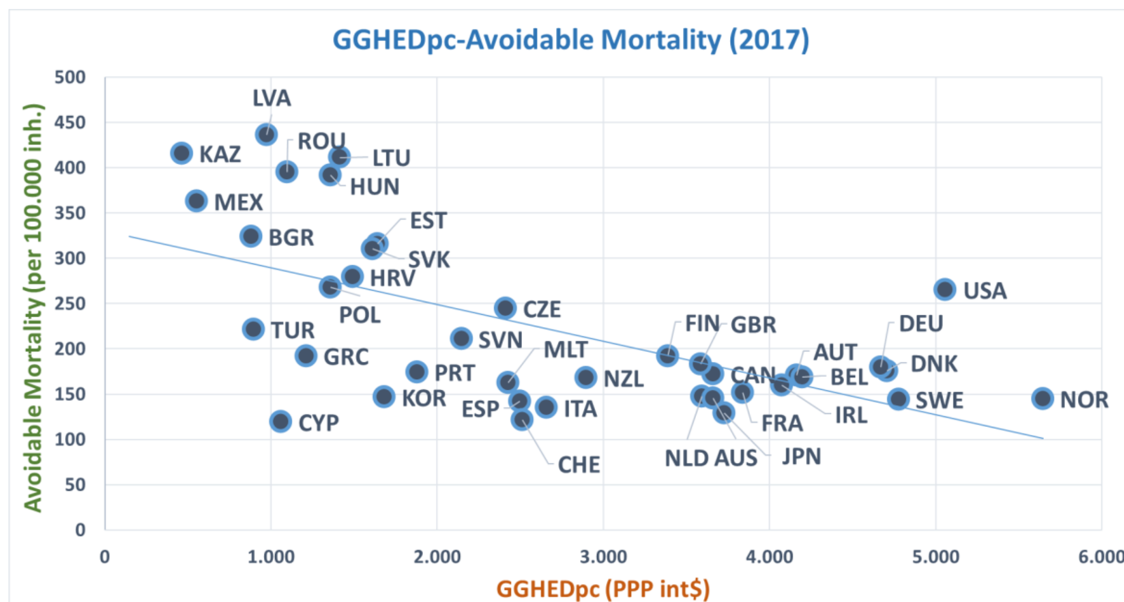
The objective of this chapter is to contribute to this evaluation framework combining two types of results. On the one hand, to analyze the productive structure of the health systems through the IO analysis and the identification of conglomerates and typologies at an international level based on the similarity or disparity in their respective productive structures. In addition, we have compared the health results obtained for each conglomerate to verify the potential relationship between the typologies of productive structures and the health results, measured in terms of avoidable mortality.

Our hypothesis is that the typology of the productive structure, conditions the results in terms of health. In this sense, when comparing the health results between these conglomerates, different results would indicate the importance of the productive structure in the efficiency of the health systems. However, similar results in health would indicate the presence of other factors to consider in the analysis. In any case, different production structures imply a different distribution of the economic impact of this sector, which also generate key information about their economic role in each case.

The typologies of health care systems constitute an important tool to identify similarities and differences between health systems and identify benchmarking possibilities. There are important differences at the international level in terms of regulation, financing models, provision, expenditure, performance and impact of the different health systems.

The figure 13 shows other example of the heterogeneity between the countries considered, comparing, for each of them, the relationship between the public expenditure and the performance in terms of the avoidable mortality across an adequate prevention or treatment. The countries that are above the trend line present a higher avoidable mortality, in relation to their per capita expenditure.

Figure 13. Relationship between the GGHE per capita (PPP int$) and the avoidable mortality indicators[7]



Source: Own elaboration based in WHO Mortality Database and Global Health Expenditure Database. PPP Int$.

In general, a certain trend towards lower avoidable mortality can be observed in the graph in those countries with higher health spending. Cyprus presents the best mortality and spending values, while the United States presents a high avoidable mortality despite incurring one of the highest per capita expenses (only surpassed by Norway). Nevertheless, the results show an important heterogeneity and how countries with similar levels of per capita spending present very different avoidable mortality rates. This is the case of countries like Switzerland, Spain or Italy whose results in terms of avoidable mortality are even better than those of countries like

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[7] Standardized rates (per 100.000 inh.)

Sweden or Norway whose per capita spending is approximately double. The different performance of the Health Care Systems justifies further studies and comparisons to deep in the possible causes of such unequal results.

To analyze the productive structure and the sectoral interrelationships of the different health systems in the economy as a whole, the input-output framework is used, as the only tool that offers this possibility. The basic information from which an input–output model is developed is contained in an interindustry transactions table. The rows of such a table describe the distribution of a producer's output throughout the economy. The columns describe the composition of inputs required by a particular industry to produce its output (Miller & Blair, 2009).

Additionally, a cluster analysis is applied to identify conglomerates of countries with similar production structure and to define typologies at international level. Finally, these results are compared with the health results obtained for these countries in the chapter 1 in terms of avoidable mortality.

To the best of our knowledge this is the first study based on the cluster analysis of the input-output production technology to identify different typologies of health sectors between the countries considered.

The integration of these concepts in the analysis allows, not only a better knowledge of the health systems and the health production, but also the identification of benchmarking possibilities at international level. These results may constitute an important addition to the Health Systems Performance Assessment systems. They integrate an assessment of the production structure and its sectoral and economic impact associated with the performance and the health outcomes.

The reminder of this chapter is estructured as follows. The section 2.2 presents the literature review. Sections 2.3 and 2.4 describe the methodology and databases used in this study. Section 5 shows the main results and discussion about the identification of the typologies of production by cluster. The final conclusions are developed in the section 6.

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2.3 Literature review

From the economic point of view, the report of the WHO Commission on Macroeconomics and Health (WHO, 2002) already evidenced the role of this sector as a key determinant of economic development and poverty reduction.

Suhrcke *et al.*, (2006) review the evidence of the different positive effects of health and health systems in aspects such as disease costs; the impact of health at the individual and family level; the macroeconomic impact of health, the 'full income' impact of health, and the impact of the health system on the economy. According to Cylus *et al.*, (2017), the health systems provide crucial support for the health, the well-being and quality of life of the population, social protection, reduction of impoverishment associated with poor health, active aging and the reduction of demands associated with preventable illness and premature mortality (health care services, pensions, welfare payments, etc.).

The typologies of health systems and the cluster analysis

In the literature, the heterogeneity of the health systems has been reflected in several types of classifications at international level. In general, these classifications are based in financing systems, or institutional, legal or administrative aspects.

Ferreira and Tavares, (2018) offer a summary of these previous classifications such as those made by (Field, 1973), based on criteria such as stewardship, ownership or autonomy of the doctor; funding-based classifications such as those developed by WHO, (2000) or the classifications by Wendt (2015) and (Böhm et al., 2013) based on funding, provision and regulation criteria.

Finally, they propose a new classification of the countries of the European Union based on the cluster analysis applying variables of provision, generation of resources and financing. They found 5 groups of countries 1) Austria-Germany, 2) Central and Northern Countries, 3) Southern Countries, 4) Eastern Countries A and 5) Eastern Countries B, characterized by a diversity of socioeconomic characteristics among the groups and different outcomes in terms of health.

In the absence of a standard and perfect method for classifying health systems, cluster analysis has become one of the methods used to define typologies and analyze their characteristics and

results. The clustering analysis has been already applied in the literature to classify and identify typologies of health systems (Reibling et al., 2019), use the clustering analysis method to identify conglomerates of countries based on five theoretical dimensions as supply, public-private mix, access regulations, primary care orientation, and performance. On the other hand, (Lotrič Dolinar et al., 2019), have applied the same method using a classification of causes of death to identify clusters between the EU28 countries.

The identification of typologies offers key information about the health systems, their position in the international context and facilitates the identification of the benchmarking possibilities between them.

The input-output framework

Based in the input-ouput model of Wassily Leontief, previous analyses have applied the Input – Output methodology to analyze the impact of the health sector. Yamada and Imanaka, (2015), applied the input-output methodology to estimate the economic impact of medical care in Japan and examined its estimation range with a probabilistic sensitivity analysis. They estimated un impact about two to three times the medical care expenditure, like another important industrial sectors of the country.

Jagrič et al., (2020) have calculated the input-ouput multipliers to analyze, for 19 european countries, the economic impact of the change in spending on the health sector in the output, households' incomes, the employment, the value-added of the national economies and the imports. They found that the importance of the sector is related with the level of development with more important benefits in the case of countries with lower levels of GDP.

Gutiérrez-Hernández and Abásolo-Alessón, (2021) have used the IO framework for 2010 to analyze the importance of the health sector in the European Union. The results obtained showed the key importance of the sector to generate value added and employment but it present direct backward and forward linkages lower than the average for the rest of the sectors.

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2.4 METHODOLOGY AND DATA

The Input-output framework and the production technology

As Miller and Blair, (2009) describes "the fundamental information used in input–output analysis concerns the flows of products from each industrial sector, considered as a producer, to each of the sectors, itself and others, considered as consumers. This basic information from which an input– output model is developed is contained in an interindustry transactions table. The rows of such a table describe the distribution of a producer's output throughout the economy. The columns describe the composition of inputs required by a particular industry to produce its output".

The production equation of the Leontief model (Leontief, 1936) can be expressed, in matrix notation, as:

$$x = Z_i + f$$

Where:

- x: Total output (production) of the economy.
- Z_i: Interindustry sales by sector i.
- f: Total final demand for sectoral production that integrates household. consumption, government spending, investment and exports.

The amount of output produced in that sector "j" in a specific year, determine the necessary inputs from other industries "i", to achieve that production. In this sense, the technical coefficients are defined as the quotient between each element of the matrix of intermediate transactions and the effective production of the corresponding branch of activity and represent the proportion of each input in the production process., i.e., the production technology:

$$a_{ij} = \frac{z_{ij}}{x_j}$$

The terms of the formula are:

- a_{ij}: Technical coefficients, where j = 1, …, n (n is the number of products)
- z_{ij}: Value of the input "i" bought by producers of the sector "j", the last year, to produce X_j
- x_j: Value of the production of the sector "j"

This ratio can be interpreted as the monetary value of inputs from sector "i" per unit of monetary unit of output produced by the sector "j". The model implies that the technical coefficients represent fixed proportions, i.e., they measure fixed relationships between a sector's output and its inputs.

The matrix of Input-Output technical coefficients (a_{ij}) shows for each branch of homogeneous activity the relative weights or input-output coefficients used by the sector of each one of the intermediate consumptions to develop its production. In this sense, the column vector of each sector represents the production technology of that sector, i.e., how produce each sector in terms of the composition of inputs employed in its production. It offers an important overview of the sectoral costs structure in each country.

The international comparison of the production vector of the Human Health Sector offers an interesting overview about the similarities and differences in the producing way of the countries, heir sectoral cost structures and their possible implications.

The input–output framework is made up of three types of tables: supply and use tables and symmetric input– output tables.

The dependence of domestic consumptions and imports

In addition to the study based on the production technology in the total IOTs, the technical coefficients extracted from the domestic and import matrices have been considered. The reason for their use is that they complement the information on the way of producing and the impact of health systems. These coefficients provide us with additional information on the origin of the sector's inputs, their domestic impact and their greater or lesser dependence on imports.

The dependence study is done across the imports needs coefficients that reflect the unitary value of necessary imports of good "i" to produce the good "j".

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$$M_{ij} = \frac{z_{ij}^{m}}{X_j}$$

Where Z_{ij}^{m} are the imports of the good “i” that do the sector “j”, and X_j is the output of the sector “j”.

The health sector in the input-ouput tables. The disaggregation of the sector.

Using the OECD symmetric Input-Ouput tables, they include the sector “Human health and Social Services” which aggregates both types of activities. As Schoer et al., (2021) highlights, the input-output analysis assumes that all products within one group are identical with respect to the production inputs and sales structure and equal to the average of the product group, but can exists aggregation errors. To avoid this error and concentrate the analysis in the health sector we have disaggregated the sector of “human health activities” from the “social services activities”.

The OECD Supply and Use Tables (hereinafter, “SUTs”) datasets give information by industry (at the 2-digit ISIC Rev 4 level: 89 industries) with corresponding breakdowns by product (using the comparable European CPA product breakdown). They are available at the total economy level, with separate splits of domestic and import use, at both purchasers and basic prices. This information just covers 32 countries. For the 9 countries not covered we have used the WIOD SUTS (2014).

The WIOD database (2016 release) offers us the USE tables at basic prices, with a fob adjustment column and the Supply tables are constructed at basic prices (with a conversion at purchasers´ prices). In both cases with SNA 2008 data, the ISIC Revision 4 industry classification and using the comparable European CPA product breakdown.

The information contained in the national SUTs (OECD and WIOD) has been used to create a transformed symmetric matrix with the health vector disaggregated. The vector of weights of the Human Health and Social Work branches has been calculated as proportion over the total sector in the transformed symmetric matrix of each country. Finally, the weights obtained have been used into the national symmetric matrices of the OECD resulting on the disaggregated the Human Health vector.

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The first step, i.e., the calculation of the transformed symmetric matrix, has been based on the processes described by, respectively:

a. Manual "Handbook on Supply and Use Tables and Input Output-Tables with Extensions and Applications" (UN, 2018), applied on OECD SUTs. According with the methodology published, it has been selected an industry-by-industry transformation, based on the relationship between IOTs and SUTs (UN, 2018).
b. Eurostat Manual of Supply, Use and Input-Output Tables (2008) applied to the SUTs extracted from the WIOD database (Eurostat, 2008).

Both manuals offer an analog system for transforming the information collected in the SUTs. The United Nations Manual explains "as the basis of the use table is a product-by-industry matrix, it is not possible to directly link the required outputs to the required inputs, and thus it is necessary to transform either the product dimension into an industry dimension or vice versa, which can be achieved by applying the information available in the supply table". This Manual offers different models of transformation.

The model selected in this case has been the named Model "D" that consider a fixed product sales structure assumption, i.e., each product has its own specific sales structure, irrespective of the industry where it is produced. This model avoids the problem of the negative elements.

Considering the Input-Output Model, the framework to do the transformation and to get the IOT industry-by-industry is:

Table 6. Framework to transform the SUTs in Sysmmetric matrix

Transformed IOT (industry by industry)	Industries	Final Use	Output
Domestic Industries	B_d	F_d	g
Imports from industries	B_m	F_m	m
GVA	W		w
Output	g^T	y	

Source: Own elaboration

Where,

T = D, Transformation matrix.

$D = V(\hat{X})^{-1}$, Market share matrix and, together with the intermediate uses and final uses of the industry-by-industry IOTs.

$\hat{X}$, Diagonal matrix of product output.

V, Transpose of supply matrix (industry-by-product).

$B_d = T * U_d$, Domestic intermediates. U_d represents domestic intermediates in use table.

$B_m = T * U_m$, Imported intermediates. U_m represents imported intermediates in use table.

W = W, Global Value Added.

$F_d = T * Y_d$, Final use of domestic products.

$F_m = T * Y_m$, Final use of imported products.

This transformation is analogous to the method described in the Eurostat Manual and developed in the case of the WIOD database.

To apply the weights calculated from the SUTS transformation to symmetric IOTs, we have considered:

- The weight vector of the two branches was applied, for each country, on their respective symmetric OECD IOTs multiplying the values of the aggregate sector of the symmetric matrix (intermediate flows) by the weights obtained from the transformated SUTs for both branches, according to the process described above.

- When we substitute the aggregated sector with two new branches, in the process, we generate 4 cells, where the two new branches cross their rows and columns. The value of this cells was specifically calculated applying the same proportion for each of them.

After the transformation, we get new symmetric IOTs with the sector disaggregated. This disaggregation allows us to calculate the specific technical coefficients of the "Human Health Sector" and operate with them.

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To apply these priors in the OECD Symmetric Input – Output Tables allows us to get a database for 41 countries, with the Human Health Sector disaggregated, which we can analyze and compare in terms of its production technology. The tables data are valuated in US Dollar, Millions.

The cluster analysis. Identification of international conglomerates based in the inpupt-output production structure.

All the clustering methods try to define the distance between the observations as a measure of their similarity or difference. If the observations were represented in a n-dimensional space, being “n” the number of associated variables to each observation, as more similar two observations are, they will be closer (with less distance). The main objective of the clustering algorithms is to identify conglomerates with minimize the differences intra-cluster (into the same cluster) and maximize the difference intra-cluster (with other conglomerates).

To our analysis we have selected the K-Means partitioning method (Lloyd, 1957), (MacQueen, 1967); (Everitt and Wiley, 2001)), as one of the most widely used similarity measures. We have considered the squared Euclidean distance as the most common measure of the distance. The K-Means method attempts to create “k” clusters or groups as homogeneous as possible within each cluster and heterogeneous from other clusters by minimizing the squared of the standard Euclidean (L_2) distance between each unit (x) and the centroid (c_i):

$$MIN_{SSE} = \sum_{k}^{j=1} \sum_{x \in ci} L_2\,(c_i, x)^2$$

The algorithm identifies the optimal number of clusters guarantying that, at each step, the total intra-variance of the clusters is reduced, until an optimum is reached.

The procedure of the algorithm has the next steps (Saxena et al., 2017):

1. Initialization: We decide to form K clusters of the given dataset. Now take K distinct points (patterns) randomly. These points represent initial group centroids. As these centroids will be changing after each iteration before clusters are fixed, there is no need to spend time in decision of choosing the centroids.

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2. It assigns each object to the group that has the closest centroid.

3. When all objects have been assigned, it recalculates the positions of the K centroids.

4. Then, it repeats steps 2 and 3 until the centroids no longer move. This produces a separation of the objects into groups from which the metric to be minimized can be calculated.

For obtain the optimal number of clusters we apply the Calinski – Harabasz pseudo-F Index Stopping-Rule (Calinski and Harabasz, 1974):

$$CH(K) = \frac{ss_2}{ss_W} x \frac{N-k}{k-1}$$

being K the number of clusters, N the number of observations (countries considered), SS_W the intra-cluster variation (within-group sum of squared distances) and SS_B the inter-cluster variation (between-group sum of squared distances).

This index, also known as the Variance Ratio Criterion, is calculated as a ratio of the sum of inter-cluster squared distances and the intra clusters squared distances. Considered its definition, the criteria to interpret this ratio is that the higher values mean better clustering results because, according to the formula, this implies that the observations in each cluster are closer while the different clusters are further away between them.

To identify international typologies of Health Systems, based in their production structure, we have applied a **Two-Steps Cluster Analysis. The first step was applied** on the set of production columns of the health sectors from the national total IO tables, using the columns wich represent the production technology for each country, ie, the columns of technical coefficients of the sector by country. The second step has been applied to the column of the technical coefficients calculated for the health sector in the domestic and imports input-output tables (DOMIMPs)

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2.4.1 THE WAPE INDICATOR. ANALYSIS OF DIFFERENCES OF INTERMEDIATE CONSUMPTION

The distance of the values of the coefficients with respect to the cluster mean show us the variability within each cluster. To evaluate the existing distances between the different national Input-Output vectors of the health sector integrated in each cluster with respect to their average, we have used a basic distance measure such as the Weighted Average Percentage Error – WAPE (Sawyer and Miller, 1983), commonly used in the IO analysis. This indicator is calculated according to the formula of the mean absolute deviation (MAD) as a percentage of the mean value $\hat{a}_{ij}$:

$$\text{WAPE} = \frac{\sum_i^n \sum_j^t \left|\hat{a}_{ij} - a_{ij}\right|}{\sum_i^n \sum_j^t \left|a_{ij}\right|} * 100$$

Where,

- a_{ij}: Technical Coefficients of the Health Sector for each country, i.e., column vector of intermediate consumptions of the HS
- $\hat{a}_{ij}$: Mean value of Technical Coefficients of each cluster
- n: Number of provider sectors for the Health Sector (44 sectors)
- t: Number of countries in each cluster

Based in this production structures, the study identifies the typologies at the international level through a cluster analysis applied to the sectoral technical coefficient's vectors, for the set of countries. Once the clusters or types of production have been identified, the results that each of them obtains, on average in terms of avoidable mortality by disease group, have been compared.

2.4.2 DATA AND SETTINGS

The OECD Input-Output database

To compare the health production structures of different countries, it is important to start from an international database that allows economic and structural comparisons between countries. In this sense, the database offered by the OECD harmonized national Input – Output Tables

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(2018) has been used[8]. These matrices take the *industry x industry* approach, and they are valuated at basic prices with identical sectoral classification (44 sectors). Imports are valued at basic prices of the country of origin. Thus, we have used the set of symmetric IO tables, previous disaggregation of the health sector (respect of the Social Services sector), applying the cluster analysis on the health production structure vector (column) from both, the total matrix and the matrix with domestic transactions and imports[9]

The databases for the disaggregation of the sector

The original symmetric IOTs from the OECD database (Total and Domestic-Imports) present the sectors "Human Health Activities" and "Social Work Sector" aggregated. To can study its individual effects, we have disaggregated both branches. For this disaggregation we have applied priors calculated with additional information from the Supply and Use Tables (SUTs) from the OECD database (2018)[10]. For 8 countries, not included in this database, we have used the information of the Supply and Use Tables (SUTs) from WIOD database (2014)[11]. In both databases the sector is disaggregated in the SUTs.

