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Is Public-Private Partnership a Significant Factor when Achieving Horizontal Equity in Public Healthcare Resources in Spain?

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ABSTRACT

Achieving horizontal equity in the access and use of public health resources is one of the main goals of the 17 Spanish regions. We analyse geographical inequities in the allocation of human and material resources for specialised care in Spanish hospitals, paying attention to the public-private partnership. We measure inequity using Gini, Concentration and Dissimilarity indices, and Lorenz and Concentration curves, and find that regions having fewer resources in the public sector and less public health spending tend to have higher levels of resources in the private sector, which could contribute to achieve horizontal equity in the public health system.

JEL Classification: I10, I13, I14, I18, D63

1 | Introduction

The United Nations has clearly identifed 'ensuring universal access to health and health care services and achieving universal health coverage' as the main goal in the 2030 Agenda for Sustainable Development. The pandemic has shown the shortage of health professionals in many countries, particularly in the regions that have carried the highest burden of disease. More than 40% of all countries have less than 10 doctors for every 10,000 people and more than 55% of countries have less than 40 nurses and midwives for every 10,000 people [1]. According to projections made in 2016 by the World Health Organization, an additional 18 million health workers are needed, mainly in low- and lower-middle-income countries, Africa and Southeast Asia, to achieve universal health coverage by 2030. In addition to the lack of health resources, there is the problem of regional inequities within each country. Large unequal geographical distribution of health resources and services can increase disparities in health outcomes and quality of life [2, 3].

Studies on the measurement of the degree of inequality at the regional/country level analysing different indicators of health resources have increased since the beginning of the last century. The reason of this growing interest is that the distribution of healthcare resources is a critical component of healthcare access [4]. The equitable allocation of healthcare resources helps deliver such resources to those most in need and ensures accessibility to basic health services as well as fairness for vulnerable populations. Inequity is the presence of systematic and potentially remediable differences among population groups defined socially, economically, or geographically [5]. It is not the same as inequality, which is a much broader term, generally used in the human rights field to describe differences among individuals, some of which are not remediable [6, 7]. Equity in health resources is divided into vertical and horizontal dimensions. Horizontal equity refers to the fact that the same needs of health resources should be satisfied in the same amount for each member of any society. Vertical equity shows that individuals with different levels of need may receive

Summary

- Not distinguishing between public or private sectors tends to underestimate inequities.
- We found a slight pro-rich distribution in specialised hospital care.
- Regions located from Madrid to the north have better levels of public resources.
- Regions with the worst situation in public health have the largest endowments in the private sector.

appropriately different amounts of healthcare resources. Most of the studies in the literature, including the present one, are focused on horizontal equity in the allocation of health resources.

Considering international studies about inequality in health resources we find an extensive bibliography analysing data from China; previous research found out that regional health inequality was associated with the distribution of wealth as well as the distribution of health resources and primary health care services [8]. Studies also find geographical inequalities between hospitals and primary care institutions [9], and between urban and rural areas in Shangai [10]. There are also alternatives for the consolidation of a comprehensive social health insurance system [11], and recently, high quality medical resources distribution based on a classification of high-level hospitals has been analysed [12]. Other international contributions have studied inequalities and inequity in the utilization of general practitioners, specialists, hospitals, and dental services in Canada [13], the geographical distribution of hospitals and inequalities in hospital beds against socioeconomic status of residents in Iran [14], and disparities in the distribution of material and human resources through a wide range of inequality indicators showing a highly inequity among the 18 states of Sudan [15]. There has been less previous evidence for Spain, although it was studied that healthcare devolution is not a driver of regional inequalities in healthcare outcomes and outputs, and it did not increase public health expenditure [16].

The present work joins the prevailing trend in the most recent research, addressing geographical disparities in the allocation of human (healthcare personnel) and materials (healthcare infrastructure) resources at the hospital level in the 17 Spanish regions and the cities of Ceuta and Melilla. The novelty of our study is that we consider health resources differentiating between publicly funded healthcare and privately funded healthcare, which lets us evaluate the usefulness of the public-private partnership when achieving horizontal equity. Only a few studies have considered the role of the public-private partnership when analysing healthcare inequities in the last decades. Recently, a positive correlation between people being screened for cancer and having Voluntary private health insurance in Europe has been found [17]; the absence of health insurance is the factor most closely associated with the use of private services when studying the private sector's contribution to Universal health coverage in Vietnam [18]; the study of public-private partnership in Ghana has revealed that building the policy capacity of actors across vertical and horizontal levels of the partnership needs an effective policy making and significant governance attention [19]; Previous studies found horizontal inequity favouring the rich in general outpatient care and inpatient care in Hong Kong's mixed public-privare health system [20]; the unequal distribution of private health insurance coverage by income contributes to the phenomenom that the better-off and the less well-off do not received the same mixed of services in Australia [21]; there exists limited evidence on vertical equity in the Itanlian health-care system suggesting equal access to primary care but lower income groups face barriers to specialist care [22].