To can use the priors, previously, all the SUTs have been transformed in symmetric tables, according to the United Nations and Eurostat methodologies (UN, 2018) (Eurostat, 2008) to get the priors to disaggregate the sector in the OECD Symmetric Input – Output Tables for each of the respective countries[12]

In the process we have homogenized the number of sectors between the different databases considering 43 sectors in the definitive symmetric IOTs. The main changes made are (tables 7 and 8):

[8]https://stats.oecd.org/Index.aspx?DataSetCode=IOTS_2021

[9] In the OECD Input-Output database, the imports are valued at basis prices of the country of origin, i.e., the domestic and international distribution included in goods imports in c.i.f. purchasers´ prices are re-allocated to trade, transport, and insurance sectors of foreign and domestic industries. Taxes paid and subsidies received in foreign countries are excluded the sectors rows and shown separately.

[10] The OECD Use and Supply database has been used in the case of: Australia, Austria, Belgium, Bulgaria, Canada, Switzerland, Cyprus, Czech Republic, Denmark, Spain, Estonia, Finland, France, United Kingdom, Greece, Croatia, Hungary, Italia, Korea, Lithuania, Latvia, Mexico, Netherlands, Norway, New Zealand, Poland, Portugal, Singapore, Slovakia, Slovenia, Sweden, United States and Turkey. https://www.oecd.org/sdd/na/supply-and-use-tables-database.htm

[11] The WIOD Use and Supply database has been used in the case of: China, Germany, Indonesia, Ireland, Japan, Malta, Romania and Taiwan. https://www.rug.nl/ggdc/valuechain/wiod/wiod-2016-release

[12] This methodology is developed in the Annex 1

Table 7. Disaggregation of the sectors "Human Health" (86) and "Social Work" (87T88)

	INITIAL SECTOR
86T88	Human health and social work activities
	DISAGGREGATED SECTORS
86	Human health activities
87T88	Social work activities

Source: Own elaboration

Table 8. Aggregation in the OECD tables of the sectors related with "Mining and Quarrying" (05T09)

	INITIAL SECTORS
05T06	Mining and quarrying, energy producing products
07T08	Mining and quarrying, non-energy producing products
09	Mining support service activities
	AGGREGATED SECTOR
05T09	Mining and quarrying energy producing products, non-energy producing products and service activities

Source: Own elaboration

Considering the countries included in the analysis, we have used the HS vector from OECD database of domestic & imports IOTs (DOMIMP). However, this database doesn´t include the next countries of our study: Bulgaria, Switzerland, China, Germany, Indonesia, Ireland, Japan, Kazakhstan, Malta, Romania, and Taiwan. To can integrate these countries in our analysis we have approximated the proportion of domestic consumption and imports of the HS based on the proportion domestic/imports extracted from the SUTs.

The table of the sectors considered is included in the appendices of the chapter (table 14).

2.5 Results and discussion

2.5.1 Clusters based on the productive structure

As we have mention before, to define typologies of Health Systems, analyze their characteristics and compare the results, we use Cluster Analysis of the Human Health technology production vector that identifies the conglomerates with more similarities intra-cluster and more differences inter-cluster.

In the **first step,** we have applied this methodology to the set of column vectors of the 41 HS included in the study. These column vectors were extracted from the total symmetric IO tables published by the OECD database with 43 rows/sectors. This clusters identify the groups of

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countries with similar production structure in terms of technical coefficients, according with the IO framework.

Once we have defined the optimal number of clusters based on the production technology, and their composition we have applied **the second step of the cluster analysis** on the set of vectors extracted from the DOMIMP IOTs only for the countries of the first Cluster (36) because the size of the Cluster 2 is too small to be divided (5 countries). The algorithms were applied on the column vectors of 86 coefficients/variables of domestic and Imports consumptions of the HS (43 corresponding to the domestic consumption of the HS from the rest of the sectors and 43 to the imports consumption of the HS by sector).

Based on the Cluster Analysis with K-Means algorithm, we have identified 2 clusters as the optimum of the analysis using the Calinsky Harabasz Index (Table 9). The optimal number of clusters indentifyed using the Calinski Index are 2.

Table 9. Results of Calinsky-Harabasz Index

K-MEANS METHOD	
Number of clusters	Calinski-Harabasz Index
2	**16,28216**
3	11,68466
4	9,293001
5	7,343957
6	13,7129
7	12,61767
8	10,52245
9	9,553977
10	8,79641
11	7,963036
12	7,446435
13	6,726092
14	6,986866
15	6,805029

Source: Own elaboration

The composition of the cluster are shown in the (Table 10). To understand the results and show how different the production structures of the Human health are, we have analyzed the means of each cluster for the technical coefficients vector of the Human Health sector (without include the Social Services sector). Based on these data, we can see for each cluster, the average intersectoral relationship of the sector with the rest of sectors of the economy. As we can

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observed in the figure 14, the clusters present a clear difference in terms of their productive structure.

Table 10. Clusters based on the Input-Output production technology.

CLUSTER 1				CLUSTER 2
AUT	FIN	LTU	SWE	CHE
BEL	FRA	LVA	TUR	SVN
BGR	GBR	MLT	AUS	CHN
CYP	GRC	NLD	IDN	KAZ
CZE	HRV	NOR	NZL	KOR
DEU	HUN	POL	TWN	
DNK	IRL	PRT	CAN	
ESP	ITA	ROU	USA	
EST	JPN	SVK	MEX	

Source: Own elaboration using the OECD Input-Output Database

In the figure 14 it can be clearly seen how cluster 2, is characterized by a more pronounced weight of consumption from the sectors:

- 21: Pharmaceuticals, medicinal, chemical and botanical products. In the first cluster the mean of the technical coefficient is 0.035 and in the second cluster is 0.139, almost 4 times higher and the higher mean of technical coefficient by sector in the global analysis.
- 45T47: Wholesale and retail trade; repair of motor vehicles. In this case the consumption of the second sector 38% is higher than in the first. However, this is the most important provider for the Human Health activities in the first cluster and the second in second in the cluster 2.
- 64T66: Financial and insurance activities: This sector is the third more important for this cluster and its weight in the production structure is almost 4 times higher than in the first cluster, where is the nineth provider sector.
- Other sectors are especially relevant to produce Human Health activities, as Manufacturing nec.; repair and installation of machinery and equipment (31T33);

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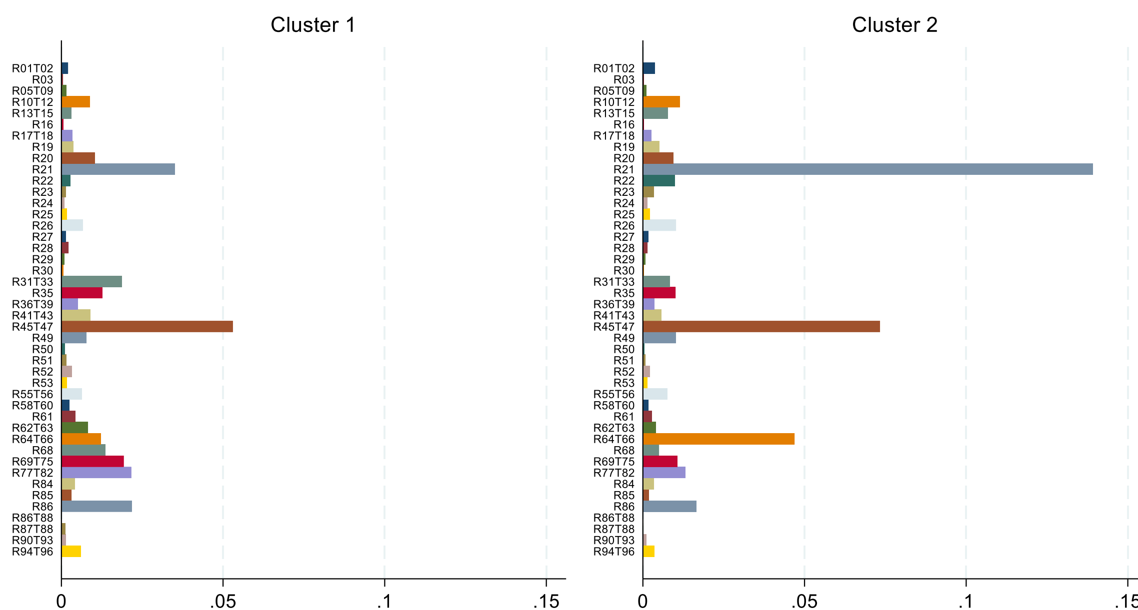
Professional, scientific, and technical activities(69T75); Administrative and support services (77T82) or the self-consumption of the sector (86)[13].

Figure 14. Human health sector. Means of technical coefficients by cluster and sector



Source: Own elaboration with information from the IO Tables of the OECD Databases and Stata 15.

These results allow us to define both typologies as 1) HS more dependent of the pharmacy and private insurance (Higher pharmacological and insurance dependence) and 2) HS less dependent of the pharmacy and private insurance (Lower pharmacological and insurance dependence). This optimal number of 2 clusters indicates a low variability between countries in their productive structure, something that a priori seems logical.

As can be seen in the previous graph, there is a limited number of sectors that lead the provision of resources to the health sector, in general, and that "weigh" more in production technology and in the definition of clusters.The next step is to identify the clusters taking as a reference the coefficients of domestic consumption and the imports of the sector to discover if new differences can be appreciated considering this detail of the consumption of the sector by country.

[13] The self-consumption or intra-consumption is integrated by purchases of goods and services to external health entities (market) to be used in the production of health care activities (diagnostic test, blood tests, by hiring their professional health workers, etc.) (ESA (2010))

2.5.2 Clusters based on domestic consumption and imports of the health sector

The results obtained by applying the cluster analysis on both matrices offer us an interesting complementary perspective about the origin of the productive factors:

- The relationship of the health sector with the rest of the sectors within each economy

- The dependence of the imports in each case

The subclusters identified based in the vector of technical coefficients disaggregated by domestic consumption and imports (DOMIMP) are reflected in the Table 11:

Table 11. Subclusters based on the domestic and imports coefficients[14].

CLUSTER DOMIMP K-MEANS SECOND STEP: 4 SUBCLUSTERS				
SUBCLUSTER 1	SUBCLUSTER 2	SUBCLUSTER 3		SUBCLUSTER 4
GBR	BEL	AUT	LTU	CHE
AUS	ESP	BGR	LVA	SVN
IDN	FIN	CYP	MLT	CHN
NZL	IRL	CZE	NLD	KAZ
USA	ITA	DEU	NOR	KOR
	POL	DNK	ROU	
	PRT	EST	SWE	
	SVK	FRA	CAN	
	TUR	GRC	MEX	
		HRV	JPN	
		HUN	TWN	

Source: Own elaboration

The previous cluster 2 (now named subcluster 4) has not been subdivided because it has a low size (only 5 countries) and it is integrated by the same countries i.e., Switzerland, Slovenia, China, Kazakhstan, and Korea. The clusters 1, 2 & 3 are a division (second step) of the previous cluster 1.

Considering the new clusters, we can see as, in general, the most important providers sectors are the same, however we can appreciate some singularities in the subclusters. In the figure 16, we can see as, additionally to the "*Wholesale and retail trade; repair of motor vehicles*" (45T47), the sectors that conditionate the production of health from the domestic consumption

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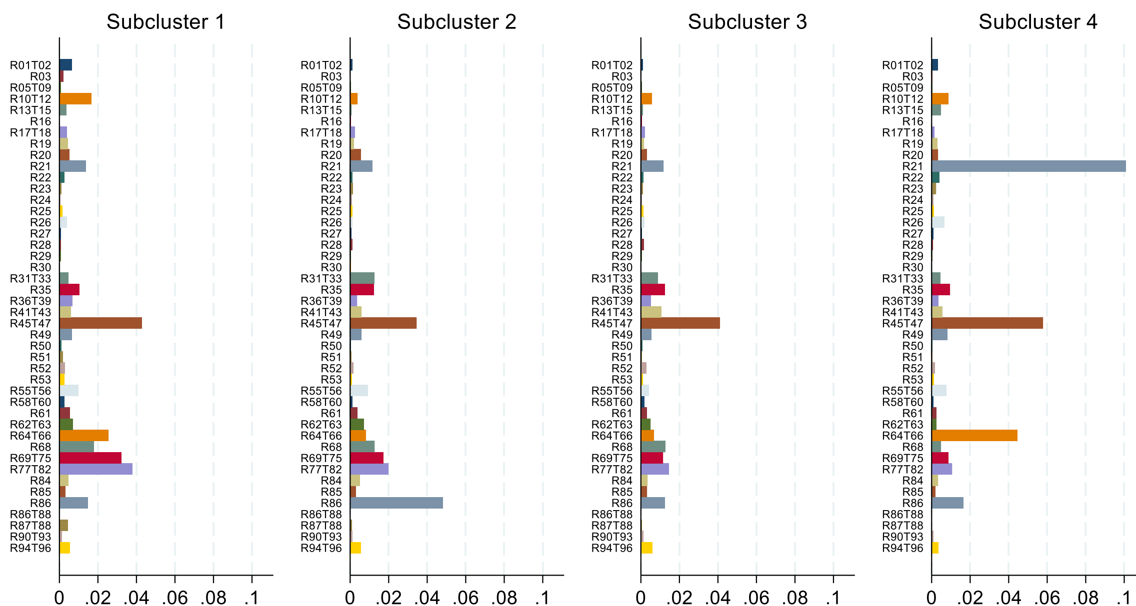
[14] The acronyms of the countries are included in the Annex 3.

point of view, are again, the “Pharmaceuticals, medicinal, chemical and botanical products” (21), the self-consumption ((86) and some kinds of services as “Administrative and support services”(77T82), “Professional, scientific and technical activities”(69T75) and the “Financial and insurance activities” (64T66).

From the point of view of imports, especially highlights the foreign dependence on pharmaceutical products, with high values in all the clusters. Also, Wholesale and retail trade, chemical products, manufacturing, or technological equipment.

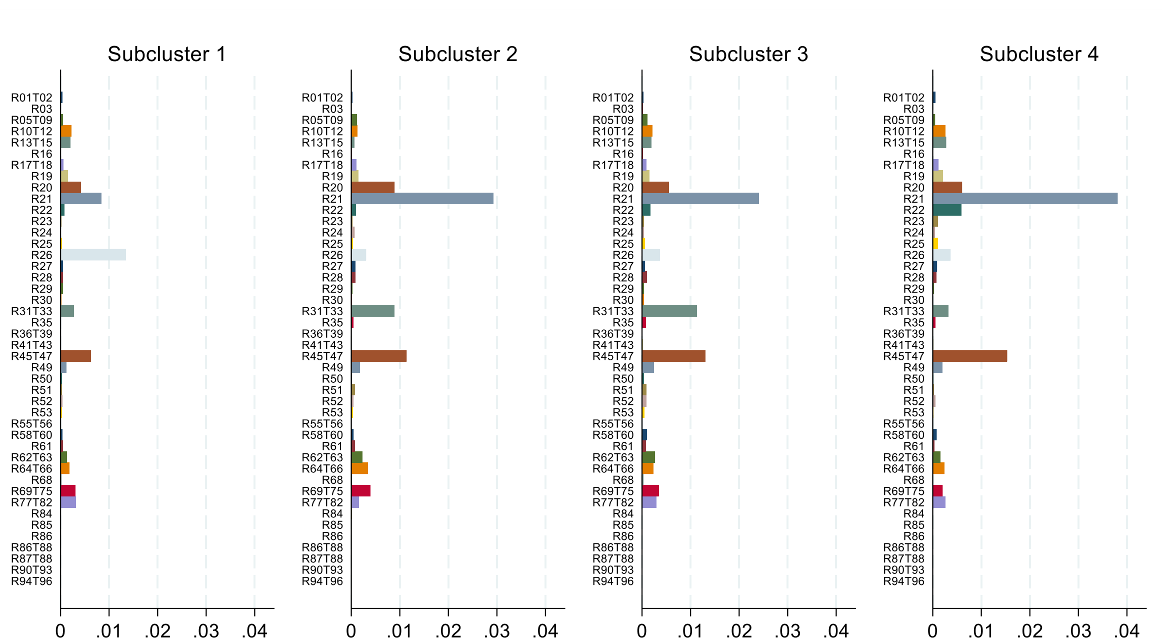
Considering the production structure from the domestic consumptions point of view, we can define the four typologies of clusters identified as 1) More externalized; 2) Highest Self-consumption; 3) Lowest Self-consumption and 4) Dependent on insurance and pharmaceutical purchases.

Figure 15. Domestic consumptions by sector and IO cluster



Source: Own elaboration with information from the IO Tables of the OECD Databases.

Figure 16. Imports consumptions by sector and subcluster



Source: Own elaboration with information from the IO Tables of the OECD Databases.

Table 12. WAPE by subcluster

SUBCLUSTERS	WAPE
1	49,9
2	41,2
3	53,4
4	69,7

Source: Own elaboration with information from the IO Tables of the OECD Databases.

Calculating the WAPE indicator to measure the distance of the values of the coefficients with respect to the cluster mean, the results (Table 12) show us how the subcluster 2 presents the lowest value of the indicator, i.e., the countries have the lowest variation in their production structure respect of the average of their cluster (lowest heterogeneity). The subcluster 4 presents the highest differences.

2.5.3 Typologies of health systems identified and performance in terms of avoidable mortality

Considering both parts of the input-output table, domestic and imports, we can define the cluster typologies found as:

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- **Cluster 1: Externalized**
  - High dependence of domestic external services (administrative-77T82 and professionals-69T75) and insurance and financial activities-64T66. Low dependence of the self-consumption or the rest of the domestic sectors.
  - Lower dependence of pharmacological imports and highest dependence of technical equipment imports (computer, electronic and optical equipment).
- **Cluster 2: Highest self-consumption**
  - Highest self-consumption.
  - High dependence of pharmaceutical imports.
- **Cluster 3: Lowest self-consumption**
  - High dependence of imports of pharmaceutical products and manufacturing and services for machinery and equipment.
  - Lower dependence of the rest of the domestic sectors.
- **Cluster 4: Dependent on insurance and pharmaceutical purchases.**
  - Highest domestic pharmacological and insurance dependence. Low self-consumption and low dependence of other external services (technical or professional).
  - Highest pharmacological imports dependence and wholesale and retail trade.

To interpret these results and identify benchmarking possibilities, it must be considered the need to adapt the analysis and conclusions to the context and characteristics of each country and the diversity and variability within each cluster.

2.6 CONCLUSIONS

Health systems have traditionally been evaluated from an expenditure perspective, which entails constant pressure on health policies to reduce them and guarantee their long-term sustainability. But, from the economic point of view, it must be considered as a key sector due to its ability to generate employment and value added. The World Health Organization (WHO) highlights the need to consider its integral impact and assess its crucial role in the society as provider of the health, the more important right for the people.

This work has integrated both perspectives, comparing the different productive structures of the sector, at international level, from the point of view of their interrelationships with the rest of

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the economy and their results in terms of health outcomes. This analysis has allowed the identification of new typologies of health systems based in their production structure. Additionally, when we compare the dependence of the HS on domestic consumption and imports, the analysis offers us another key piece of information, which is the effects of each typology in the rest of the domestic economy and the dependence on foreign markets in each case. Something that because of the Covid-19 crisis has emerged as crucial in health production planning due the lockdowns adopted during the pandemic that disrupted economies and global supply chains. The most important sector from the point of view of dependence on imports is the pharmaceutical sector, which presents particularly high technical coefficients in the different subclusters.

In general, the results corroborate the important interrelationship of the HS with some specific sectors of the economy. The main providers of the Human Health Activities are the sectors *Wholesale and retail trade* (45T47), *pharmaceutical* (21), *financial and insurance activities* (64T66), the self-consumption, the *administrative services* (77T82) or the *professional and technical services* (69T65).

The typologies identified present important differences in the combination of inputs used to produce health, but also important differences in health outcomes have been detected. This leads us to think that the different health production ways are directly related to health outcomes in terms of avoidable mortality.

Using a two-steps cluster analysis, we have identified 4 different conglomerates of countries: subcluster externalized (GBR, AUS, IDN, NZL, USA), subluster of highest self-consumption (BEL, ESP, FIN, IRL, ITA, POL, PRT, SVK, TUR), subluster of lowest self-consumption (AUT, BGR, CYP, CZE, DEU, DNK, EST, FRA, GRC, HRV, HUN, LTU, LVA, MLT, NLD, NOR, ROU, SWE, CAN, MEX, JPN, TWN) and subcluster with highest dependence of insurance and pharmaceutical purchases (CHE, SVN, CHN, KAZ, KOR).

These results show how the variation in the way health systems produce is smaller if we analyze production technology as such, that is, the proportion of inputs per sector used by health systems. This international disparity grows if we take into account the origin of the inputs, something especially relevant from the point of view of the domestic economic impact, the

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value chain and other aspects such as dependence on imports, which can play a key role in situations of health crisis such as the one experienced with COVID-19.