We use a set of inequality indices that provide different methodologies in the quantification of horizontal equity such as the Lorenz Curve, the Gini coefficient, the Concentration index and curve, and the Dissimilarity index. In addition, we carried out an analysis of correlations between human and material resources and health outcomes, as well as another series of economic variables. Results show the contribution that the private health sector makes over the public one for specialised care. Understanding regional inequities would provide policymakers useful evidence to help reduce inequalities in the Spanish healthcare system.

This article is organised as follows. Section 2 presents the Spanish National Health System and Section 3 the inequality measures. Section 4 introduces the data. Section 5 provides the results from the inequity indices and the correlation analysis. Discussion and conclusions are provided in Sections 6 and 7, respectively. Supplemental material includes Spanish regional distribution of human and material health resources and Spanish regions' population and GDP per capita in 2021.

2 | The Spanish National Health System

Spain is famous for its high-quality healthcare system which is based on the principles of universality, free access, equity and fairness of financing. Nevertheless, the great increase in infections, hospital admissions and deaths put the health systems of all countries of the world under pressure [23]. The public-private partnership takes place through agreements with private entities, and there is a certain margin for public institutions to be managed by private entities. However, the draft law on Health Equity (2022) that protects Spanish public health against the private management of public health institutions has been approved. If it were to be law, such partnership would be reduced to exceptional cases which could worsen the waiting lists' problem that the system is suffering from [24]. The impact that the absolute lack of public-private partnership could have on the Spanish National Health System has been estimated, and the difference in cost to be assumed by the public system could be in the range of 25%–35% higher than the costs derived from the public-private partnership [25].

The provision of services in the Spanish National Health System (NHS from now on) is organised from primary to specialised care, trying to avoid inequalities among citizens in the access. The health activity is carried out mainly in public

centres and is complemented by private ones, hence users do not pay directly for health services, except for a percentage of the price of medicines and some health products. The health services depend on the 17 Autonomous Communities (regions from now on) and the health budget is set each year by the regional parliaments, discounting it from the general budget received annually from the central government. The territories of Ceuta and Melilla, unlike the regions, are managed by the National Institute of Health Management so they have a state dependency.

In this regard, the Spanish Ministry of Health prepared the report Estrategia de Salud Pública 2022 [26] which constitutes the first common roadmap for the entire national territory and establishes the actions to be carried out. In addition, it will be the instrument that efficiently links the different public health initiatives developed at the international level with national policies.

According to data published by the OECD Health Data 2020, the latest available, Spain allocates 10.7% of its GDP to health spending, representing a cost of 2538 euros per inhabitant. This value is exceeded by countries such as Germany with the largest value in the European Union (12.8%, 5192 euros/inhab), followed by France (12.2%, 4160 euros/inhab). Spanish position improves with respect to countries such as Portugal (10.6%, 2050 euros/inhab) and Greece (9.5%, 1469 euros/inhab). In Spain, the 10.7% health expenditure is distributed as follows: the NHS accounts for 7.8% and the private system 2.9%. Being 43% of the NHS expenditure allocated to staff remuneration and only 10% to public-private partnership [27]. In the private system expenditure, 2.1% corresponds to Household out-of-pocket payments and 0.8% to Voluntary health care payment schemes.

According to data from the Specialised Care Information System [28], SIAE for its Spanish acronyms, of the Spanish Ministry of Health, in 2021, the number of physicians per 1000 people is notably lower in the private sector (values less than 1), with a national average of 0.18 physicians compared to 1.93 in the public sector. There are 99,684 physicians in the hospitals under study in 2021, 91.61% belong to the public sector and 8.4% to the private one. The variation rates in the public and private sectors from 2020 to 2021, are 3.37% and 11.64%, respectively. The increase in private physicians was only 1% from 2019 to 2020, therefore showing how private care progressively complements public care. One of the reasons why Spaniards use private health services is because a high percentage have private insurance [29]. The number of nurses per 1000 people follows the same trend with an average of 3.65 in the public sector and 0.36 in the private one. In 2021, the public sector had 172,704 nurses and 17,207 the private one, values substantially higher than that of physicians. The number of nurses in the NHS increased by 8.1% from 2019 to 2020, and from 2020 to 2021 an additional 4.15%. However, in the private sector the increases were very small. Regarding basic equipment, the average data of hospitals per million people is 9.88 in the public sector, and 6.46 in the private one. The distribution of beds, operating rooms and outpatient care stations is very different in quantity in the private sector and much lower than in the public sector.

2.1 | The Role of the Private Healthcare in Spain

The achievement of horizontal equity: equal access and use of public health services for equal needs, is not at odds with the existence of private health. If we assume the equitable distribution and the best quality of public health services, horizontal equity could be achieved regardless of the socioeconomic pattern observed in the use of private health services [30]. As an example, in the United Kingdom, the NHS has achieved its equity goal of equal care for equal medical necessity in arthritis care even though more educated patients use private care more often than less educated patients [31].

The private sector assumes a relevant part of the public assistance activity in Spain. Specifically, in 2020, private hospitals with substitution agreements or with partial agreements carried out about 15.9% of the total surgical interventions, 11.6% of the consultations, attended about 11.8% of emergencies and more than 12.2% of hospital discharges (12.2%) [25]. These numbers reveal the significant role that the private sector had in the COVID-19 pandemic. Public and private health coexist. Those who pay for private health care, mostly through a private insurance, also pay for public health care through taxes. This fact saves the state around 1597 euros per year per person [25]. The effect that the absolute lack of public-private partnership could have on the Spanish National Health System has been estimated: the cost to the public health system could be of at least 1200 million euros per year; the average waiting time for first consultations with specialists would increase of up to 58 days, and in the case of surgical by an average waiting time of up to 75 days [25]. Universal public health coverage is compatible with the desire of some patients to access private medical services because they want faster access, to obtain a second opinion or because they have more confidence in private medical services [29]. Moreover, to access a specialist doctor's consultation through the NHS one needs prior authorisation from the primary care physician, while in private health care, one can access directly.

All these circumstances together with the pandemic have triggered the number of insured through private companies. Specifically, the number of people with private insurance increased 9.15% from 2019 to 2021 [25]. According to the INE, the type of health coverage for Spaniards is distributed as follows: 83.36% choose exclusively public health coverage, which is clearly the predominant option in Spain; 0.88% choose exclusively private and 15.42% choose the mixed type.

The planning and development of human resources in health is a key instrument to promote the quality of care [32]. After COVID, the needs for health personnel in Spain have become clear, mainly physicians and nurses who bear the burden of health care. The training of a doctor in Spain takes about 10 years on average (6 for a career and 4 for a specialty). The fact that they stay to work in Spain is conditioned to the region where they decide to work, the salary they will receive, the type of contract, and other issues such as days off, work hours, guards, etc. It is estimated that in 2027 there will be a deficit of 9000 physicians [33]. The need for nurses is also relevant, but they start from higher levels and their complete training period is shorter, with an average of 6 years (4 for careers and 2 for hospital training).

3 | Inequality Measures

The indices used in this work are Gini coefficient (G), Concentration index (C) and Dissimilarity index (D). It is necessary to bear in mind that these measures use different methodologies in the analysis of inequity, consequently results do not necessarily have to be the same. Other methods consider the decomposition of the concentration index [34] for variables related to the use of health resources as an alternative way of studying regional inequalities [35, 36]. We select the G, C and D indicators following reviews of methodological developments and debates for the measurement of horizontal equity in the use of health resources [4, 37].