These results offer a key starting point for further analysis of this relationship. This first approach has revealed different typologies in the productive structure of the health sector in the different countries and the existence of different ways to produce health with differences in terms of their health outcomes. It can contribute for the detection of benchmarking possibilities between countries without prejudice to consider that the different context of each health system and other variables of influence in the health results must be considered to define the policies in each case. In this sense, those countries with a greater affinity in their productive structure, but with different results in terms of avoidable mortality, will be able to deep into the causes of these differences, since their input structure is similar, and the results should also be similar. This relationship must be explored in the future research derived from this thesis.

The proposed analysis contributes to HS assessment framework, identifying similar production structures with better health performance that offer benchmarking possibilities to other countries. Also offers a tool that allows, applying different IO analysis techniques, to know the economic impact of the sector in the respective economies. Considering the complexity of the determinants of health, in future developments would be interesting to add other variables which can be involved in the HS performance and efficiency by country.

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APPENDICES TO CHAPTER II

Table 13. Countries included in the cluster analysis based on the production structure

tr	COUNTRY	ACRONYM	COUNTRY	ACRONYM	COUNTRY
AUS	AUSTRALIA	GRC	GREECE	NOR	NORWAY
AUT	AUSTRIA	HUN	HUNGARY	POL	POLAND
BEL	BELGIUM	IDN	INDONESIA	PRT	PORTUGAL
BGR	BULGARIA	IRL	IRELAND	ROU	ROMANIA
CAN	CANADA	ITA	ITALY	SVK	SLOVAKIA
CHN	CHINA	JPN	JAPAN	SVN	SLOVENIA
HRV	CROATIA	KAZ	KAZAKHSTAN	ESP	SPAIN
CYP	CYPRUS	KOR	KOREA (REPUBLIC OF)	SWE	SWEEDEN
CZE	CZECH REPUBLIC	LTU	LITHUANIA	CHE	SWITZERLAND
DEU	GERMANY	LVA	LATVIA	TUR	TURKEY
DNK	DENMARK	MLT	MALTA	TWN	TAIWAN
EST	ESTONIA	MEX	MEXICO	GBR	UNITED KINGDOM
FIN	FINLAND	NLD	NETHERLANDS	USA	UNITED STATES OF AMERICA
FRA	FRANCE	NZL	NEW ZEALAND		

Source: Own elaboration

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Table 14. Sectors considered in the analysis

CODES	OECD SECTORS
01T02	Agriculture, hunting, forestry
03	Fishing and aquaculture
05T09	Mining and quarrying, energy producing products, non-energy producing products and support service activities
10T12	Food products, beverages and tobacco
13T15	Textiles, textile products, leather and footwear
16	Wood and products of wood and cork
17T18	Paper products and printing
19	Coke and refined petroleum products
20	Chemical and chemical products
21	Pharmaceuticals, medicinal chemical and botanical products
22	Rubber and plastics products
23	Other non-metallic mineral products
24	Basic metals
25	Fabricated metal products
26	Computer, electronic and optical equipment
27	Electrical equipment
28	Machinery and equipment, nec
29	Motor vehicles, trailers and semi-trailers
30	Other transport equipment
31T33	Manufacturing nec; repair and installation of machinery and equipment
35	Electricity, gas, steam and air conditioning supply
36T39	Water supply; sewerage, waste management and remediation activities
41T43	Construction
45T47	Wholesale and retail trade; repair of motor vehicles
49	Land transport and transport via pipelines
50	Water transport
51	Air transport
52	Warehousing and support activities for transportation
53	Postal and courier activities
55T56	Accommodation and food service activities
58T60	Publishing, audiovisual and broadcasting activities
61	Telecommunications
62T63	IT and other information services
64T66	Financial and insurance activities
68	Real estate activities
69T75	Professional, scientific and technical activities
77T82	Administrative and support services
84	Public administration and defence; compulsory social security
85	Education
86	Human health activities
87T88	Social work activities
90T93	Arts, entertainment and recreation
94T96	Other service activities
97T98	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
OUTPUT	Output at basic prices

Source: Own elaboration

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CHAPTER 3

The impact analysis of the regional health care systems in Kazakhstan

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3.1. INTRODUCTION

Based on the analysis developed in the two previous chapters, this chapter aims to analyze the performance of the health system in Kazakhstan and its relationship with the productive structure of the country. Also approach its relationship with the different regional economies.

The choice of Kazakhstan as a particular case study is motivated by several factors. The results obtained so far have shown us a quite differentiated behavior of the country in terms of performance. In fact, in the results obtained in Chapter 1, the country maintains a fairly high avoidable mortality compared to other countries within the same cluster. Globally, its preventable and treatable mortality in 2018 (276 and 161 deaths per 100.000 pop., respectively) is more than double the OECD average (137 y 79 deaths per 100.000 pop.)[15].

In the chapter 2, when we have identified clusters of countries based on the input-output production technology of each health system, we were able to observe how Kazakhstan forms part of a minority cluster, along with a very small number of countries (China, Korea, Slovenia and Switzerland). This cluster differs especially from the other cluster (35 countries), in a much higher weight of inputs from the pharmaceutical sector and those related to financial and insurance activities.

Regarding the health system model, it should be noted that, after achieving independence from the Soviet Union (USSR) on December 16, 1991, Kazakhstan has been immersed in a series of reforms, among which is the reconfiguration of its health system that originated from a model semashko, strongly centralized and with a poorly developed primary care. The soviet model was also specially oriented to the treatment of communicable diseases.

Currently, the country is trying to reform the model and improve its performance through measures to improve the accessibility, efficiency and equity of its health system. According with the OECD report about the health system in Kazakhstan, in the last years they have created a basic package of benefits free-of-charge, the primary health care has been strengthened, and they have developed different measures to reduce dependency on hospital care.

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[15] Data based in the OECD Health Status Database. Year 2018. https://stats.oecd.org/index.aspx?queryid=96018.

In fact, in recent years the country has improved considerably in a series of indicators such as life expectancy, which between 2000 and 2017 had increased from 65.7 years to 73.1 years. They have also managed to significantly reduce maternal and infant mortality, although with significant regional differences. But despite its economic growth and the improvements made to its health system, its health results are still well below the OECD and countries with similar income levels such as Hungary, Poland or Turkey (OECD, 2018b).

It is therefore a country in which, both the particularities of its health system, as well as its current performance, the reform process initiated and the previous data obtained, make it a very interesting case study from the point of view of the benchmarking. In this sense, the country can adopt or implement certain strategies from other countries with better health outcomes, adapting them to its own socioeconomic context.

In order to contextualize better both, our work and the results obtained, a brief historical and economic contextualization of the country is provided below.

The Republic of Kazakhstan is the world's largest landlocked country and is the most developed economy in Central Asia (see figure 17).

Figure 17. Kazakhstan: geographical position

Source: Own elaboration

In total, it has an area of 2.724,9 thousand km², which means that is the third country in Asia in extension and the ninth in the world. The population does not reach 20 million inhabitants in January of 2022. These data give us an idea that we are facing a country of significant dimensions but with a very low average population density in almost all its territory, except for some concentrations, especially in cities in the north and south of the country such as the capital, Astana, Almaty city or Shymkent city.

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From the point of view of its administrative and territorial structure Kazakhstan, currently, the country has a territorial structure integrated by 17 regions and 3 cities of republican significance[16]. The capital is Astana since 1998, when it was moved from Almaty. The capital was renamed Nur-Sultan during some years but, currently, the name of the city is, again, Astana[17]. The country share borders with Russia, China, Kyrgyzstan, Uzbekistan, Turkmenistan and the Caspian Sea (13.200 Km.).

From the economic point of view, the country is classified an upper- middle income country in the recent report of the United Nations, (2022). The report reflect that Kazakhstan is in the position 56 out of 191 countries and territories in the world, based in the Human Development Index (HDI) which stood at 0.811, a very high value, according to the report. The currency of the country is the tenge (KZT).

The economy in Kazakhstan

Kazakhstan is characterized as a country with a significant endowment of natural resources. According to the information published by the Kazakhstan government, it is the ninth country in the world in oil and gas production (in terms of explored reserves), whose extraction has been more concentrated in the western regions. It is also the second country in the world in uranium reserves and the eighth in coal reserves. Regarding other minerals, it is the world's leading producer of zinc, tungsten and barites and is among the top 4 producers of silver, lead, chromite, copper, fluorite, molybdenum and gold.

Regarding international trade, it stands out for its exports of mining, energy, fuel and chemical products. Also for its exports of cereals and flour, appearing among the top 10 countries in the world in this type of product.

However, it should be noted that the country is also characterized by significant regional inequality, the highest in the OECD, (2018a).

[16] Data come from the official web page of the government of the Republic of Kazakhstan: https://www.gov.kz/article/19305?lang=en.
[17] In the text we will use the name of Nur-Sultan at times because it corresponds to the name that appears in the databases for the years of study.

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History

In the 1920s, the government's decision to transform grazing lands into vast tracts of cereal production for commercialization forced a large population of Kazakhstan, until then nomadic, to settle as sedentary populations, many of them remaining in the central part of the country while a smaller group, mainly made up of Russians and Ukrainians, settled in the north of the country. This decision was followed by a campaign of confiscation of cattle in 1928 that would become concentrated in collective farms called “kolhos”.

The previous decisions, together with an extreme drought that occurred in 1931, ended up leaving nomads whose diet was based on products of animal origin without food. The cattle died on the farms due to lack of food (they went from having 6,509 thousand heads in 1928 to 945 thousand in 1932). All this, together with the impossibility of converting the steppe areas into agricultural land, caused a severe famine whose health consequences were not only given in the short term, but it can also have had other effects in the long term.

Authors as Cockerham et al., (2004) have studied the lifestyle as a condition of health in Kazakhstan and mention different studies that relate the low life expectancy of the Soviet Union and Eastern Europe with lifestyles that are negative for health. They also confirm that lifestyles and life choices in the former Soviet Union were strongly conditioned by the dominant political ideology and strong social dynamics beyond the individual. In this sense, they point to the strong dynamics of alcohol and tobacco consumption, especially in middle-aged men, which were also normally accompanied by diets rich in fats and lack of physical exercise. The authors note that in 2002, the average life expectancy of Russian men was only 58.5 years and premature deaths were due more to lifestyle than to other factors or communicable diseases. Currently, Kazakhstan has an important problem with these habits and the differences by gender (alcohol and tobacco in the case of men and obesity in the case of women)

Considering the recent history of this country and the current reforms, in this chapter we will try to deepen the study of avoidable mortality by region of Kazakhstan and the predominant causes of mortality in each of them. The OECD has recently published assessments of Kazakhstan's healthcare system(OECD, 2018b). It even mentions excess mortality from some specific causes at the national level, but not for all those considered preventable or treatable or at the regional level.

They will also try to analyze the health sector and its sectoral interrelationships at the national and regional level with the aim of offering this double perspective to public policy decision-makers. The moment of reforms that the country is experiencing makes this double consideration essential in order to improve the performance of the health system in all its regions and at the same time see the potential of the health sector as an investment sector with a significant capacity to generate growth and quality employment in the country.

This chapter is developed in thre sections more. The section 3.2 describes some of the differences between regions which show their heterogeneity: The section 3.3 describes the methodology and data used, and the section 3.4 show the main results found with this study. Finally, the conclusions are summarized in section 3.5.

3.2. The regional economies in Kazakhstan

The heterogeneity between regions can be a challenge that need to improve the information and tools for taking decisions. At the same time can be a good opportunity to improve the assessment in each territory of the different measures adopted to improve the health and to evaluate the investments in health.

Kazakhstan is a very diverse country that has experienced significant growth in recent decades associated with the extraction and commercialization of its natural resources.

The following map shows the territorial division of Kazakhstan, made up of 14 regions and 3 cities of republican significance, Astana, the capital, Almaty city and Shymkent:

Figure 18. Regions of Kazakhstan

Source: Own elaboration

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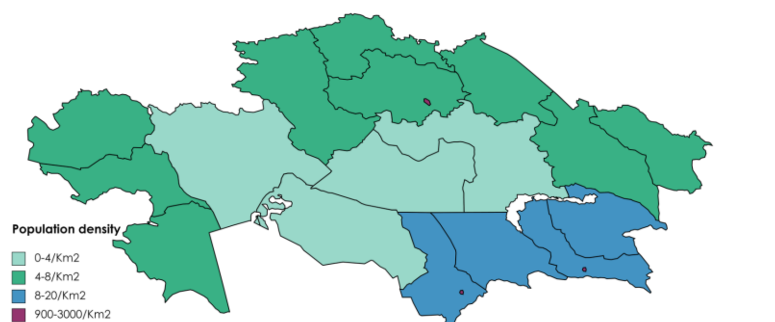
From the demographic point of view, Kazakhstan has a low population density (around 7%). The weight of the regions is unequal in terms of population and they also present different densities between them. The regions and cities with the greatest demographic weight in the country are Almaty, Almaty city and Turkestan with figures of between 10% and 11% of the national population each. On the opposite side we can find North Kazakhstan and Atyrau with a population percentage of 2.8% and 3.5%, respectively of the national total. In terms of population density, the following graph shows us the important disparities at the national level. In the center of the country and Kyzylorda the density does not reach 4hab./Km2. In the north and west this density oscillates between 4 and 8 inhabitants per km2. The density increases in the southeast of the country, reaching almost 18 inhab./km2 in Turkestan. However, more than 23% of the country's population is concentrated only in the 3 large cities. This configuration affects the accessibility of the health system, with many inequalities, specially between the rural and urban areas. In the rural areas the transport difficulties and the big distances to the health system centers.

Figure 19. Population density by region in Kazakhstan (population per Km2)



Source: Own elaboration

From the point of view of economic specialization, oil extraction is concentrated in the western regions of the country such as Atyrau, West Kazakhstan, Kyzylorda and Mangystau. Regarding the concentration of other non-oil heavy industries, such as those associated with coal, copper, aluminium, steel or electricity, the regions of Karaganda and Pavlodar stand out. Traditionally agriculture has had a greater development in regions such as Akmola, Almaty, Zhambyl. Kostanay, North Kazakhstan and Turkestan.

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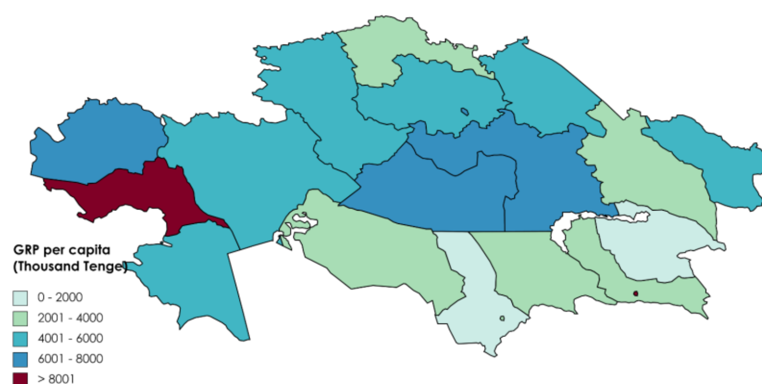
Kazakhstan shows important differences in the economic structure between its regions and main cities. A recent OECD report (2018) highlights that despite general economic progress in the last two decades regional disparities have not been reduced and this translates into important differences in terms of regional economic structure, health resources and health outcomes.

The following map shows, as an example, the differences in Gross Domestic Product per capita by region. The details of these data by regions can be found in Annex 3.3 As can be seen, the differences between regions are very important, with Turkestan's GDPpc being 12 times lower than Atyrau's.

Figure 20. Population density by region in Kazakhstan (population per Km2)



Source: Own elaboration

The report OECD, (2020) describes as "Gross regional product (GRP) per capita is the highest in the Western regions bordering the Caspian Sea (Atyrau, Mangystau and West Kazakhstan), where the main oil and gas deposits are located, and in the two largest cities, the former capital Almaty, and Astana, the country's administrative capital since 1998. The Pavlodar and Karaganda regions, which host the largest coal mines, also have per capita GRP levels on par with the national average. Ten of Kazakhstan's 16 regions have lower GRP per capita levels than the national average, despite the mineral's concentration of two (Karaganda and Aktobe)". The report also highlights that a combined performance of all regions should not be neglected since the national growth is currently concentrated in few regions.

In this sense, it is essential to develop the regionalization of the Input- Output Tables that allow the synthesis, comparison and use of information at the regional level. The RIOTs are crucial to analyze and compare the regions in macroeconomic terms. Through their contents, the predominant sectors and intersectoral relationships in each region can be analyzed and

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compared by applying the Input-Output methodology to calculate direct and indirect impacts or compare sectoral structures.

However, obtaining them through survey methods can be expensive and difficult from the point of view of the necessary information, and for this reason some countries doesn't have RIOTs.

The non-survey methods allow to overcome the budgetary limitations of the survey-methods and the problems associated with the regional data restrictions. In this sense, the location coefficients (LQ), in particular the Flegg´s formula and its extensions are usually used in the creation of RIOTs. The 2DLQ methodology is also based in the LQ methods but it improves the adjustment (Pereira-López, Carrascal-Incera and Fernández-Fernández, 2020), (Pereira-López et al., 2021) and it is the method used in this paper.

This paper develops the first Regionalization of the Input- Output Table for Kazakhstan. These regional tables will offer a systematized information database from the point of view of economic analysis. To the aim of this paper, we use the regional information to analyze the weight and the intersectoral relationships of the regional Health Care Systems, although the information contained on the RIOTs can be used for many other purposes on the regional and sectoral economic analysis.

Thus, the aim of this paper is to use the RIOTs to analyze the behavior of the Human Health sector at regional level identifying important differences between regions in their contribution to the health sector and to compare the results with the national data.

3.3. METHODOLOGY AND DATA

3.3.1. CALCULATION OF AVOIDABLE MORTALITY INDICATORS

The avoidable mortality indicators have been calculated using the same methodology described in chapter 1. That is, taking the mortality data classified according to the ICD-10 lists of diseases and causes of death, they have been classified according to the methodology of the OECD/Eurostat. The indicators of preventable and treatable mortality have also been standardized in this case by age group.

3.3.2. THE 2DLQ METHOD

Due to the limitations of existing information at the regional level, it has not been possible to advance in the study of production technology by region. However, if it has been possible to apply a method based on Location Coefficients (LQ) to regionalize the production of the Input-Output table of Kazakhstan and to know how the different regions contribute to the production of health in the country.

The importance of generating regional IO tables for analysis, descending from the national level to a sub-territorial level, makes it necessary to have a method that allows their generation at an affordable cost and that allows obtain consistent and robust information.

To achieve this goal, there are various formulas or methods that have been recently applied in the literature based on the LQ coefficients. However, there is still no single solution or definitive method for this purpose.

The Simple Location Quotient (SLQ) is the most common approach, which compares the relative weight of a certain sectoral industry of a region with its relative weight in the total of the country. Their generic formula is:

$$SLQ = \frac{\frac{x_i^R}{x^R}}{\frac{x_i^N}{x^N}} = \frac{\frac{x_i^R}{x_i^N}}{\frac{x^R}{x^N}} = \frac{wx_i^R}{wx^{R'}}$$

Where, the components of the formula are:

- x_i^R: production of the sector i in the region R
- x^R: total production of the region R
- x_i^N: production of the sector i in the whole country
- x^N: total production of the country
- wx_i^R: weight of the production of region R's sector i in the production of the total economy's sector i
- $wx^{R'}$: weight of the production of region R in the total production of the country

This methodology includes two different simultaneous corrections on the intermediate's consumption matrix: one by rows and other by columns. Extension based SLQ such as CILQ, and in particular, the Flegg´s formula (FLQ) and its derivations are the generalized accepted solutions.

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Pereira-López, Carrascal-Incera and Fernández-Fernández (2020) propose a new approach (2DLQ) based on the performance of bidimensional location quotients for constructing input–output tables. This method uses sectoral degrees of specialization at the sub-territorial level (by rows) with an alternative formulation that excludes the sub-territorial effect size at global level.

Starting from the analysis of previous methods based on the location coefficients, the authors propose a bidimensional approximation, as a first step in the design of a generalization of the Flegg methodology, that is synthesized in the following expression:

$$\tilde{A}^R = R(\alpha)A^N S(\beta)$$

Where,

- A: Matrix of intermediate domestic coefficients,
- R(α) and S(β): Diagonal matrices, whose elements appear in the main diagonal work as weighting factors.
- α and β (scalars) are the influential parameters in row and column corrections, respectively. There are different ways to address these corrections, and they do not necessarily have the same behavior. The authors indicate the possibility of using different smoothing (semilogarithmic, potential, or hyperbolic tangent function) to address such corrections.