3.1 | Lorenz Curve and Gini Coefficient

The Lorenz curve is a common tool to evaluate the equity of health resources allocation in the field of public health. The bending degree of the Lorenz curve can reflect the inequality of resource allocation. This graph is a way to measure horizontal equity, where the *x*-axis represents the cumulative proportion of individuals by level of health resource, ranked in increasing order, while the *y*-axis represents the cumulative total proportion of health resource of the country. A 45° line indicates absolute equity, meaning that the health resource is equally distributed among individuals. If the Lorenz Curve is closer to the absolute equity line, the allocation of health resources is more equitable. Gini coefficient (G) is usually used to assess the equity of income and resource allocation, which was derived from the Lorenz curve. G ranges from 0 to 1. '0' means the evenest distribution of health resources while '1' means the most concentrated and inequitable. $0 < G < 0.2$ indicates that the distribution of resources is of absolute equity; $0.2 \leq G < 0.3$, relative equity; $0.3 \leq G < 0.4$, proper equity; $0.4 \leq G < 0.5$, relative inequity; $0.5 \leq G < 1$ severe inequity [12].

The formula of the G is as follows,

$$G_j = \frac{\sum_{i=1}^{N-1} P_i - Q_i}{\sum_{i=1}^{N-1} P_i};$$

where P_i represents the cumulative population of the region i, $i = 1,...,N$, to the total population in the country ranked by health resource, j, and Q_i is the cumulative health resource.

3.2 | Concentration Index and Curve

This index is the horizontal inequity index derives from the Gini index [38–40]. It is based on the concentration curve for medical care and for need, ranking individuals by a socioeconomic variable, for example, income (from the worst-off to the most well-off). The concentration index, C, is an index to investigate the unfair degree of a certain variable associated with social and economic status, which dynamically reflects the effect of the variable influenced by income [4]. We applied the concentration index (C) to measure inequity of health resources. C is defined as twice the area between the concentration curve (cumulative proportion of resources mapped onto the corresponding cumulative proportion of wealth) and the line of equality:

$$C = \frac{2COV(x, h)}{\mu};$$

where x is fractional rank in terms of GDP per capita (socioecomic variable); h is the health (resource) indicator; $COV(x, h)$ is the covariance between (x, h), and μ is the mean of the health indicator. The range of C lies in between −1 and 1: a value of zero indicates absolute equity; a negative value indicates a concentration of health resources or services on the poorer populations; a positive value represents a concentration of health resources or services on the richer populations [9, 35]. C takes a negative value when the concentration curve lies above the line of equality, indicating disproportionate concentration of the health resource among the poor (pro-poor inequity), and a positive value when it lies below the line of equality (pro-rich inequity). If the health variable represents a 'bad' health state (e.g., malnutrition) a negative value of C means ill health is higher among the poor [41].

3.3 | Dissimilarity Index

Dissimilarity index (D) expresses the extent to which the distribution of the health event studied in the population approximates the situation in which everyone has the same socioeconomic level [42, 43]. In the field of health service allocation, this indicator can be applied to variables related to health resource, such as the number of physicians that would be necessary to redistribute among regions to achieve equity [44]. D also can judge whether there are differences in health service allocation between regions, and the degree of differences between regions can be calculated [4]. The definition of D is as follows,

$$D_j = \frac{1}{2}\sum_{i=1}^{N}\left|\frac{p_i}{p} - \frac{h_{ij}}{h}\right|;$$

Where $\frac{p_i}{p}$ is the proportion of population in region i with respect to the total population of the country, and $\frac{h_{ij}}{h}$ is the proportion of resource j in region i with respect to the total resource j in the country. The greater the difference between both proportions, the greater degree of inequity will exist in the regional distribution of said resource. It ranges between 0 and 1: if $D = 0$, there is equity in the allocation of the resource between the different regions of the country, values close to zero indicate a greater equity in the allocation of the resource, and values close to one show a greater inequity.

4 | Data

We analyse the allocation of specialised care resources for hospitals using cross-sectional data for the 17 Spanish regions and the cities of Ceuta and Melilla for the year 2021. Table 1 presents the indicators used in the present analysis which are divided into Human resources, Material resources and socioeconomic factors. Human resources include the number of

TABLE 1 | Indicators for hospitals inequity study.