The generic element of the projected matrix, $\tilde{A}^R$, through the proposed alternative, is:

$$\tilde{a}_{ij}^R = \begin{cases} (SLQ_i)^\alpha a_{ij}^N \left(wx_j^R\right)^\beta \; if \; SLQ_i \leq 1 \\ \left[\frac{1}{2}\tan h\,(SLQ_i - 1) + 1\right] a_{ij}^N \, (wx_j^R)^\beta \; if \; SLQ > 1 \end{cases}$$

The function y = tan h(x) is propitious, since it is increasing for x > 0, and when x tends to +∞, the function approaches 1, expressing an asymptotic behavior with respect to line y = 1. In this context, the function, $\left[\frac{1}{2}\tan h\,(SLQ_i - 1) + 1\right]$ permits slightly higher factors (when SLQi > 1) than the ones in the reference table.

Pereira-López, Sánchez-Chóez and Fernández-Fernández (2021), have demonstrated 2DLQ robustness and how it improves previous estimations based in other LQ as CILQ, FLQ and,

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overcoming some of the rigidities presented by the previous alternatives. For this reason, we use the 2DLQ for the regionalization of the Input-Output Table of Kazakhstan.

3.3.3. DATA

The calculation of the avoidable mortality indicators for Avoidable mortality indicators

The data on preventable mortality and population by region, used to calculate preventable and treatable mortality, have been provided by the company Ayeconomics Research Centre. The company has this data through projects with the Kazakhstan Ministry of Science and Education.

The population structure used to standardize the data by age groups has been, once again, that published by the OECD.

Regionalization of the Input-Output Table of Kazakhstan

We apply the 2DLQ on the Kazakhstan symmetric IOT published in the OECD Input-Output Tables (IOTs) database (2021 ed.)

https://stats.oecd.org/Index.aspx?DataSetCode=IOTS_2021.

Since our main interest is the health sector, previously to the regionalization, we need to disaggregate the sector Human Health and Social Work (86T88) in two branches, Human Health Care Activities (86) and Social Services (87T88).

To the disaggregate the sector into the symmetric OECD IOTs we had used weights of each of the branches, obtained through the information provided by the SUTs published by the OECD and the WIOD. In both cases:

1. The information contained in the national SUTs (OECD and WIOD) has been used to create a transformed symmetric matrix with the vector disaggregated in each case.
2. The vector of weights of the Human Health and Social Work branches has been calculated as proportion over the total sector in the transformed symmetric matrix of each country.
3. The weighs obtained have been used into the national symmetric matrices of the OECD resulting on the disaggregated the Human Health vector.

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For the first step, i.e., to calculate the transformed symmetric matrix, we based on the methodology described by:

c. Manual “Handbook on Supply and Use Tables and Input Output-Tables with Extensions and Applications” (United Nations, 2018), applied on OECD SUTs. According with the methodology published, it has been selected an industry-by-industry transformation, based on the relationship between IOTs and SUTs (UN, 2018).
d. Eurostat Manual of Supply, Use and Input-Output Tables (2008) applied to the SUTs extracted from the WIOD database(Eurostat, 2008).

To regionalize the national IOT and to calculate the weight of each sector within the total of the region (wx), we have used the sectoral production data by region (Gross Regional Product-GRP) for the year 2018. Since the gross regional product Human Health Care Activities (86) is also aggregated with Social services (87T88), we have used the GVA to calculate the weight of each sector and to disaggregate the production to at regional level.

The GRP (2018) and the GVA (2018) (in this case for Health Care Activities (86) and Social services (87T88)) have been download from the Agency for Strategic planning and reforms of the Republic of Kazakhstan. Bureau of National Statistics of Kazakhstan website. https://stat.gov.kz/

3.4. Results and discussion

Preventable and treatable mortality in Kazakhstan at regional level

The next figures (21 and 22) shows us the position of the different regions of Kzakhstan with respect to the country's average. Taking into account the levels of preventable and treatable mortality in Kazakhstan in 2018 (276 and 161 deaths per 100,000 inhabitants, respectively) the regions that appear in the upper left quadrant of the graph, Almaty city and Atyrau show lower levels of mortality from preventable causes than the country average. However, mortality that can be avoided through treatment is higher than the country's average. In the case of Aktobe and Almaty region, occurs the opposite in the lower right quadrant, with values higher than Kazakhstan in preventable mortality, and lower mortality by treatable causes.

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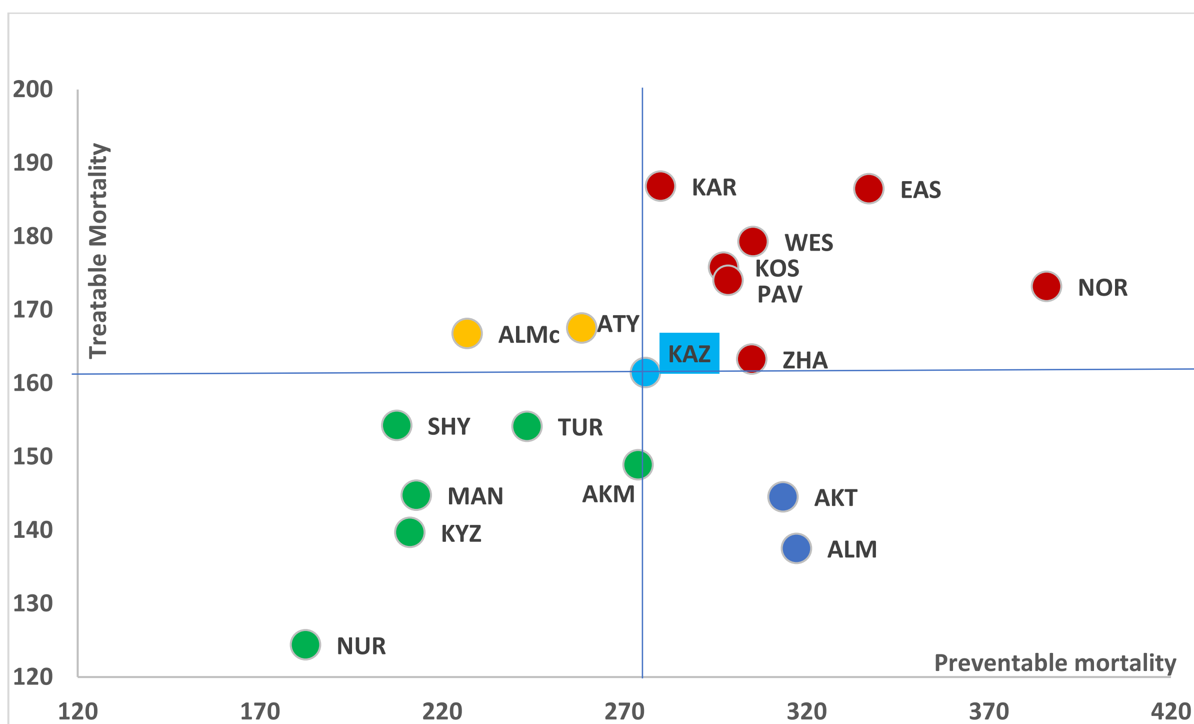
Figure 21. Preventable and treatable mortality in Kazakhstan and its regions (per 100.000 inh.)



Source: Own elaboration

Figure 22. Position of the regions of Kazakhstan according the national means of preventable and treatable mortality (per 100.000 inh.)

Source: Own elaboration

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The upper right quadrant, where the North, East and West Kazakhstan, Karanganda, Kostanay, Pavlodar and Zhambyl regions are located, is where the worst results of the country in terms of preventable mortality are found. North Kazakhstan is the region with the highest preventable mortality while Karanganda and East Kazakhstan have the highest treatable mortality.

All the regions included in the lower left quadrant present results, in both indicators below the national average. This is the case of Nur-Sultan, Kyzlorda, Mangystau, Shymkent, Turkestan and Akmola.

The following table shows the ordered regions taking into account the results of each of them in terms of total preventable mortality, both preventable and treatable (year 2018). Nur-Sultan (Astana) and North Kazakhstan are the ones with the best and worst results, respectively.

Table 15. Preventable an treatable mortality by region in Kazakhstan

REGIONS	Acronym	Preventable	Treatable	Avoidable
Nur-Sultan	NUR	183	124	307
Kyzylorda	KYZ	211	140	351
Mangystau	MAN	213	145	358
Shymkent	SHY	208	154	362
Almaty city	ALMc	227	167	394
Turkestan	TUR	243	154	397
Akmola	AKM	274	149	423
Atyrau	ATY	258	167	426
Kazakhstan	KAZ	**276**	**161**	**437**
Almaty	ALM	317	138	455
Aktobe	AKT	314	145	458
Karaganda	KAR	280	187	467
Zhambyl	ZHA	305	163	468
Pavlodar	PAV	298	174	473
Kostanay	KOS	297	176	473
West Kazakhstan	WES	305	179	485
East Kazakhstan	EAS	337	186	524
North Kazakhstan	NOR	386	173	559

Source: Own elaboration

The conclusion to these data is that the important differences between regions imply a high heterogeneity between them, which makes this type of analysis particularly relevant. On the

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other hand, the results make it possible to identify the key points of improvement by region. They also identify those regions that can be taken as a reference for presenting better results.

This comparison is an interesting starting point for setting up prevention and treatment measures, in each region, for the different causes of avoidable mortality.

Identifying benchmarking possibilities to improve the outcomes in Kazakhstan and its regions

Taking into account the position of each region in the previous figure 21, with respect to Kazakhstan, the next figures offer the distribution of the mortality by different preventable and treatable causes for the regions of each part of the graph. At the same time, each graph includes:

- Means of Kazakhstan by type of disease to compare the distribution of the avoidable mortality of each region with the national distribution.
- Means of the subcluster 1.1 from the chapter 1. We must remember that those subclusters were the result of the identification of countries conglomerates based, in a first step, in their total levels of avoidable mortality (clusters) and then, within each one of them, the subclusters which presented greater similarities in terms of distribution of mortality by disease groups. To identify the benchmarking possibilities, we consider that it make sense to compare the results of each country with the results of the rest of subclusters within the same cluster. The countries of the same subcluster are the more similar in terms of levels and distribution of avoidable mortality. However, the other subclusters in the same cluster, present similar levels of avoidable mortality but differences by groups of diseases, which favors being able to approach improvements in results. The comparison makes it possible to identify areas for improvement and even to identify possible policies or measures for improvement to reduce the impact of certain causes of disease.

First, we will compare the data for Kazakhstan with that for the subcluster. To facilitate the comparison, in the next figures the points in blue represent the results of Kazakhstan and the orange points the results of the subcluster 1.1, integrated by Guatemala, Mauritius, Mexico, Suriname and Venezuela. The data of the regions are represented by the columns.

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Before delving into the data for the regions, it is interesting to look at the relationship between the data for Kazakhstan and the mean data for the international subcluster 1.1 with which we made this comparison. As can be seen, the main causes of mortality are, in both cases, diseases of the circulatory system, both preventable and treatable, in which Kazakhstan presents a clearly higher mortality than the subcluster.

If we focus on preventable causes of mortality, Kazakhstan presents worse results than subcluster 1.1, in terms of mortality from cancer, circulatory system diseases, or due to alcohol and drug use. Although the biggest difference in performance is related to respiratory diseases, where Kazakhstan performs significantly worse.

Regarding treatable causes of mortality, the country presents worse results than the subcluster in terms of mortality related to diseases of the circulatory system.

Although it is necessary to delve into the causes of these differences in mortality in each case, taking into account the context and the different determining factors in each region, what does become clear is that the levels of mortality from certain causes are a much greater problem. in some regions than in others, so that the adoption of public policies, as well as the design and distribution of resources should take this information into account in order to improve health results, which is the fundamental objective of health care systems.

Thus, considering its position with respect to the data from Kazakhstan, these are the results by quadrants which can define us the typologies by regions:

Better preventable but worst treatable. Leading causes: circulatory system diseases

The bars represent the results of the regions, the point blue the results of Kazakhstan and the orange point the results of the subcluster 1.1.

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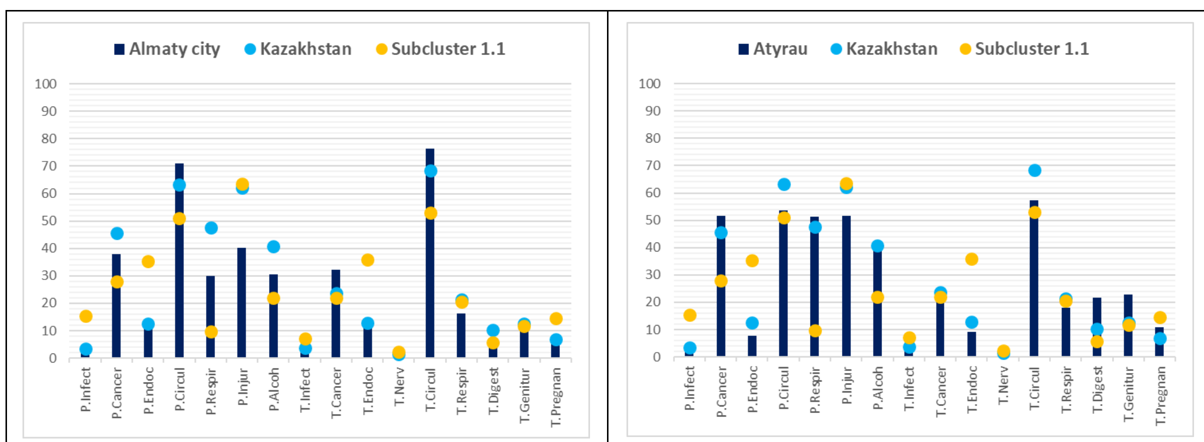
Figure 23. Avoidable mortality by groups of causes or diseases: Almaty city and Atyrau

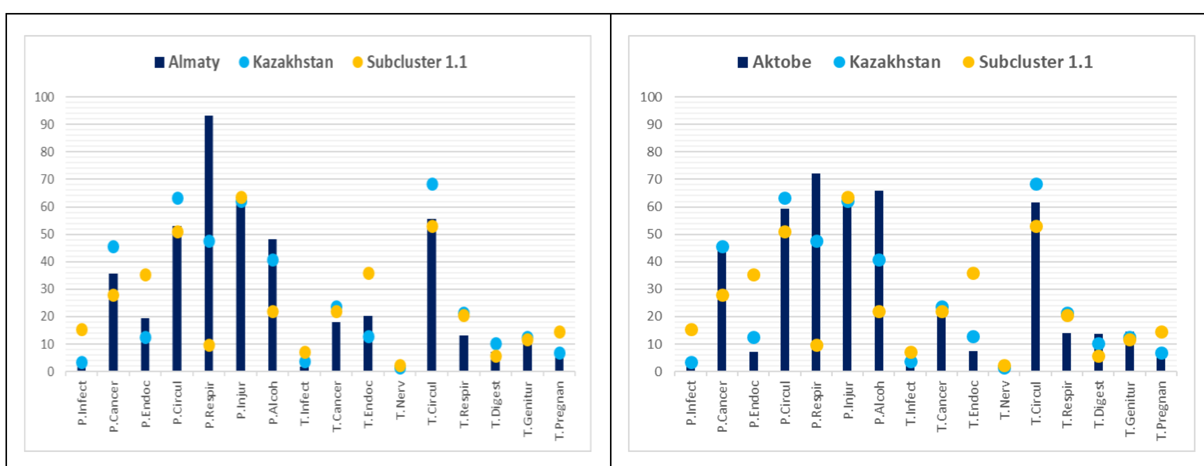


Source: Own elaboration

If we compare the distribution of mortality in Almaty city and Atyrau, notable differences can be seen. Almaty city, presents higher mortality values due to diseases of the circulatory system and treatable diseases related to cancer. In the case of Atyrau, it presents higher mortality in the case of diseases related to the respiratory system, injuries, cancer prevention or treatable diseases related to the genitourinary, digestive or respiratory systems. These differences make sense if we take into account that, while Almaty is a city that concentrates numerous services, Atyrau is a region especially dedicated to oil extraction.

Better treatable but worst preventable. Leading causes: Preventable respiratory diseases, injuries and alcohol

Figure 24. Avoidable mortality by groups of causes or diseases: Aktobe and Almaty region



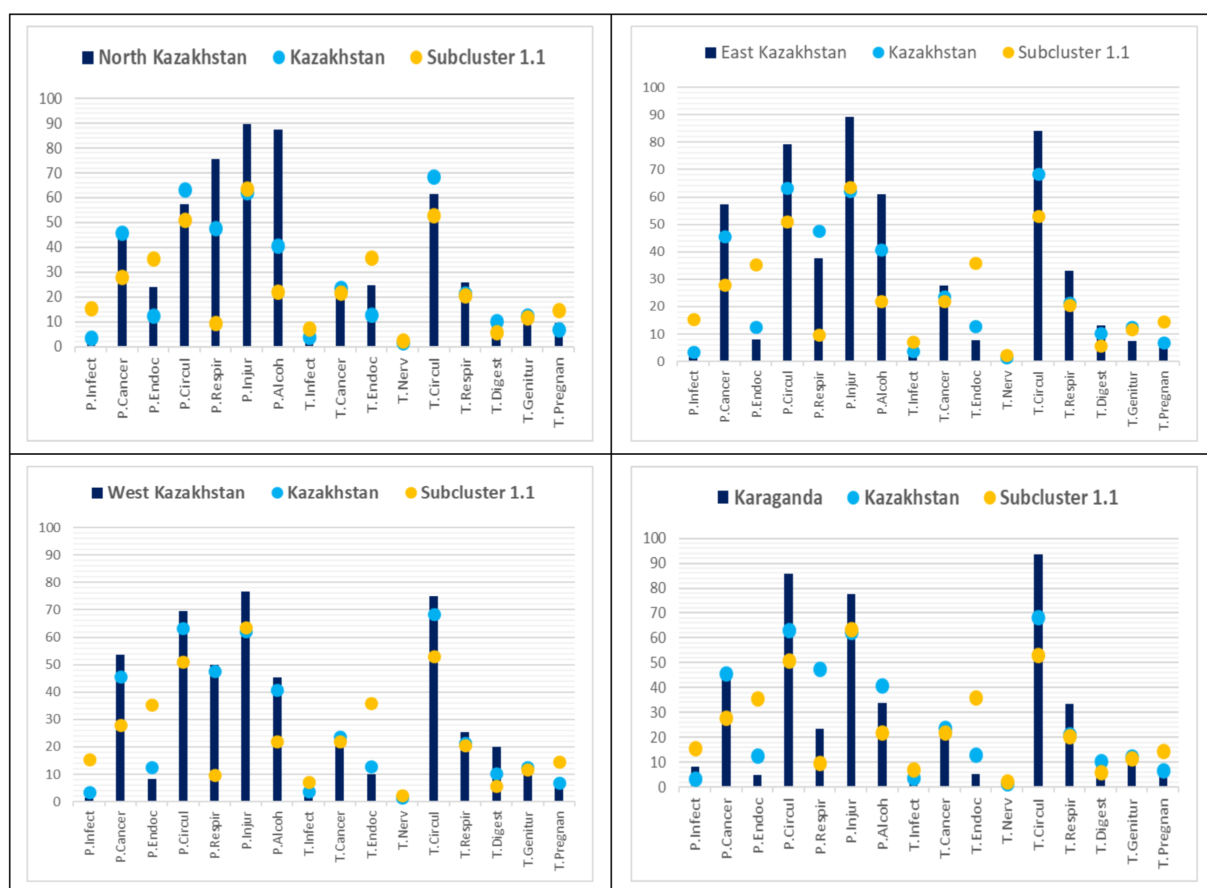
Source: Own elaboration

In the case of Almaty, the problem of the region with the prevention of diseases derived from the respiratory system stands out. If we analyse the data for this type of disease, which can be

avoided through treatment, mortality is much lower and similar to that of Aktobe. It is also worth noting the high mortality in both regions caused by injuries. This should prompt a reflection on the need to adopt preventive measures to avoid this high mortality. Also particularly noteworthy is the high mortality associated with alcohol and drug use in both regions, with Aktobe presenting the worst figures of the two regions.

Worst preventable and treatable. Leading causes: injuries and treatable circulatory diseases

Figure 25. Avoidable mortality by groups of causes or diseases: North, East and West Kazakhstan, Karaganda, Kostanay, Pavlodar and Zhambyl



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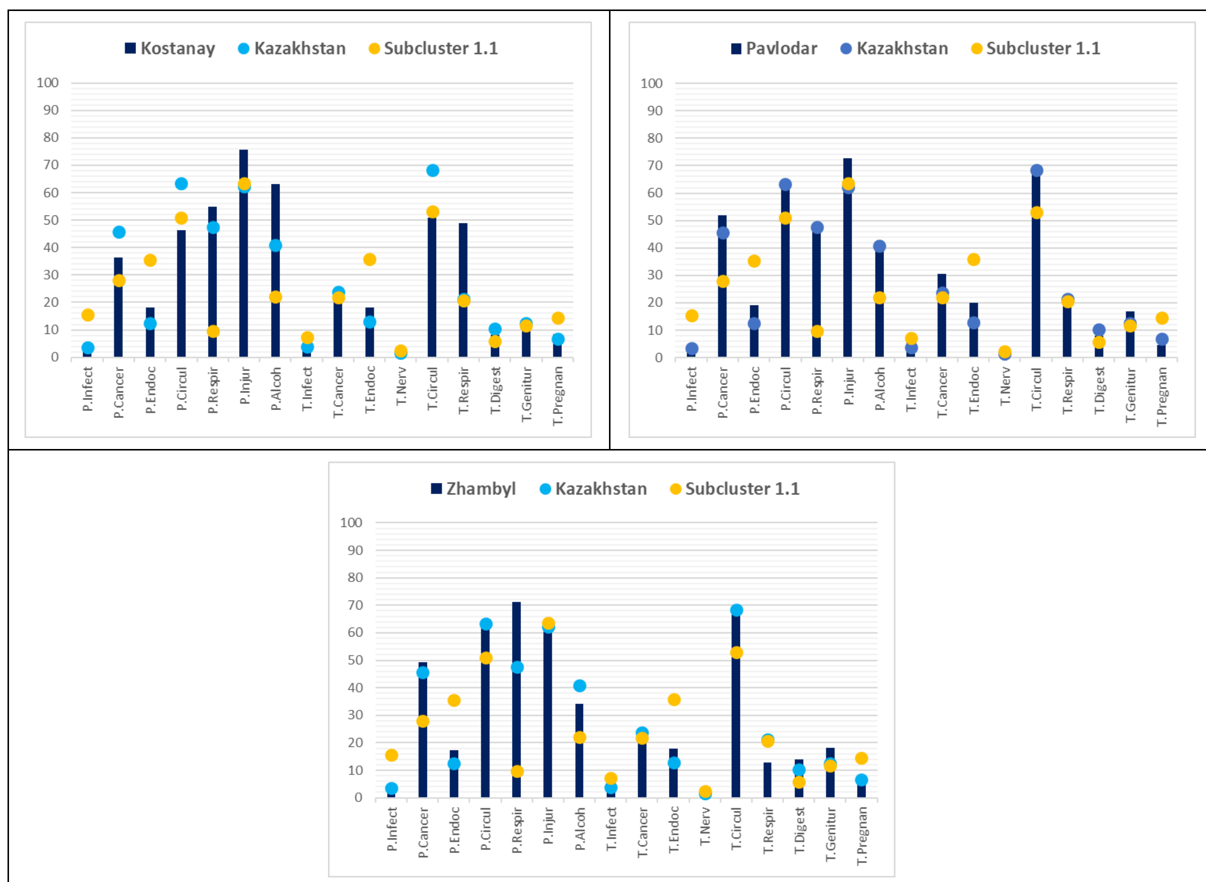

Source: Own elaboration

All the above regions present some common patterns such as the high numbers of avoidable mortality associated with preventable diseases, both cardiovascular, respiratory system, cancer, injuries and alcohol and drugs. From the point of view of treatable diseases, mortality levels are lower, with the exception of cardiovascular diseases which are especially high in Karaganda, East Kazakhstan and West Kazakhstan. In Zhambyl, the preventable respiratory diseases leading the avoidable mortality.

Best preventable and best treatable. Leading causes: circulatory diseases, cancer and injuries

Regarding the possibilities of benchmarking with subcluster 1.1, we can observe how in general the performance of the subcluster is better in terms of mortality derived from diseases of the respiratory system and that related to injuries. Additionally, the regions of Kazakhstan that are in the upper right quadrant, that is, with the worst performance in preventable and treatable mortality, perform significantly worse in the prevention of cancer and the prevention and treatment of diseases of the circulatory system.

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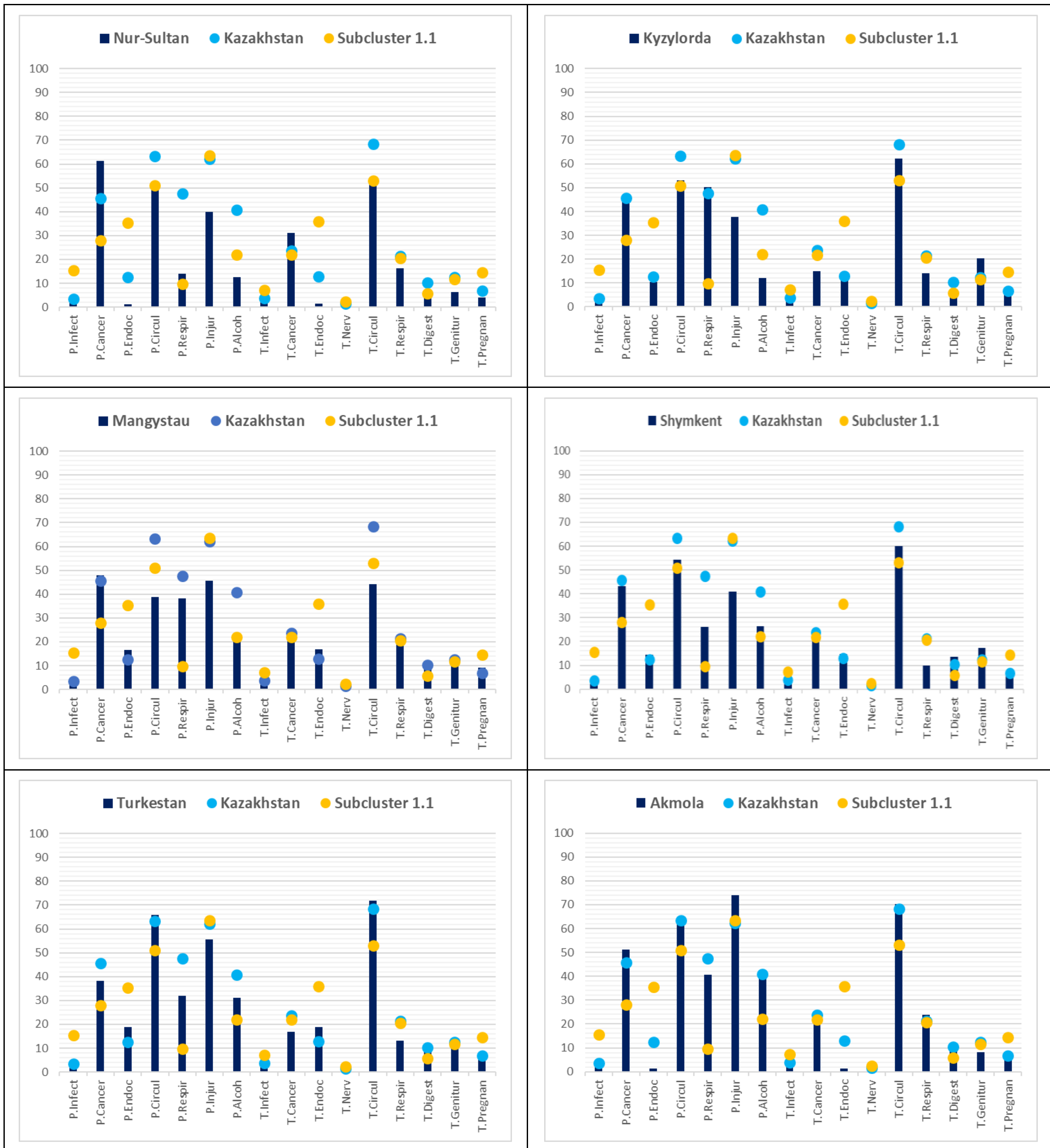
Figure 26. Avoidable mortality by groups of causes or diseases: Nur-Sultan, Kyzylorda, Mangystau, Shymkent, Turkestan and Akmola



Source: Own elaboration

Regionalization of the Input-Output Table of Kazakhstan

The input output table show us the interrelations of each sector with the economy. To know its specific impact, the sector has previously been disaggregated from the social services sector.

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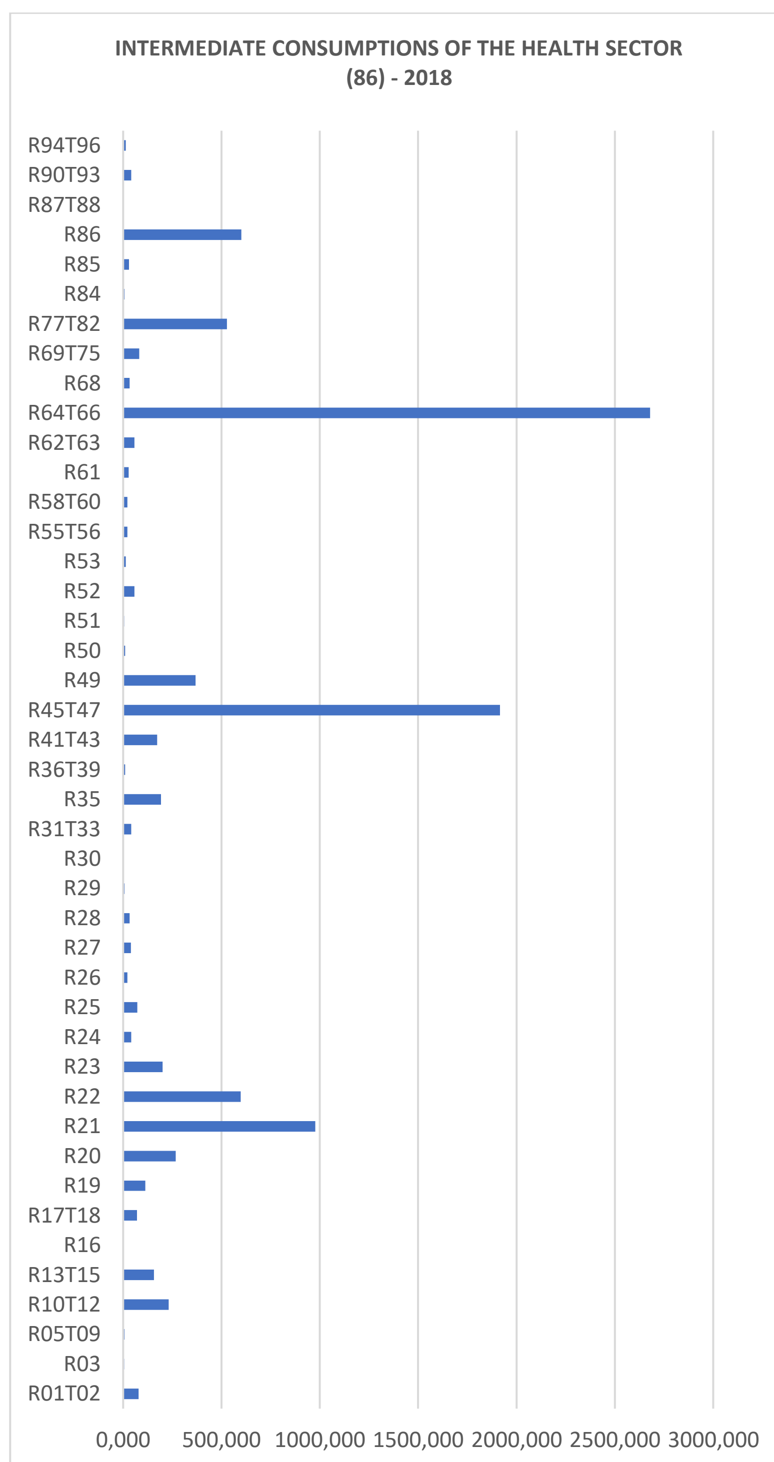
Figure 27. Production technology of the health sector in Kazakhstan. Year 2018



Source: Own elaboration using the OECD Input-Ouput Database

These calculations allow us to see the requirements are the intermediate consumption of the sector to produce health. Before delving into the regional data, we are going to analyze what the intermediate consumption of the Kazakhstan health sector has been in 2018, compared to the remaining sectors of the economy.

The figure 27 shows us how the intermediate consumption of the sanitary sector is distributed in volumes (not in coefficients) and offers us very interesting data. First of all, it is worth noting the importance of the sector of private financial and insurance activities (R64T66), in addition to pharmaceutical consumption (R21). Also, from the R45T47 sector which, as in the rest of the OECD, is a key sector in the supply of the health sector. They are followed in importance by self-consumption of the sector itself (R86), spending on "Rubber and plastic products" (R22) or the transport sector (R49).

Spatial distribution of the health production between the different regions

As we have highlighted in the introduction of the chapter, Kazakhstan still has a highly centralized management system with little margin of autonomy on the part of the regions. In this sense, it can be expected that the mode of production of public services is determined by the central government and that there are strong similarities between them due to the limited possibilities to produce in a different way.

However, it is important to analyse whether the production structure by region is similar or heterogeneous and also to know the role of the health sector in the different regional economies. For this reason, the Kazakhstan table has been regionalized.

As mentioned in the methodology, for the regionalization of the table a method based on Location coefficients, the 2DLQ, has been used, which based on the regional output allows us to know what part of each input or intermediate consumption contributed to the health sector occurs in each region.

To regionalize the Kazakhstan national table for each region we should take into account that the accuracy of the regional tables depends on the weight of regional production on the national output. We consider that the calculated RIOTs are accurate for those regions which represent about 5% of total production. As a result, the regions whose weight in the total Output of Kazakhstan represents, for the year 2018, less than 4% of the total, are discarded from this analysis, considering that they may not have sufficient consistency and require a deeper analysis or adjustments before their publication. The discarded tables are those corresponding to Akmola, Zhambyl, Kostanay, Kyzylorda, North Kazakhstan, Turkestan and Shymkent city.

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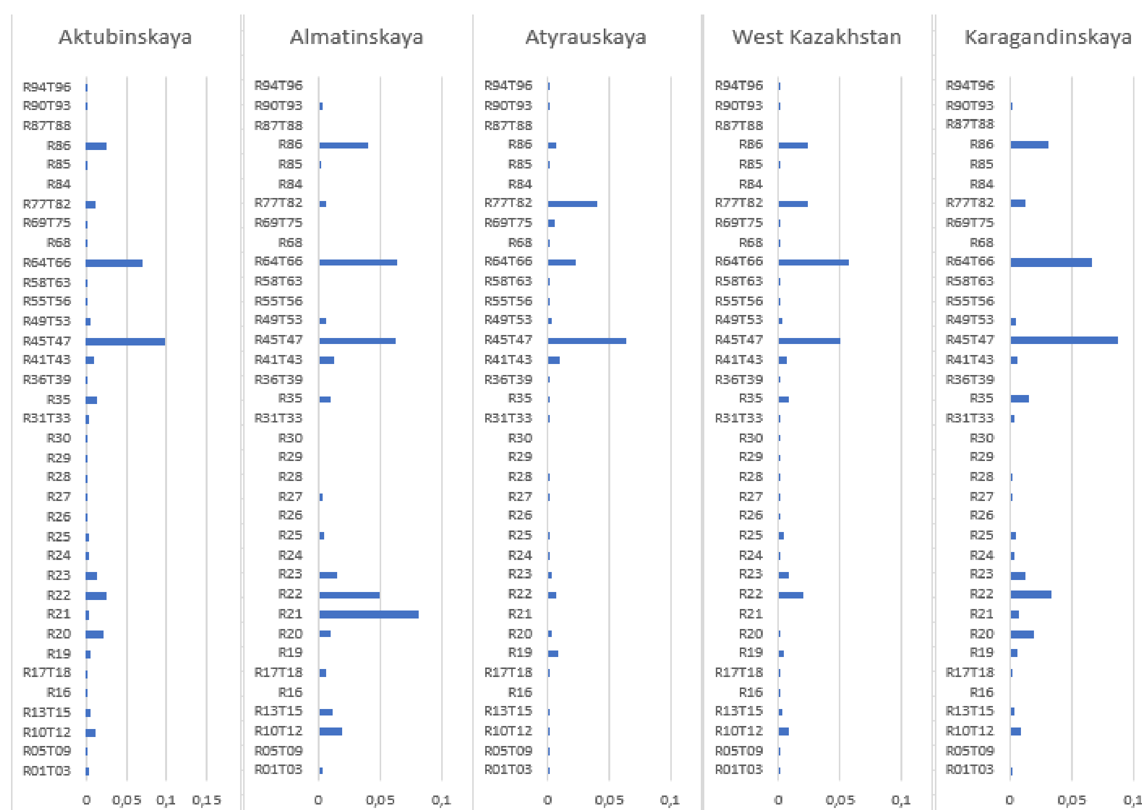
As result we have obtained the tables for the remaining regions. In the appendices of the chapter is reflected a representation of the sectoral direct coefficients of the RIOTs for each of the regions considered (figure 31 to figure 40) taken the national table of Kazakhstan as a reference (Figure 30). As we can see, there are important differences between regions and their intersectoral relationships, what proves the importance of having and use regional input-ouput for the analysis.

Figure 28. Production technology of the health sector in Kazakhstan. Year 2018. Regions: Aktobe, Almaty, Atyrau, West Kazakhstan and Karaganda



Source: Own elaboration

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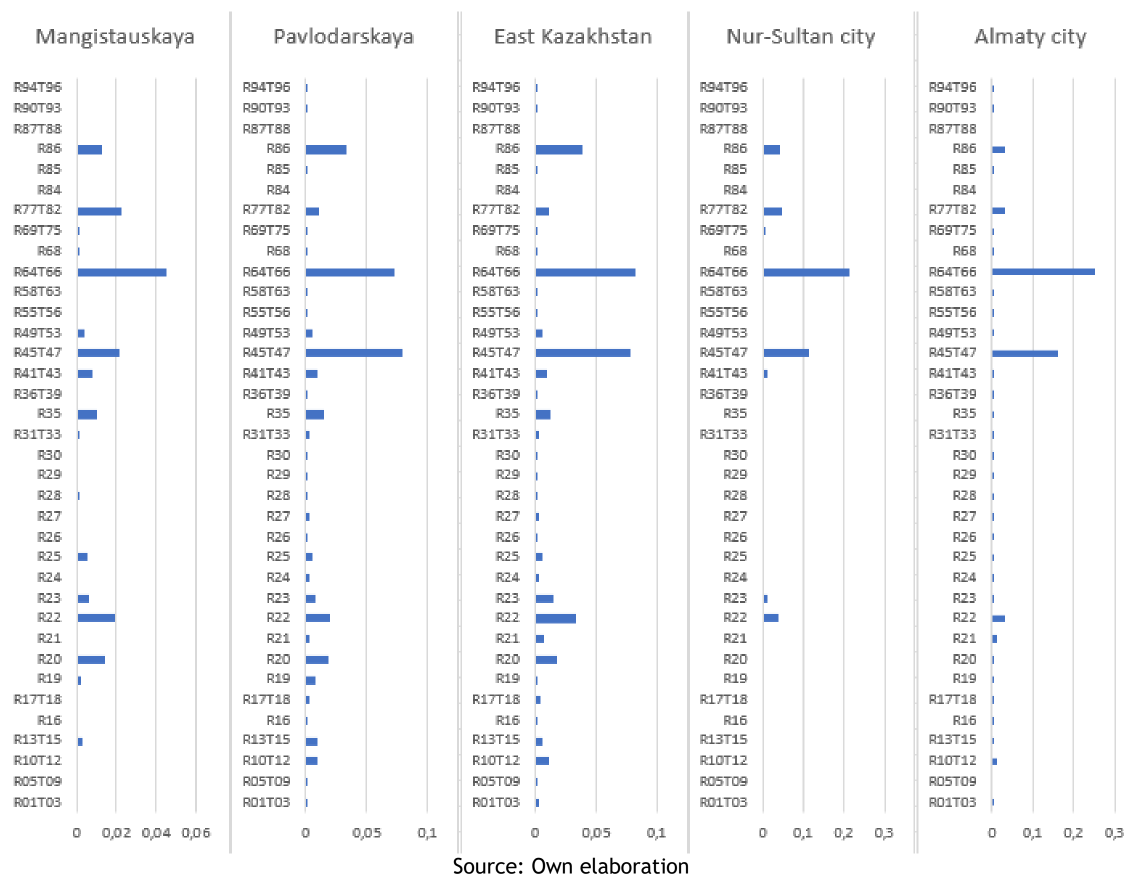
Figure 29. Production technology of the health sector in Kazakhstan. Year 2018. Regions: Mangystau, Pavlodar, East Kazakhstan, Nur-Sultan city and Almaty city



Source: Own elaboration

In the case of the Human Health sector, we can observe how its behavior is different by regions and show different production structures in each case.

The Table 19 (in the appendices of the chapter) show the column vector of direct coefficients for the different regions of Kazakhstan.

If we compare the results of these vectors with the column vector of the Z matrix corresponding to the health sector (see figures 28 and 29), we observe that there is heterogeneity in the way that each region contributes to the health sector. We also observe that, regarding consumption in volumes at the national level, there are several regions that present different production patterns, which justifies the importance of regionalizing IOTs and analysing results in detail.

By comparing the column of the sector in the Z matrix and the columns of coefficients by sectors, we can observe how the consumption of financial and insurance activities (64T66) by the health sector originates mostly in the 2 large cities; Astana and Almaty, something that seems logical given that services tend to be more concentrated in urban areas with a high

population density. However, its contribution in terms of other inputs is lower than in other regions. With regard to pharmaceutical or chemical inputs (21), the leading role that Almaty region has can be observed or rubber or plastic products (22). Other regions are more important as providers of other requirements of the health sector at national level as in the case of 86 and 77T82. Es el caso de estos insumos, la sanidad también tira de regiones como Almaty, East Kazakhstan o Pavlodar en el caso del autoconsumo, o Atyrau en el caso del R77T82.