Factor	Indicator	Unit
Human resources		
	Physicians	per 1000 people
	Resident physicians (MIR)	per 1000 people
	Nurses	per 1000 people
	Resident nurses (EIR)	per 1000 people
	Medical technicians	per 1000 people
	Non-medical staff	per 1000 people
Material resources		
Basic	Hospitals	per 1,000,000 people
	Beds in operation (beds)	per 1000 people
	Operating rooms	per 1000 people
	Outpatient care stations	per 100,000 people
Technological	Computarized axial tomography equipment (CAT)	per 1,000,000 people
	Magnetic resonance imaging equipment (MRI)	per 1,000,000 people
Socioeconomics	Population	People
	Gross domestic product (GDP)	per person

Notes: Physicians and Nurses: Doctors and Nurses (including midwives), respectively, who provide services in the hospital, and receive a salary for it, whether as an official, labour, statutory, or of another type, developing their activity full-time or part-time. Collaborating Physicians are not included. MIR and EIR (Spanish abbreviation): Resident Physicians and Nurses, respectively, who are integrated into the specialised training programme in the different specialties in the hospitals. Medical technicians: health personnel with a higher level of studies such as podiatrists, nutritionists, etc., as well as intermediate level such as nursing assistants, emergency health technicians, etc. Non-medical staff: leadership and management professionals, social workers, as well as administrators, warders and other graduates not related to the health profession. Hospitals: Total number of hospitals in each region and cities (Ceuta and Melilla) that are authorised as hospitals by the SIAE. Outpatient care stations: Differentiated places for hospitalisation for a few hours, either for diagnosis, clinical investigations and/or multiple examinations, as well as for treatments that cannot be carried out in the outpatient clinic, but do not justify a full hospital stay.

physicians, resident physicians (MIR in Spanish abbreviation), nurses, and resident nurses (EIR in Spanish abbreviation). Material resources are divided into basic equipment (number of hospitals, beds in operation, operating rooms, and outpatient care stations) and technological equipment (computerised axial tomography equipment, CAT, and magnetic resonance imaging equipment, MRI). We consider Population and Gross Domestic Product, GDP per capita, as socioeconomic indicators.

Human and material indicators data are available in the Specialised Care Information System [28], SIAE for its Spanish acronyms, of the Spanish Ministry of Health, accessed March 2023. The specialised care data available in the SIAE are provided by hospitals and outpatient specialised care centres. Data for outpatient specialised care centres have not been included due to lack of data in some regions, however most of the specialised care takes place in hospitals. Population and GDP per capita are provided by the National Institute of Statistics [45], INE for its Spanish acronyms, accessed March 2023.

The Public-NHS is made up of publicly funded centres plus private centres (with or without profit) that maintain a substitute agreement (when the centre has a contractual relationship with the NHS, such that the centre provides all its healthcare offer to an assigned population belonging to the NHS, and centres where more than 80% of its activity comes from this contract) or belong to a Public Use Network (when a private dependency centre dedicates more than 80% of its resources to the provision of services financed by the NHS, considering that this centre belongs to a socio-sanitary or mental health public use network). The Private network includes centres dependent on private non-profit entities (Mutual insurance companies for occupational accidents and illnesses, Red Cross, Church, and Other private centres), and centres dependent on private for-profit entities [46].

The sample size is 774 hospitals from which the SIAE prepares its statistics. The regions of Catalonia, Andalusia and Madrid Autonomous Community concentrate more than half of the private hospitals in Spain, 55.37%, compared to 44.8% of public hospitals. Figure 1 shows a map with the location of the 17 regions and the cities of Ceuta and Melilla.

There are 468 hospitals that belong to the Public-NHS network, and 306 that do not. The case of the region of Catalonia is significant, with a total of 68 public hospitals that have increased to 155 of the Public-NHS type (there are 87 private dependency hospitals belonging to the Public Utilization Network (XHUP) in Catalonia, exceeding the 68 existing public hospitals). Likewise, in the Basque Country, there are 19 public hospitals that increase to 26 publicly funded (Public-NHS). These cases reflect the public-private partnership. In addition, other types of agreements can be given between public and private centres, such as partial agreements, in which a private dependency centre has a contract with the NHS through which the latter arranges determined volumes of activity with a fixed rate.

The regional distribution of health resources, both human and material, used to calculate the inequality measures in this study, as well as the socioeconomic variables, are available in

FIGURE 1 | Map of spanish regions. Authors' own elaboration.

Supporting Information S1: Tables A.1, A.2 and A.3 in the supplemental material, respectively.

5 | Results

5.1 | Inequity Indices

As can be seen in the Spanish regional distribution of human and material health resources, Supporting Information S1: Tables A.1 and A.2 respectively in the supplemental material, there exists differences on the allocation of resources between the regions, even more if a distinction is made between the type of financing, Public-NHS or private, public and private sector from now on. Hence, the need to quantify the degree of inequality in these assignments through different indicators. Table 2 shows the values of the Gini (G), Concentration (C) and Dissimilarity (D) indices. G estimates the differences in equity that the different regions of a country may present, for this the population is ranked from less to greater amount of the resource in each region. C has equal purpose that G but, in our case, the population is ranked from smaller to higher GDP per capita (indicator of wealth), measuring inequality in terms of a socioeconomic factor. Finally, D evaluates the differences in the allocation of resources in the implicit socioeconomic levels in each region.