Now, if we compare the vector of technical coefficients for the Human Health between the 10 regions considered, we observe that, in general, the sectors more important for Health production are: the Financial and insurance activities (64T66) and the Wholesale and retail trade; repair of motor vehicles (45T47), with the higher coefficients. The following sector in order of importance are the self-consumption of the sector (86) and the sector of the Rubber and plastics products. This general order by regions holds by national table, where the most important sector in the production structure of the Health System are the Financial and insurance activities (64T66) followed by the sector 45T47. The third more important is the pharmaceutical sector, and this is not a regularity for all regions.

The sector Wholesale and retail trade; repair of motor vehicles (45T47) is, in fact, the main provider of the sector "*Human Health Activities*" in the regions of Aktobe, Atyrau, Karaganda and Pavlodar. The Financial and insurance activities (64T66) are the most important production for the Human Health sector in West Kazakhstan, Mangystau, East Kazakhstan, Nur-Sultan and Almaty city.

In the case of Almaty region, the sectors that more contribute to the production of the health sector, is the pharmaceutical sector (21: Pharmaceuticals, medicinal chemical and botanical products). This is the third more important sector in the column vector for Kazakhstan and, it seems that this result is driven by this region since for the rest of the regions pharmaceutical sector is not that important.

3.5. CONCLUSIONS

As indicated in the introduction, Kazakhstan is an interesting case study both from the point of view of evaluating its performance and from the point of view of its relationship with the rest of the economy.

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The country is immersed in a process of various reforms that have led to the improvement of some of its health outcomes, such as infant mortality or maternal mortality. However, as the OECD, (2018b) establishes in general, the reforms undertaken have so far not obtained the expected results. For this reason, improving your performance evaluation is especially important at this time.

From an economic point of view, the health sector is characterized by the strong centralization of its health system. It also has a very strong dependence on out-of-pocket spending by households and on financial and insurance services to finance health at the national level. This strongly conditions the possibility of access for the population with the lowest income in the country.

The strong regional disparities that have been verified are also an important aspect to take into account in the design of the country's public policies. Being a centralized system, the decisions made should take special care in adapting them to the socioeconomic reality of each of the regions to guarantee their efficiency.

For this reason, it is important that the country have in-depth evaluations that also allow it to compare itself with other health systems and identify benchmarking possibilities.

This chapter offers information that contemplates all these aspects and that constitutes an important contribution to the existing literature to date for carrying out this type of analysis in national health systems. The results obtained show us different typologies of regions depending on the types of preventable and treatable mortality that predominate in each case. Some especially problematic causes of mortality for the country are also detected.

At the national level, diseases derived from the circulatory system are those with the highest preventable mortality, both preventable and treatable. It should be noted that, in general, the country has high mortality from preventable causes, such as deaths from injuries (the second most important), respiratory diseases, preventable cancer, or deaths from alcohol and drug use. This causes explain the most excess of mortality in the country. If we consider that prevention is more associated with primary care, this is important information when defining the planning of system resources and even measures that go beyond the health system. Regarding mortality

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that can be avoided through treatment, cardiovascular diseases, which are by far the highest, are followed in importance by those derived from cancer or respiratory diseases.

At the regional level there is significant heterogeneity, both in the standardized mortality data and in the distribution of mortality from the different types of causes studied.

These data at the regional level make it possible to identify the diseases on which action is a priority in each case. In addition, it also makes it possible to identify which regions obtain lower mortality values for each type of cause or disease. This is the starting point for identifying the origin of these differences and the possible measures to be adopted to reduce them.

From the point of view of the analysis of production structures, given the information limitations, it has not been possible to develop the Regional Input-Output Tables of Kazakhstan and replicate for the regions the analysis carried out at the national level in Chapter 2. In its First, the Kazakhstan table has been regionalized to obtain how the origin of inputs is distributed by region. That is, what each region produces for the national health system. The results indicate, on the one hand, the strong dependence at the national level of certain supplier sectors on Kazakhstan's production technology, such as the financial and insurance activities (64T66), the Wholesale and retail trade (45T47) or the pharmacist, who stand out significantly from the rest. In the first two cases, the main providers are the cities of Almaty and Nur-sultan (Astana). In the case of pharmaceutical products, it is the Almaty region that almost entirely supplies the national health system.

This chapter offers information that contemplates all these aspects and that constitutes an important contribution to the existing literature to date for carrying out this type of analysis in national health systems.

These contributions contain key data for the design of public policies related to the efficiency of the health system in Kazakhstan. They also constitute a starting point to analyze the importance of the health sector as a buyer of the rest of the industries in the different regions. Undoubtedly, necessary information for the future planning of the health system and the investments associated with it.

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APPENDICES TO CHAPTER III

Table 16. Regions of Kazakhstan.2018

Regions in Kazakhstan in 2018
Akmola
Aktobe
Almaty
Almaty city
Astana city
Atyrau
East Kazakhstan
Karaganda
Kostanay
Kyzylorda
Mangystau
North Kazakhstan
Pavlodar
Shymkent city
Turkestan
West Kazakhstan
Zhambyl

Source: Own elaboration

Table 17. Density of population by region. 2022

	Number of population as of January 1, 2022, thousand people	Area (Km2)	Density of population
Kazakhstan	**19.503,2**	**2.725,0**	**7,157**
Aktobe	916,8	300,6	3,049
Karaganda	1.355,9	428,0	3,168
Kyzylorda	823,3	226,0	3,642
Kostanai	835,7	196,0	4,264
Mangystau	745,9	165,6	4,503
West Kazakhstan	683,3	151,3	4,515
East Kazakhstan	1.344,9	283,2	4,748
Akmola	785,7	146,2	5,374
North Kazakhstan	539,1	98,0	5,502
Atyrau	681,2	118,6	5,743
Pavlodar	756,5	124,8	5,244
Zhambyl	1.209,7	144,3	8,385
Almaty	2.177,3	223,9	9,724
Turkistan	2.088,5	117,2	17,813
Shymkent city	1.162,3	1,2	993,426
Astana city	1.295,7	0,8	1599,248
Almaty city	2.101,5	0,7	3081,356

Source: Own elaboration

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Table 18. Gross Regional Product per capita. 2022

Regions	IPV GRP, %	GRP per capita, thousand tenge
Republic of Kazakhstan	103,3	5240,5
Turkistan	100,5	1666,6
Zhetisu	102,4	1985,9
Zhambyl	105,3	2264,8
Shymkent city	106,8	2689,2
Kyzylorda	102,4	2824,0
Almaty	106,3	2847,3
Abay	102,1	3780,6
North Kazakhstan	105,5	3956,3
Akmola	108,4	4263,6
Aktobe	100,0	4675,0
Kostanay	104,5	4997,9
East Kazakhstan	103,7	5328,4
Mangystau	101,3	5357,8
Pavlodar	100,2	5528,9
West Kazakhstan	101,0	6420,4
Karaganda	100,3	6517,4
Ulytau	103,1	7569,3
Astana city	105,5	7881,9
Almaty city	105,1	8944,8
Atyrau	101,6	20541,2

Source: Own elaboration

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Table 19. Column Vector of direct coefficients of the sector 86 “Human Health Activities”, by region in Kazakhstan

Column vector of direct coefficients of the sector 86 "Human Health Activities" by region											
	Aktubinskay	Almatynska	Atyrauskaya	West Kazakl	Karagandins	Mangistausl	Pavlordarsk	East Kazakhs	Nur-Sultan (	Almaty city	Kazakhstan
R01T03	0,0024	0,0035	0,0004	0,0015	0,0019	0,0002	0,0024	0,0033	0,0000	0,0000	0,0031
R05T09	0,0004	0,0000	0,0005	0,0005	0,0003	0,0005	0,0002	0,0003	0,0000	0,0000	0,0005
R10T12	0,0121	0,0192	0,0005	0,0080	0,0088	0,0006	0,0100	0,0117	0,0037	0,0110	0,0167
R13T15	0,0053	0,0121	0,0015	0,0027	0,0041	0,0032	0,0090	0,0061	0,0025	0,0048	0,0113
R16	0,0000	0,0000	0,0000	0,0000	0,0001	0,0000	0,0001	0,0001	0,0000	0,0001	0,0001
R17T18	0,0010	0,0058	0,0003	0,0006	0,0024	0,0004	0,0036	0,0049	0,0024	0,0058	0,0051
R19	0,0045	0,0001	0,0085	0,0044	0,0057	0,0020	0,0088	0,0000	0,0000	0,0002	0,0082
R20	0,0207	0,0104	0,0035	0,0020	0,0197	0,0143	0,0188	0,0175	0,0002	0,0018	0,0194
R21	0,0027	0,0812	0,0000	0,0000	0,0082	0,0007	0,0035	0,0072	0,0001	0,0128	0,0709
R22	0,0244	0,0496	0,0066	0,0207	0,0335	0,0192	0,0200	0,0333	0,0398	0,0337	0,0434
R23	0,0123	0,0149	0,0027	0,0084	0,0123	0,0063	0,0077	0,0152	0,0105	0,0042	0,0145
R24	0,0022	0,0001	0,0000	0,0001	0,0035	0,0000	0,0033	0,0035	0,0012	0,0002	0,0030
R25	0,0033	0,0043	0,0009	0,0042	0,0049	0,0051	0,0058	0,0053	0,0025	0,0022	0,0053
R26	0,0011	0,0004	0,0000	0,0012	0,0008	0,0000	0,0001	0,0002	0,0015	0,0019	0,0015
R27	0,0000	0,0033	0,0001	0,0014	0,0019	0,0000	0,0032	0,0029	0,0007	0,0009	0,0029
R28	0,0016	0,0010	0,0000	0,0008	0,0026	0,0018	0,0014	0,0023	0,0004	0,0008	0,0024
R29	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0001	0,0005	0,0000	0,0001	0,0005
R30	0,0000	0,0000	0,0000	0,0001	0,0000	0,0000	0,0001	0,0001	0,0002	0,0000	0,0001
R31T33	0,0022	0,0010	0,0011	0,0023	0,0031	0,0011	0,0031	0,0028	0,0012	0,0024	0,0030
R35	0,0131	0,0104	0,0024	0,0081	0,0149	0,0104	0,0154	0,0128	0,0050	0,0060	0,0140
R36T39	0,0007	0,0004	0,0005	0,0004	0,0008	0,0005	0,0008	0,0005	0,0002	0,0003	0,0007
R41T43	0,0091	0,0123	0,0103	0,0073	0,0068	0,0080	0,0097	0,0097	0,0120	0,0049	0,0126
R45T47	0,0984	0,0630	0,0637	0,0498	0,0881	0,0215	0,0787	0,0788	0,1121	0,1620	0,1390
R49T53	0,0050	0,0063	0,0034	0,0030	0,0051	0,0038	0,0060	0,0056	0,0043	0,0039	0,0066
R55T56	0,0010	0,0008	0,0011	0,0009	0,0007	0,0008	0,0005	0,0008	0,0017	0,0016	0,0016
R58T63	0,0006	0,0008	0,0002	0,0004	0,0007	0,0004	0,0007	0,0007	0,0031	0,0032	0,0026
R64T66	0,0697	0,0639	0,0233	0,0571	0,0668	0,0449	0,0726	0,0829	0,2144	0,2531	0,2062
R68	0,0016	0,0013	0,0006	0,0010	0,0015	0,0012	0,0010	0,0013	0,0024	0,0021	0,0022
R69T75	0,0015	0,0012	0,0055	0,0018	0,0013	0,0015	0,0008	0,0024	0,0071	0,0062	0,0059
R77T82	0,0121	0,0064	0,0396	0,0236	0,0131	0,0222	0,0113	0,0115	0,0455	0,0304	0,0387
R84	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
R85	0,0017	0,0024	0,0005	0,0014	0,0016	0,0009	0,0015	0,0020	0,0021	0,0015	0,0025
R86	0,0251	0,0409	0,0076	0,0246	0,0312	0,0129	0,0333	0,0394	0,0410	0,0309	0,0436
R87T88	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
R90T93	0,0013	0,0032	0,0006	0,0016	0,0019	0,0006	0,0014	0,0018	0,0035	0,0025	0,0030
R94T96	0,0002	0,0002	0,0004	0,0006	0,0003	0,0003	0,0003	0,0002	0,0011	0,0011	0,0009

Source: Own elaboration

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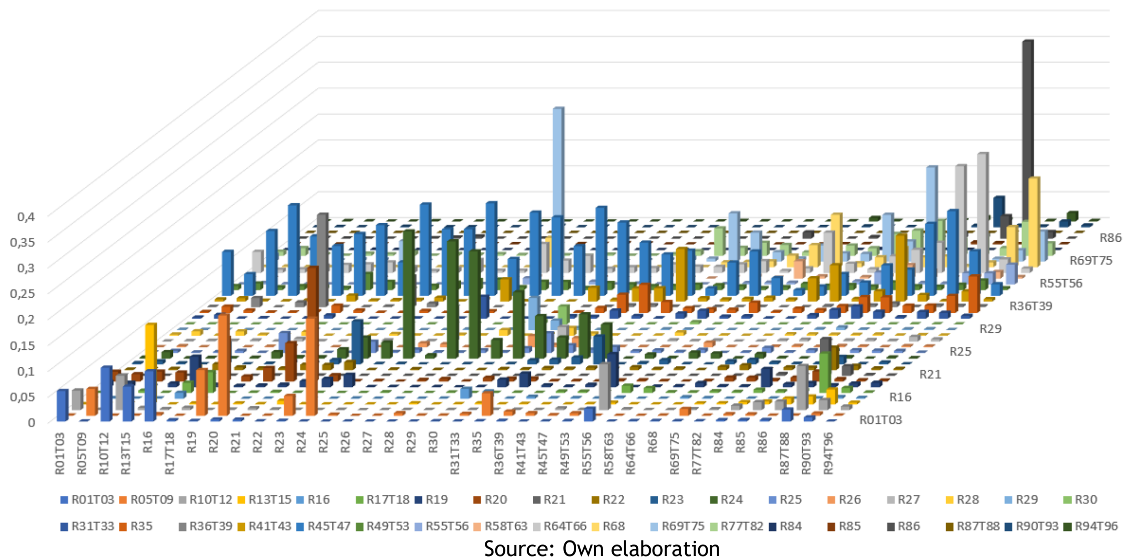
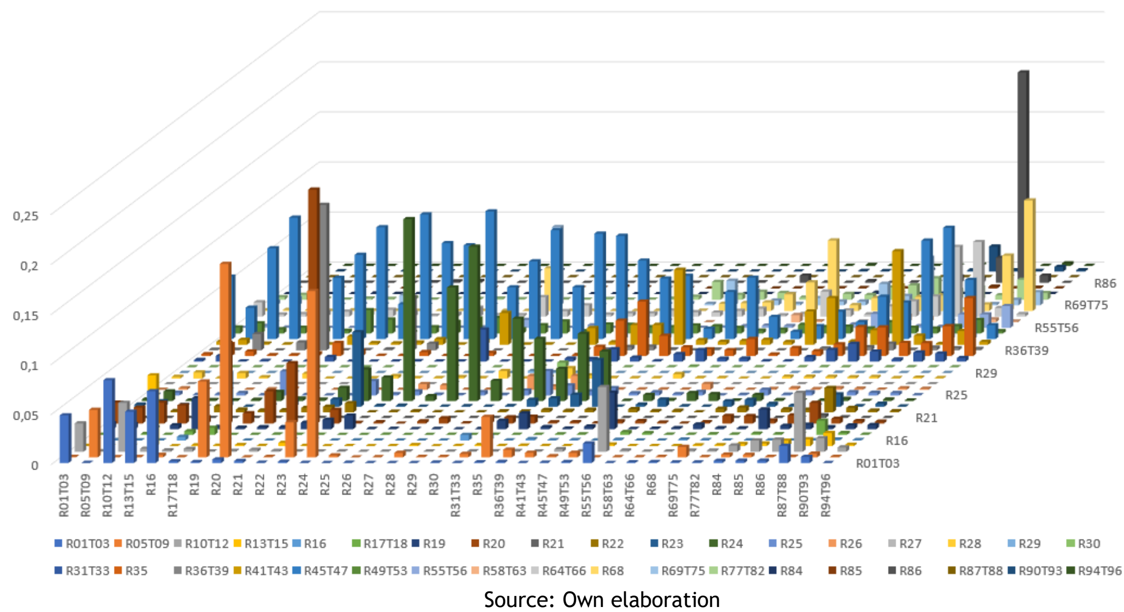
Figure 30. Production estructure of Kazakhstan. Total Input-Output matrix coefficients. 2019



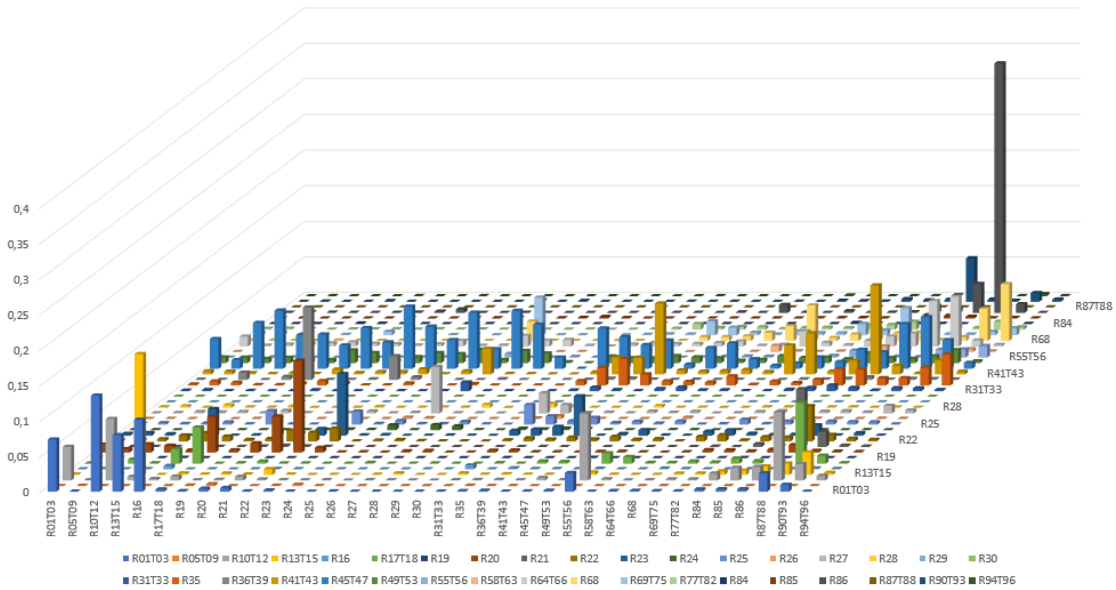
Source: Own elaboration

Figure 31. Regional distribution of the national production. Aktobe. 2019



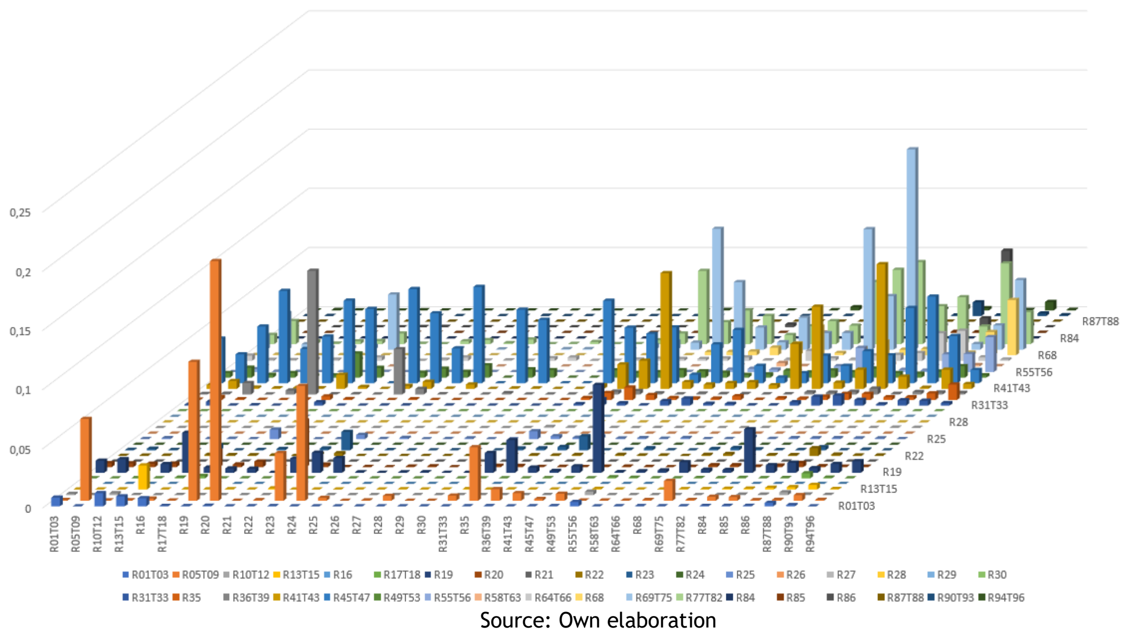
Source: Own elaboration

Figure 32. Regional distribution of the national production by sector. Almaty. 2019



Source: Own elaboration

Figure 33. Regional distribution of the national production by sector. Atyrau. 2019



Source: Own elaboration

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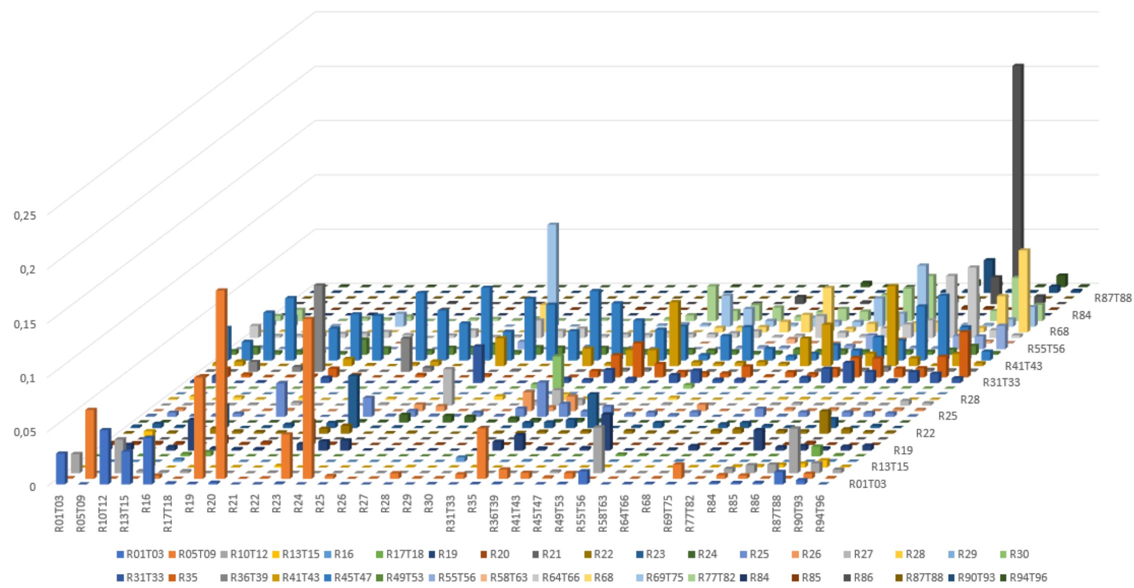
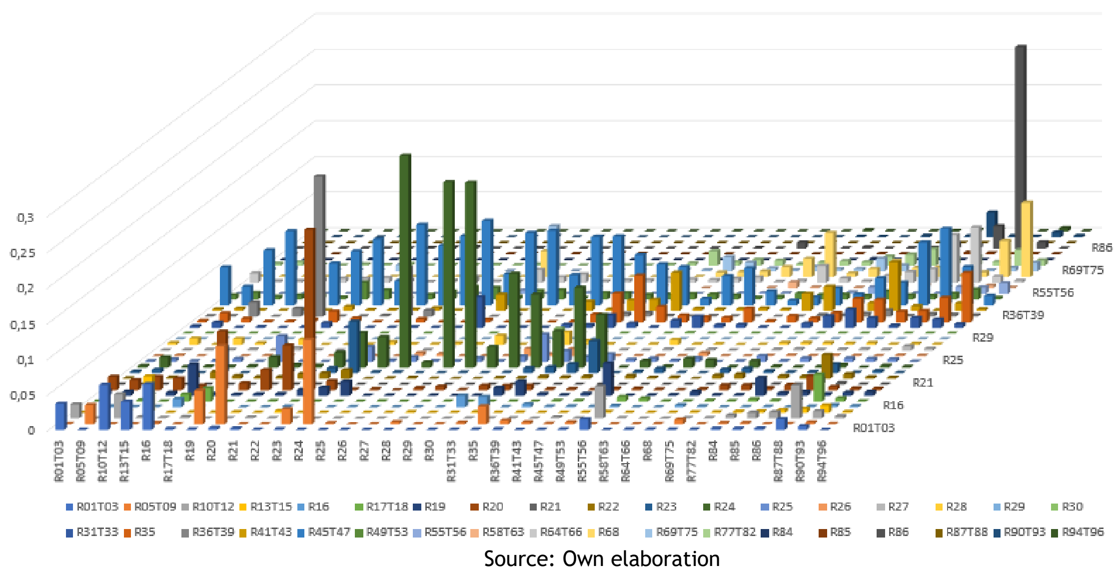
Figure 34. Regional distribution of the national production by sector. West Kazakhstan. 2019



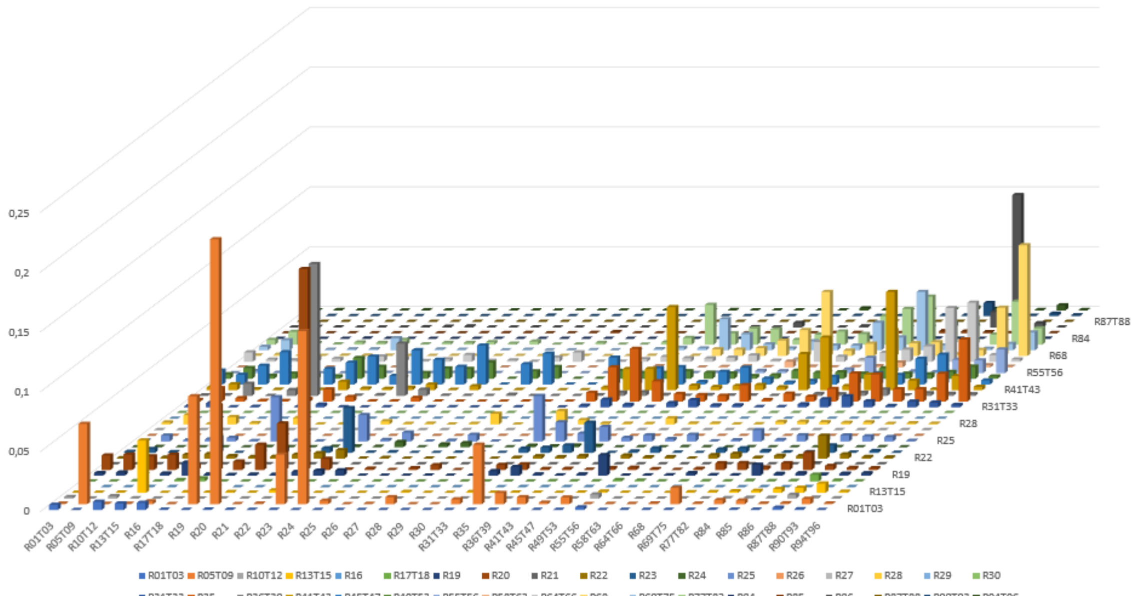
Source: Own elaboration

Figure 35. Regional distribution of the national production by sector. Karaganda. 2019



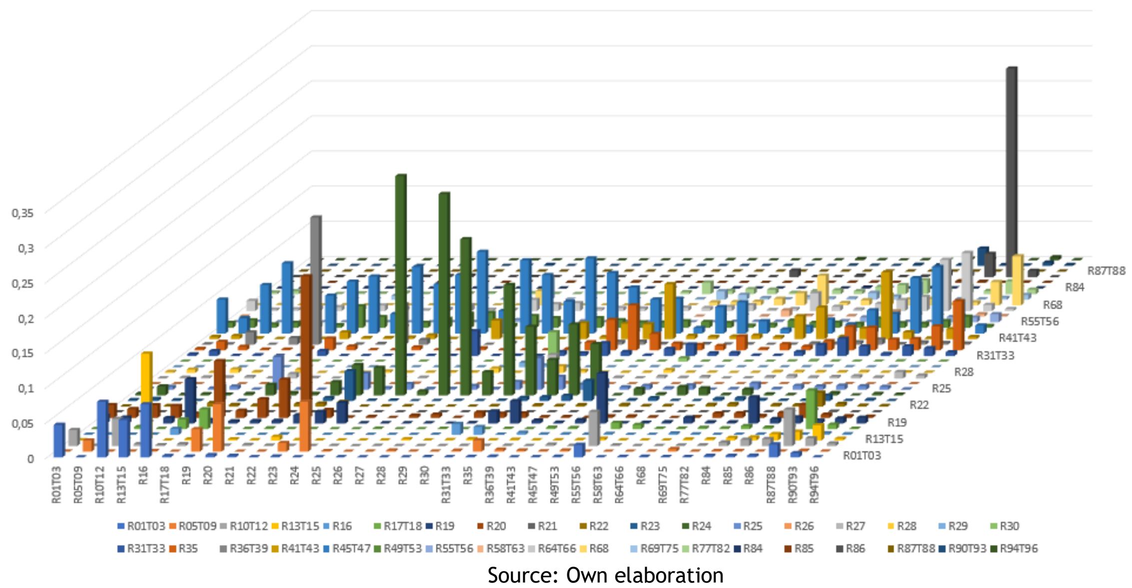
Source: Own elaboration

Figure 36. Regional distribution of the national production by sector. Mangystau. 2019



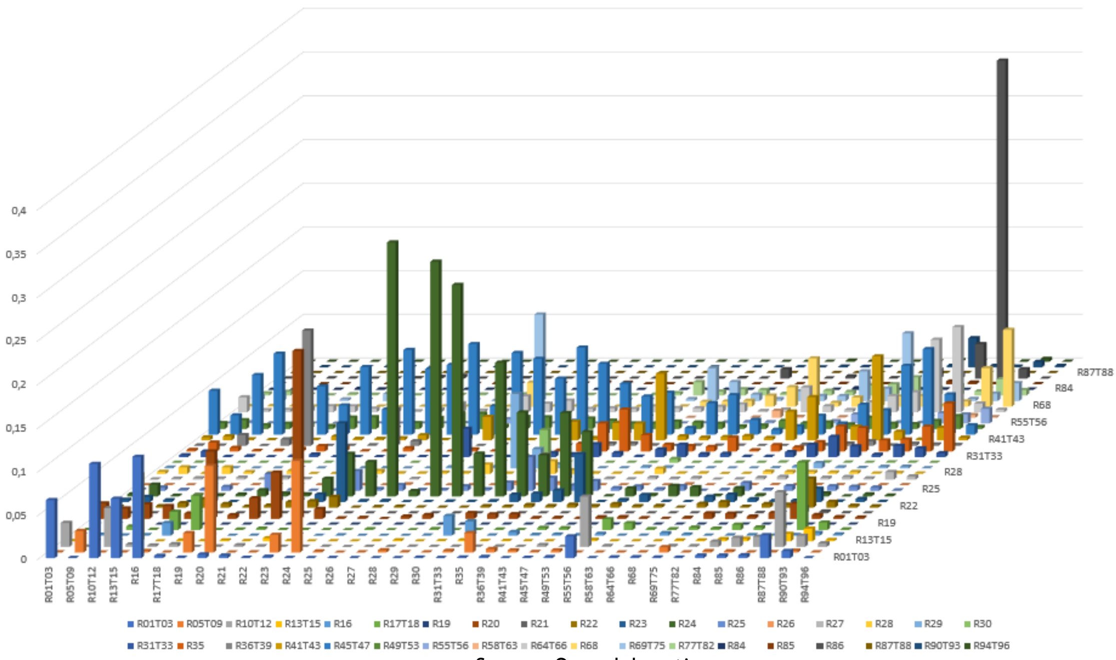
Source: Own elaboration

Figure 37. Regional distribution of the national production by sector. Pavlodar. 2019



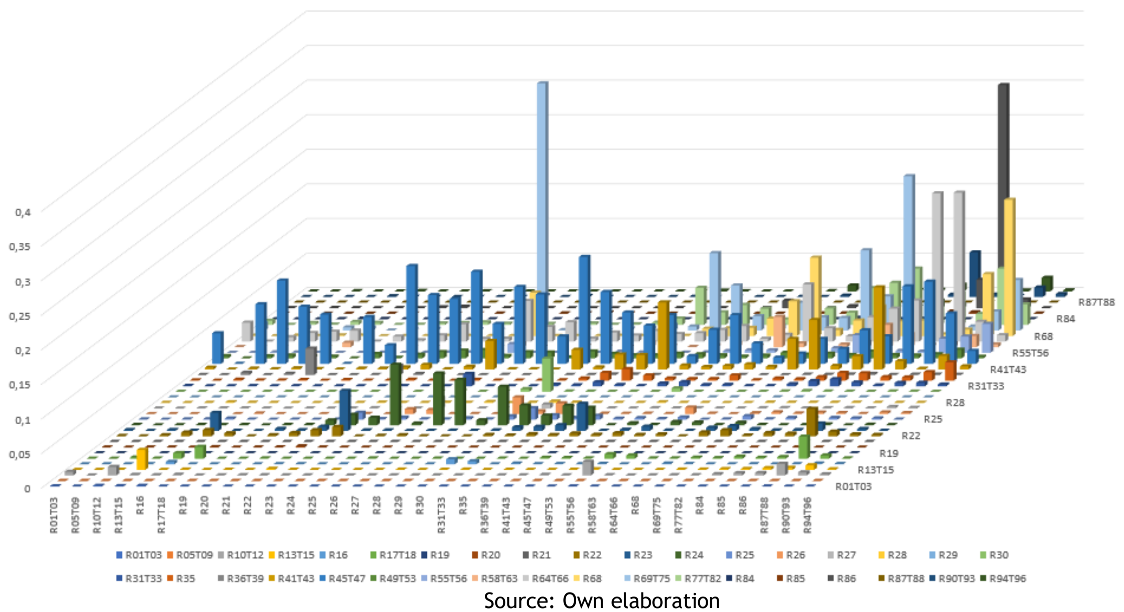
Source: Own elaboration

Figure 38. Regional distribution of the national production by sector. East Kazakhstan. 2019



Source: Own elaboration

Figure 39. Regional distribution of the national production by sector. Nur-sultan city. 2019



Source: Own elaboration

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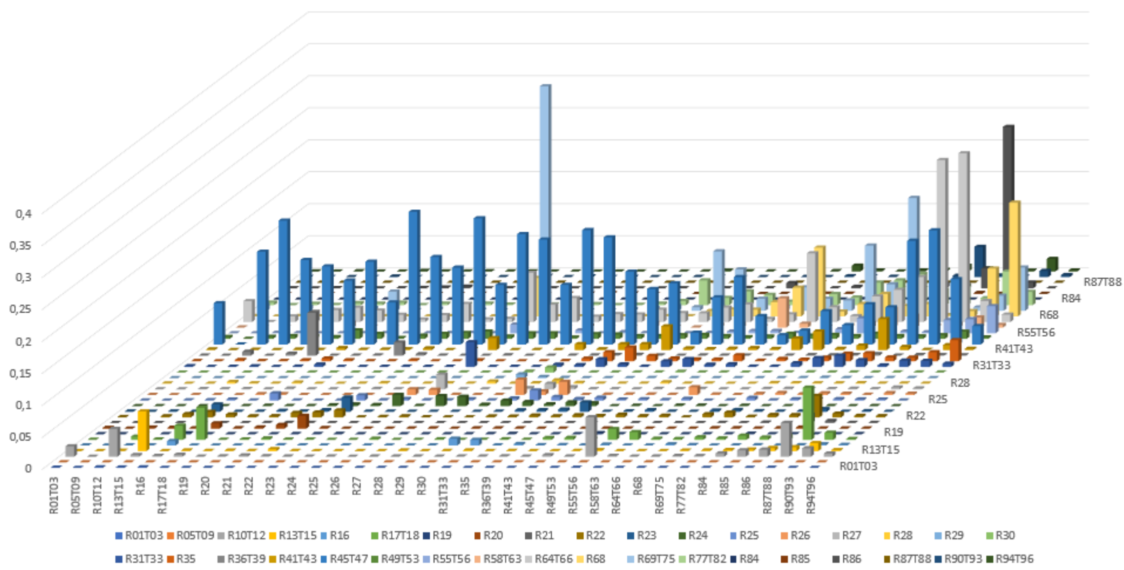
Figure 40. Regional distribution of the national production by sector. Almaty city. 2019



Source: Own elaboration

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RESULTS AND CONCLUDING REMARKS

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The starting point of this thesis point has been the idea of the crucial and growing importance of healthcare systems worldwide, recently highlighted by the COVID-19 pandemic. Their role is essential and key to being able to produce the most important good for any people or society. Without health there is no well-being or economy.

But even, from the economic point of view, we have been able to verify that its role goes far beyond the traditional and still prevailing vision that insists on evaluating it as a sector that generates social spending. Although the literature has already related in many cases the importance of health from the point of view of productivity, the reduction of work absenteeism, etc. With this analysis we have been able to verify that the role played by health systems can go much further in national and regional economies. Without going any further, having prepared, flexible and resilient health systems can reduce the tremendous impact of shocks such as the one experienced with COVID-19.

Our analysis has focused on a series of objectives and questions that we have tried to answer related to the role of health systems. We have tried to provide an international comparison based on the evaluation of its performance in terms of health outcomes and also in terms of its macroeconomic role and its interrelationships with the rest of the economy. According to the report Health at Glance 2021, the avoidable mortality in the OECD in 2019 exceeded 3 million premature deaths, approximately 1.9 million preventable deaths and about 1.1 million of treatable deaths.

We have started from the proven idea that health systems present significant heterogeneity at the level of health outcomes (for example, with very unequal levels of life expectancy at the international level), and also at the level of inputs such as public health spending and private, resources used to produce health, (doctors, hospital beds), etc. This idea reaffirms the need to deepen the study of the performance of health systems and also in the identification of their way of producing it and their true role in the economy as a whole.

Given the first question that we have asked ourselves, how to measure the results of health systems in a homogeneous and comparable way that we can relate to the different functions of a health system?, we know that there is no single precise indicator that allows this evaluation. . In our case, we have chosen to calculate, for the first time for 75 countries, the indicators of avoidable, preventable and treatable mortality, standardized by age groups and by 12 different

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causes of mortality using the same mortality database (WHO). The data obtained have revealed the importance of the development of preventive medicine as a formula to avoid excesses of premature mortality. They have also highlighted the importance, in general, of cardiovascular diseases and cancer at an international level as causes of mortality. However, different patterns of avoidable mortality have been detected in the different groups of countries or subclusters that we have identified. This comparison with other subclusters constitutes an interesting starting point for decision-makers to identify potential improvements in their healthcare systems and even identify practices or strategies that may be useful in their own healthcare policies.

The next question that we have asked ourselves has been how to produce health in each country and what is the effect of this way of producing from the macroeconomic point of view? Through the hypothetical extraction method (HEM) we have been able to see how the effect of each health system on their respective economies is different from the output point of view. But above all we have been able to observe how the production structure based on the concept of Input-Output production technology also differs between countries.

Once again applying cluster analysis, we have identified different types of production at the national level. We have confirmed that there are important differences between them in terms of the inputs used in the production of health. But, when applying the analysis, in addition to the Domestic and import Input-Output tables, we find that these differences are even greater and generate new groups of countries or subclusters based on this structure based on the origin of the inputs. This type of information reveals to what extent the consumption of the health sector is linked to each sector of its domestic economy and to what extent it depends on imports and what type of products they import. This information is crucial both from the point of view of internal impact and, for example, in the face of potential crises such as COVID-19 or lockdown situations).

Regarding the sectors that provide health systems at the domestic level, those with the greatest prominence have been identified, among which are the sectors *Wholesale and retail trade* (45T47), *pharmaceutical* (21), *financial and insurance activities* (64T66), the self-consumption, the *administrative services* (77T82) or the *professional and technical services* (69T65). From the point of view of imports, the pharmaceutical sector is the one that generates

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the greatest international trade and the greatest dependence on the Global Supply Chain. The weight of each of them varies in each subcluster.

In order to share both types of results, health and production structure, we have calculated the means and medians of preventable and treatable mortality for each of the types of production identified. From the point of view of health outcomes, without prejudice the importance of analyzing additional factors that may condition these results, it should be noted that the subcluster with the best results in terms of avoidable mortality is the cluster 1, that also presents less dependence on purchases from the pharmaceutical sector (both domestic and imported), followed closely by the cluster 2, with the best results in terms of preventable mortality (and the lowest variability respect of the median of the cluster). The avoidable mortality of the clusters 3 and 4 is considerably higher, having the cluster 3, the worst results and greater variability with respect to the median. Cluster 4 presents a high value of preventable mortality and a high coefficient of pharmaceutical consumption and financial and insurance activities both at the domestic and import level.

It should be noted that the cluster with the best results in terms of avoidable mortality is the cluster 1, that also presents less dependence on purchases from the pharmaceutical sector (both domestic and imported), integrated by GBR, USA, AUS, IDN and NZL. The cluster 2 (BEL, ESP, FIN, IRL, ITA, POL, PRT, SVK and TUR), with the best results in terms of preventable mortality (and the lowest variability respect of the median of the cluster) is characterized by the highest mean of self-consumption and a low consumption of financial and insurance activities. The third best preventable mortality data is found in cluster 4, where pharmaceutical consumption is much higher than in the rest of the clusters and whose dependence on financial and insurance activities is much more pronounced.