Regarding the Gini index, there are differences depending on whether the resources are publicly or privately financed, with higher inequities for each resource in the private sector, an aspect that can be verified through the Lorenz curves represented in Figure 2. Analysing human resources, the curves are further from the line of equidistribution in the private sector (Plot b). Studying material resources, the above is also true except in the case of Hospitals, with greater inequity in the public sector. MIR and EIR present the greatest inequities between the regions in the public sector, with a value of $G = 0.13$, and Nurses and Medical technicians are the ones with the lowest value, both $G = 0.06$. In the private sector, the greatest inequity occurs for Physicians ($G = 0.25$). Regarding material resources, the furthest curves from the equidistribution situation are Hospitals ($G = 0.29$) in the public sector (Plot c), and Outpatient care stations ($G = 0.32$) in the private one (Plot d). In general, the inequities in the distribution of resources range from absolute ($0 < G < 0.2$) to relative equity ($0.2 < G < 0.3$).

The values of the Concentration index, C, range from -0.06 to 0.1 in the public sector and from -0.02 to 0.20 in the private sector, indicating a small concentration of resources towards the richest population (pro-rich inequity). Most of the resources have a positive value very close to zero. This index has to be interpreted based on the concentration curve it generates [4], see Figure 3. The reason is that the following situation may occur: the Physicians' concentration curve, Plot b, shows areas for which the inequity of the resource is pro-poor (above the equidistribution line) and others pro-rich for the private sector. Analysing the public hospital network, we can see how Nurses and Medical technicians present pro-rich distributions in the provision of resources that are very close to equidistribution, while in the private sector the resource is less concentrated in the poor.

Figure 4 shows the Lorenz and Concentration curves of three material resources: Hospitals, Hospital beds and Outpatient care stations. The total Hospitals' Concentration index ($C = 0.05$) indicates that there is a slight pro-rich distribution of this resource, however, there are differences when distinguishing between public and private sectors. Plot b blue line presents the concentration curve of Hospitals in the private sector, it can be seen how 10% of the individuals from the poorest regions concentrate approximately 20% of the resource. Positive and negative values compensate each other, reaching a value of $C = -0.02$, indicating a low concentration of the pro-poor resource. Thus, Andalusia is the region with the lowest GDP per capita in Spain, followed by Canary Islands. Both Autonomous Communities have a greater number of privately financed hospitals than the Public-NHS, see Supporting Information S1: Tables A.2 and A.3 in the supplementary material. On the other

TABLE 2 | Gini, concentration and dissimilarity indeces.

	Gini index			Concentration index			Dissimilarity index		
Resource	**Public**	**Private**	**Total**	**Public**	**Private**	**Total**	**Public**	**Private**	**Total**
Human resources									
Physicians	0.09	0.25	0.08	0.05	0.08	0.06	0.38	0.41	0.38
MIR	0.13	NA	0.13	0.08	NA	0.08	0.35	NA	0.35
Nurses	0.06	0.21	0.06	0.05	0.15	0.06	0.41	0.37	0.40
EIR	0.13	NA	0.13	−0.06	NA	−0.06	0.44	NA	0.44
Medical technicians	0.06	0.19	0.06	0.04	0.12	0.06	0.42	0.41	0.41
Non-medical staff	0.09	0.18	0.08	0.00	0.12	0.02	0.42	0.40	0.41
Material resources									
Hospitals	0.29	0.14	0.18	0.08	−0.02	0.05	0.43	0.41	0.40
Beds in operation	0.16	0.19	0.12	0.03	0.08	0.05	0.40	0.42	0.39
Operating rooms	0.08	0.11	0.06	0.02	0.07	0.05	0.38	0.35	0.36
Outpatient care stations	0.22	0.32	0.21	0.10	0.20	0.12	0.36	0.49	0.37
CAT Equipment	0.07	0.14	0.05	−0.01	0.01	0.00	0.40	0.37	0.38
MRI equipment	0.13	0.16	0.12	0.09	0.04	0.08	0.37	0.34	0.35

Notes: Authors' own elaboration. *NA* non available.

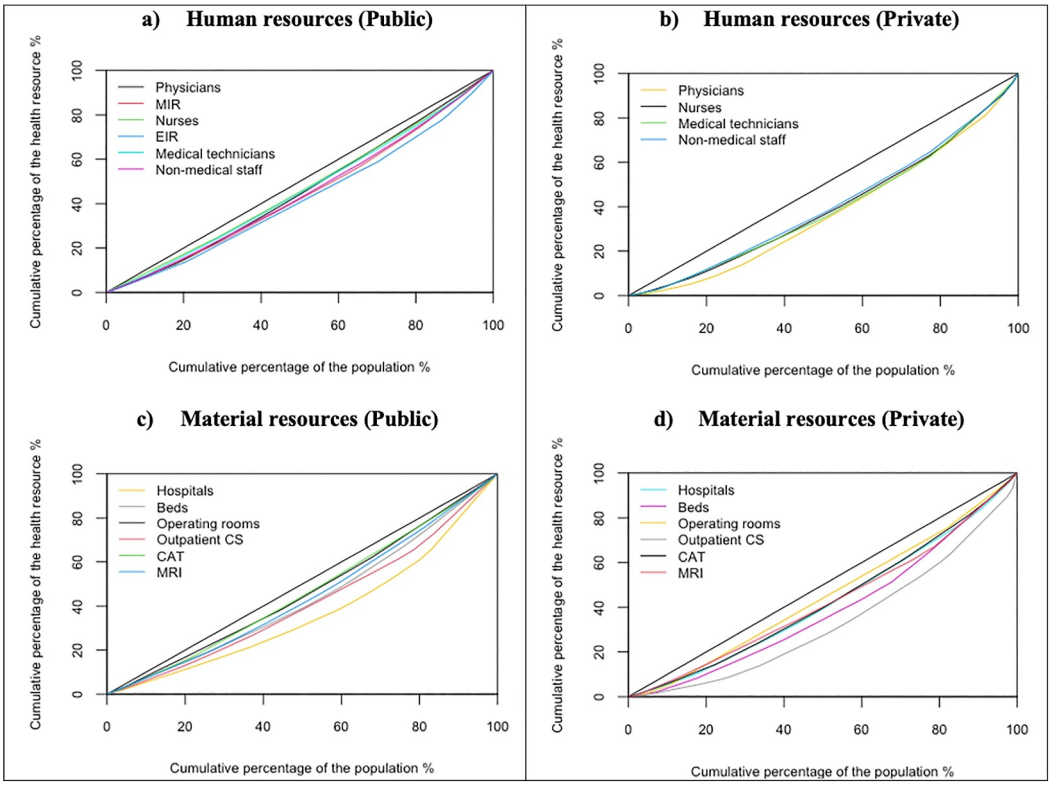

FIGURE 2 | Lorenz curves of human and material resources in public and private sectors. Authors' own elaboration.

side, Beds and Outpatient care stations (d and f plots) present pro-rich inequity, more noticeably in the case of the private sector. Finally, it should be noted that both Lorenz curves and Gini indices show how the total inequality of the health resource is systematically underestimated, showing lower values than those obtained when distinguishing between public and private sector.

The Dissimilarity index shows obvious disparities in the allocation of resources based on population size. Values range from 0.35 to 0.44 in the public sector and from 0.34 to 0.49 in the private one, without noticing greater inequity in the private sector. For example, Nurses takes a value of 0.41 in the public sector and 0.37 in the private one. The value $D = 0.41$ means that 41% of Nurses in those regions that have more Nurses