While the worst results are those obtained by the cluster 4, whose proportion of consumption pharmaceutical and insurance and financial activities is higher (CHE, SVN, KAZ and KOR. There is no data to calculate the Avoidable Mortality indicators in the case of China).

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Table 20. Avoidable mortality indicators by cluster of domestic-imports consumption

	AVOIDABLE MORTALITY (PER 100.000 INH.)			
	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4
PREVENTABLE (MEAN)	124	122	151	150
VARIANCE	1300	1098	4197	6641
STANDARD DEVIATION	36,06	33,13	64,78	81,49
COEFF. OF VARIATION	0,29	0,27	0,43	0,54
MEDIAN	110,9	115,2	97,9	126,44
MEDIAN DEVIATION	1,089	2,28	4,74	0,89
RANGE	98 - 177	84 - 181	72 - 273	82 - 265
ASYMMETRY COEFF.	1,8	0,89	0,71	1,35
TREATABLE (MEAN)	66	75	90	74
VARIANCE	283	805	1964	2769
STANDARD DEVIATION	16,82	28,37	44,32	52,62
COEFF. OF VARIATION	0,25	0,38	0,49	0,71
MEDIAN	64,8	61	56,3	52,45
MEDIAN DEVIATION	1,087	2,34	4,91	0,84
RANGE	48 - 88	51 - 130	47 - 160	39 - 152
ASYMMETRY COEFF.	0,55	1,11	0,6	1,82
AVOIDABLE (MEAN)	191	197	241	224
VARIANCE	2733	3509	11578	17852
STANDARD DEVIATION	52,27	59,24	107,6	133,61
COEFF. OF VARIATION	0,27	0,3	0,45	0,6
MEDIAN	175,7	174,6	162,4	178,9
MEDIAN DEVIATION	1,089	2,3	4,8	0,87
RANGE	145 - 265	135 - 310	119 - 436	121 - 416
ASYMMETRY COEFF.	1,47	1,04	0,64	1,56

Source: **(Own elaboration. Data:2017)**[18].

The importance of the pharmaceutical sector is reflected in the coefficients by cluster, both from the point of view of the production technology (vector of Total symmetric IOT) and from the point of view of the proportion of domestic consumption and imports. These data are in line with those offered by Belloni, Morgan and Paris, (2016) which show that spending on pharmaceuticals products is the main component of health care expenditure (they represented 1 of each 5 euros of the health expenditure in 2015, included the hospital use). However, the trends of the pharmaceutical expenditure are not homogeneous over time and between countries

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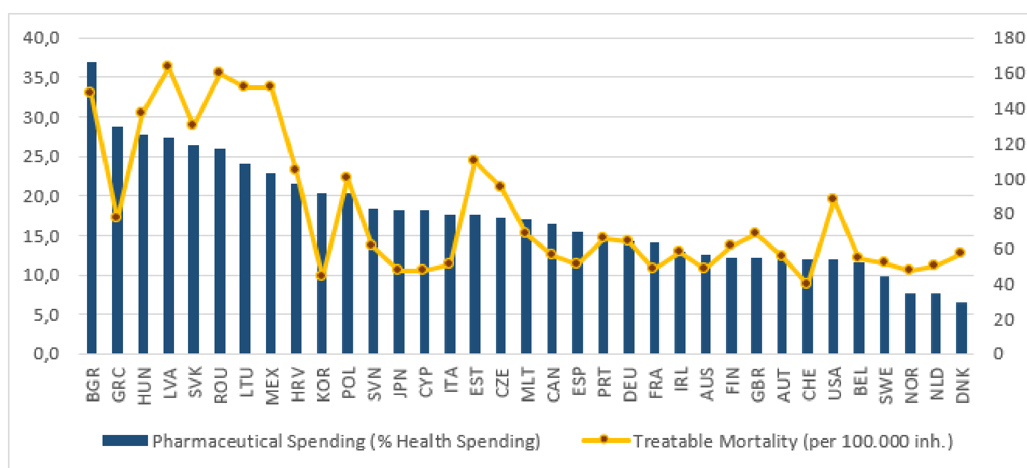
[18] We have not Avoidable Mortality Indicators data for 3 of the 41 countries considered in the study. They have not been included in the means calculations: Indonesia (Cluster 1); Taiwan (Cluster 3) and China (Cluster 4).

and they are conditioned by factors such as the health policy, the demographic change (population aging, chronicity, etc.), clinical practices, patent expiries, generic competition, or the financial coverage of medicines, among others.

However, if we compare the percentage of pharmaceutical spending over the total health spending with the treatable mortality for each country, we can observe as a higher pharmaceutical spending is associated with worst results in terms of treatable mortality (figure 7):

Figure 41. Relationship between pharmaceutical spending (% of total health spending) and treatable mortality (per 100.000 inh.) by country (2017)



Sources: Own elaboration based in WHO Mortality Database and OECD Health Expenditure and Financing Database (Health expenditure indicators)[19].

The graph indicates that some of the countries with the highest avoidable mortality are some of those cases with the highest pharmaceutical spending, greater than 50% of their total health spending (as Bulgaria, Poland, Latvia, Lithuania, Hungary or Romania).

Therefore, it could be concluded that there are interesting relationships between the different production structures existing in the countries analyzed and the results that those countries get in terms of outcomes.

By applying the methodology designed to the specific case of Kazakhstan, we have been able to verify how all the information obtained at the international level also serves as a reference when evaluating the results and position of each country. Replicating this methodology at the

[19] Notes: Pharmaceutical spending is measured as % of total health spending (year 2017 or last available). The Treatable mortality Indicators are measured per 100.000 inh. (Year 2017 or nearest available).

national and regional levels, very useful information is obtained on performance and differences by region. The case of Kazakhstan is a clear example of significant heterogeneity of results and context. Having detailed information on preventable mortality from different causes for each region has allowed us to conclude the need to adapt its health system and its centralized strategies to very different results by region, both in terms of mortality levels and in the distribution for the different causes considered. It has also been possible to verify that the contribution of each region to its health system as a provider part of the system is very different and is quite concentrated in the large cities and the Almaty region.

Limitations of the analysis

The main data limitations that we have encountered when carrying out this study have been the differences in data availability. While in the case of the avoidable mortality indicators we have been able to do the study for 75 countries, in the case of the study of the productive structure we have only been able to do it for 41 countries. The main difficulty in this last case has arisen when trying to disaggregate the "Human health activities" sector from the "Social services" sector in the OECD tables. By using the weight of each of the branches in the SUTs as a reference to disaggregate, we have found that in the case of some countries we did not have this type of information. In the case of 9 countries, as explained in chapter 2, we have approximated this calculation using the WIOD SUTs that, despite being less up-to-date (2014 vs 2018), we have adopted them as a reference, assuming the low probability major changes in production structure in a 4-year interval.

Despite the limitations indicated, we consider that the contributions of this thesis to the literature improve the current evaluation framework of health systems by considering them as a productive sector and, above all, generator of the main good of any society, health. The applied methodology delves into this double approach which allows, in our opinion, a necessary adaptation in future evaluation frameworks and in health policy decision-making.

Future research

In our study we have been able to verify the relationship between productive structure and health outcomes. However, this relationship cannot be definitively concluded since when calculating the confidence intervals, we see that they overlap, which seems to indicate that there

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are other factors to take into account to complete the analysis. In this sense, the next step of the investigation would be the creation of an efficiency model that allows the inclusion of these variables and the incorporation of new variables that allow adjusting this relationship and better defining the model.

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APPENDICES

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Figure 42. Health system models by country based on funding

Countries	Model	Countries	Model
Austria	Bismark	Australia	Beveridge
Belgium	Bismark	Cyprus	Beveridge
Bulgaria	Bismark	Denmark	Beveridge
Croatia	Bismark	Finland	Beveridge
Czech Republic	Bismark	Ireland	Beveridge
Estonia	Bismark	Italy	Beveridge
France	Bismark	Latvia	Beveridge
Germany	Bismark	Malta	Beveridge
Greece	Bismark	New Zealand	Beveridge
Hungary	Bismark	Norway	Beveridge
Japan	Bismark	Portugal	Beveridge
Lithuania	Bismark	Spain	Beveridge
Mexico	Bismark	Sweden	Beveridge
Netherlands	Bismark	United Kingdom	Beveridge
Poland	Bismark	Canada	National Health Insurance
Romania	Bismark	Indonesia	National Health Insurance
Slovakia	Bismark	Republic of Korea	National Health Insurance
Slovenia	Bismark	Taiwan	National Health Insurance
Switzerland	Bismark	China	Private-Out of Pocket
Turkey	Bismark	USA	Private - Out of Pocket
		Kazakhstan	Private-Out of Pocket

Source: Own elaboration

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Group	Causes of deaths	Preventable mortality	Treatable mortality	ICD-10 Code	Age threshold	Rationale for inclusion
Infectious diseases	Intestinal diseases	x		A00-A09	0-74	Most of these infections can be prevented through prevention measures (e.g. improve water and food safety)
	Diphtheria, Tetanus, Poliomyelitis	x		A35, A36, A80	0-74	Most of these infections can be prevented through vaccination.
	Whooping cough	x		A37	0-74	Most of these infections can be prevented through vaccination.
	Meningococcal infection	x		A39	0-74	Most of these infections can be prevented through vaccination.
	Sepsis due to streptococcus, pneumonia and depsis due to hemophilus influenzae	x		A40.3, , A41.3	0-74	Most of these infections can be prevented through vaccination.
	Haemophilus inflenza infections	x		A49.2	0-74	Most of these infections can be prevented through vaccination.
	Sexually transmitted infections (except HIV/AIDS)	x		A50-A60, A63, A64	0-74	These infections can be prevented through prevention measures.
	Varicella	x		B01	0-74	Most of these infections can be prevented through vaccination.
	Measles	x		B05	0-74	Most of these infections can be prevented through vaccination.
	Rubella	x		B06	0-74	Most of these infections can be prevented through vaccination.
	Viral Hepatitis	x		B15-B19	0-74	This condition is preventable and will not require treatment if prevented.
	HIV/AIDS	x		B20-B24	0-74	This condition is preventable and will not require treatment if prevented.
	Malaria	x		B50-B54	0-74	This condition is preventable and will not require treatment if prevented.
	Haemophilus and pneumococcal meningitis	x		G00.0, G00.1	0-74	Most of these infections can be prevented through vaccination.
	Tuberculosis	x (50%)	x (50%)	A15-A19, B90, J65	0-74	Reduction in deaths from tuberculosis in several countries has been about evenly achieved through greater prevention (reduction in incidence) and earlier detection and more effective treatment (higher survival rates).
	Scarlet fever		x	A38	0-74	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
	Sepsis		x	A40 (excl. A40.3),A41 (excl. A41.3)	0-74	Case-fatality rates can be reduced through greater quality of care and reduced patient adverse events, and early detection and appropriate antibiotic treatment.
	Cellulitis		x	A46, L03	0-74	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
	Legionnaires disease		x	A48.1	0-74	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
	Streptococcal and enterococci infection		x	A49.1	0-74	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.

	Other meningitis		x	G00.2, G00.3, G00.8, G00.9	0-74	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
	Meningitis due to other and unspecified causes		x	G03	0-74	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
Cancer	Lip, oral cavity and pharynx cancer	x		C00-C14	0-74	This condition can be largely prevented through prevention measures (e.g. reduce smoking).
	Oesophageal cancer	x		C15	0-74	This condition can be largely prevented through prevention measures (e.g. reduce smoking).
	Stomach cancer	x		C16	0-74	This condition can be largely prevented through prevention measures (e.g. reduce smoking and alcohol consumption, and improve nutrition).
	Liver cancer	x		C22	0-74	This condition can be largely prevented through prevention measures (e.g. reduce smoking and alcohol consumption).
	Lung cancer	x		C33-C34	0-74	This condition can be largely prevented through prevention measures (e.g. reduce smoking).
	Mesothelioma	x		C45	0-74	This condition can be largely prevented through prevention measures (e.g. reduce asbestos exposure).
	Skin (melanoma) cancer	x		C43	0-74	This condition can be largely prevented through prevention measures (e.g. reduce sun exposure).
	Bladder cancer	x		C67	0-74	This condition can be largely prevented through prevention measures (e.g. reduce smoking).
	Cervical cancer	x (50%)	x (50%)	C53	0-74	Cervical cancer can be prevented through vaccination and screening can also find pre-cancerous abnormalities that can be treated to prevent cancer, but five-year survival after cancer detection is also relatively high and rising.
	Colorectal cancer		x	C18-C21	0-74	Case-fatality rates have been reduced through earlier detection and treatment. Five-year survival after detection is relatively high and rising.
	Breast cancer (female only)		x	C50	0-74	Case-fatality rates have been reduced through earlier detection and treatment. Five-year survival after detection is relatively high and rising.
	Uterus cancer		x	C54,C55	0-74	Case-fatality rates have been reduced through earlier detection and treatment. Five-year survival after detection is relatively high and rising.
	Testicular cancer		x	C62	0-74	Case-fatality rates have been reduced through earlier detection and treatment. Five-year survival after detection is relatively high and rising.
	Thyroid cancer		x	C73	0-74	Case-fatality rates have been reduced through early detection and appropriate treatment.
	Hodgkin's disease		x	C81	0-74	Case-fatality rates have been reduced through early detection and appropriate treatment.
	Lymphoid leukaemia		x	C91.0, C91.1	0-74	Case-fatality rates have been reduced through early detection and appropriate treatment.
	Benign neoplasm		x	D10-D36	0-74	Case-fatality rates have been reduced through early detection and appropriate treatment.

Endocrine and metabolic diseases	Nutritional deficiency anaemia	x		D50-D53	0-74	This condition can be largely prevented through prevention measures (e.g. improve nutrition).
	Diabetes mellitus	x (50%)	x (50%)	E10-E14	0-74	Type 1 diabetes is not preventable, but appropriate treatments can reduce mortality. Type 2 diabetes is largely preventable (e.g. improve nutrition), but appropriate treatments can also reduce mortality.
	Thyroid disorders		x	E00-E07	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Adrenal disorders		x	E24-E25 (except E24.4),	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
Diseases of the nervous system	Epilepsy		x	G40,G41	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
Diseases of the circulatory system	Aortic aneurysm	x (50%)	x (50%)	I71	0-74	This condition is both preventable through prevention measures (similar risk factors as for ischaemic heart diseases) and treatable.
	Hypertensive diseases	x (50%)	x (50%)	I10-I13, I15	0-74	This condition is both preventable through prevention measures (e.g. reduce smoking, improve nutrition and physical activity) and treatable.
	Ischaemic heart diseases	x (50%)	x (50%)	I20-I25	0-74	Reduction in deaths from IHD over the past decades in several countries has been about evenly achieved through greater prevention (reduction in incidence) and earlier detection and more effective treatment (higher survival rates).
	Cerebrovascular diseases	x (50%)	x (50%)	I60-I69	0-74	Reduction in deaths from CVD over the past decades in several countries has been about evenly achieved through greater prevention (reduction in incidence) and earlier detection and more effective treatment (higher survival rates).
	Other atherosclerosis	x (50%)	x (50%)	I70, I73.9	0-74	This condition is both preventable through prevention measures (e.g.improve nutrition) and treatable. Case-fatality rates can be reduced through appropriate treatment.
	Rheumatic and other heart disease		x	I00-I09	0-74	Case-fatality rates can be reduced through appropriate treatment.
	Venous thromboembolism		x *	I26, I80, I82.9	0-74	The majority of venous thrombosis events result from hospitalisations. These cases are treatable to the extent that they are linked to the quality of care that people receive.
Diseases of the respiratory system	Influenza	x		J09-J11	0-74	Most of these infections can be prevented through vaccination.
	Pneumonia due to Streptococcus, pneumonia or Haemophilus, influenza	x		J13-J14	0-74	Most of these infections can be prevented through vaccination.
	Chronic lower respiratory diseases	x		J40-J44	0-74	This condition can be largely prevented through prevention measures (e.g. reduce smoking).

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	Lung diseases due to external agents	x		J60-J64, J66-J70, J82, J92	0-74	This condition can be largely prevented through prevention measures (e.g. reduce exposure to chemical, gases and other agents).
	Upper respiratory infections		x	J00-J06, J30-J39	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Pneumonia, not elsewhere classified or organism unspecified		x	J12, J15, J16- J18	0-74	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
	Acute lower respiratory infections		x	J20-J22	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Asthma and bronchiectasis		x	J45-J47	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment. (e.g. medication).
	Adult respiratory distress syndrome		x	J80		Case-fatality rates can be reduced through early detection and appropriate treatment.
	Pulmonary oedema		x	J81		Case-fatality rates can be reduced through early detection and appropriate treatment.
	Abscess of lung and mediastinum pyothorax		x	J85, J86		Case-fatality rates can be reduced through early detection and appropriate treatment.
	Other pleural disorders		x	J90, J93, J94		Case-fatality rates can be reduced through early detection and appropriate treatment.
Diseases of the digestive system	Gastric and duodenal ulcer		x	K25-K28	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Appendicitis		x	K35-K38	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Abdominal hernia		x	K40-K46	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Cholelithiasis and cholecystitis		x	K80-K81	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Other diseases of gallbladder or biliary tract		x	K82-K83	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Acute pancreatitis		x	K85.0,1,3,8,9	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Other diseases of pancreas		x	K86.1,2,3,8,9	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
Diseases of the genitourinary system	Nephritis and nephrosis		x	N00-N07	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Obstructive uropathy		x	N13,N20-N21, N35	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Renal failure		x	N17-N19	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Renal colic		x	N23	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Disorders resulting from renal tubular dysfunction		x	N25	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.

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	Unspecified contracted kidney, small kidney of unknown cause		x	N26-N27	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Inflammatory diseases of genitourinary system		x	N34.1,N70-N73,N75.0, N75.1,N76.4,6	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
	Prostatic hyperplasia		x	N40	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
Pregnancy, childbirth and perinatal period	Tetanus neonatorum	x		A33	0-74	Most of these infections can be prevented through vaccination.
	Obstetrical tetanus	x		A34	0-74	Most of these infections can be prevented through vaccination.
	Pregnancy, childbirth and the puerperium		x	O00-O99	0-74	Effective treatment is available in most cases to avoid maternal mortality.
	Certain conditions originating in the perinatal period		x	P00-P96	0-74	Case-fatality rates can be reduced through early detection and appropriate treatment.
Congenital malformations	Certain congenital malformations (neural tube defects)	x		Q00, Q01, Q05	0-74	These conditions can be prevented through prevention measures (improve maternal nutrition, e.g. folic acid consumption).
	Congenital malformations of the circulatory system (heart defects)		x	Q20-Q28	0-74	These conditions can be treated through surgical operations
Adverse effects of medical and surgical care	Drugs, medicaments and biological substances causing adverse effects in therapeutic use		x *	Y40-Y59	0-74	These conditions are treatable through better drug prescription and adherence.
	Misadventures to patients during surgical and medical care		x *	Y60-Y69,Y83-Y84	0-74	These conditions are treatable through better quality of care that patients receive.
	Medical devices associated with adverse incidents in diagnostic and therapeutic use		x *	Y70–Y82	0-74	These conditions are treatable through better quality of care that patients receive.
Injuries	Transport Accidents	x		V01-V99	0-74	Deaths can be prevented through public health interventions (e.g. road safety measures).
	Accidental Injuries	x		W00-X39, X46-X59	0-74	Deaths can be prevented through public health interventions (e.g. injury prevention campaigns).
	Intentional self-harm	x		X66-X84	0-74	Deaths can be prevented through public health interventions (e.g. suicide prevention campaigns).
	Event of undetermined intent	x		Y16-Y34	0-74	Deaths can be prevented through public health interventions (e.g. harm prevention campaigns).
	Assault	x		X86-Y09	0-74	Deaths can be prevented through public health interventions.
	Alcohol- specific disorders and poisonings	x		E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K85.2, K86.0, Q86.0,	0-74	Deaths can be largely prevented through public health interventions (e.g. alcohol control policies).

				R78.0, X45, X65, Y15		
Alcohol-related and drug-related deaths	Other alcohol-related disorders	x		K73, K74.0-K74.2, K74.6	0-74	Deaths can be largely prevented through public health interventions (e.g.alcohol control policies).
	Drug disorders and poisonings	x		F11-F16, F18-F19, X40- X44, X85, Y10-Y14	0-74	Deaths can be largely prevented through public health interventions (e.g. drug control policies).
	Intentional self-poisoning by drugs	x		X60-X64	0-74	Deaths can be largely prevented through public health interventions (e.g. drug control policies).

* Some of these conditions that are mainly acquired when people are hospitalised or in contact with health services might also be considered to be preventable, in the sense that the incidence of these health care-associated infections or health problems might be reduced through greater prevention in health care facilities.

** Drug-related deaths include both illegal and legal drugs.

Ayuda *Referencia de la ayuda* financiada por:

Ayudas para contratos para Doctorados industriales 2015 – 2019, 2021, 2022 Ayuda *Referencia de la ayuda* financiada por MCIN/AEI /10.13039/501100011033

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