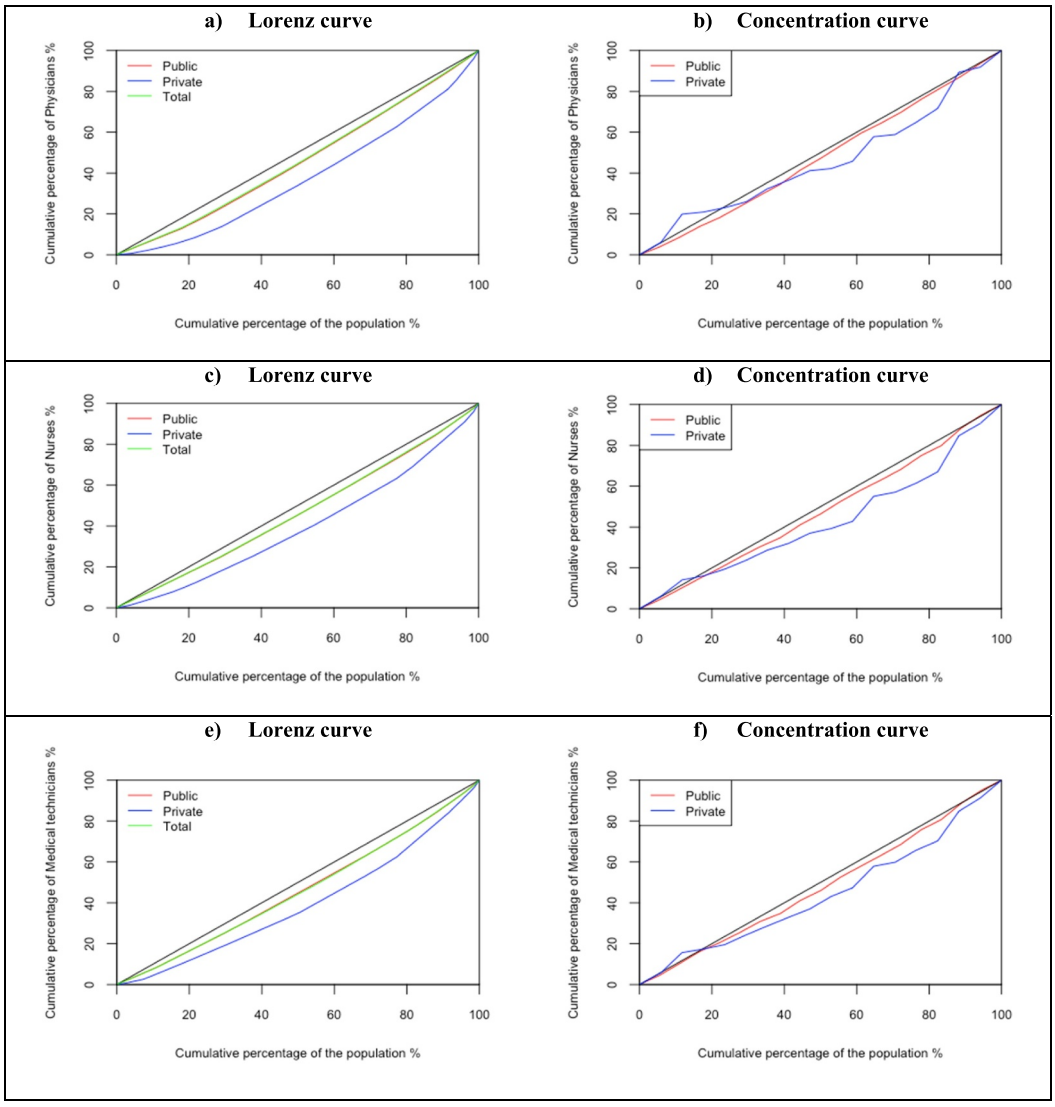

FIGURE 3 | Lorenz and concetration curves of human resources in public and private sectors. Authors' own elaboration.

relative to their population size need to be transferred to regions that have fewer Nurses to achieve equal distribution across the regions. *D* obtains higher values (farther from zero) than those obtained with *G* and *C*, thus showing greater inequity than previous methodologies in the distribution of resources between Spanish regions.

5.2 | Health Context and Influencing Factors

The lack of equity in the distribution of health resources can cause discomfort among the inhabitants of a country, given that some regions have more resources than others. This may affect the values of health outcomes indicators, as well as economic indicators. This section presents a correlation analysis using Spearman's rank correlation coefficient to examine the relationship between four basic human and material resources (Physicians, Nurses, Hospitals and Beds) and three health outcomes represented by life expectancy at 65 years, percentage of people with chronic morbidity, and mortality rate (deaths per 1000 inhab). Two economic variables are also included in the analysis: GDP per capita, as an indicator of economic development, and spending on hospital care per capita.

According to the INE, life expectancy at age 65 was 21.15 years in 2021, a value higher than the European average of 19.2 years according to Eurostat. This data reveals the progressive increase in the ageing of the Spanish population, which is already a challenge for health authorities. The mortality rate took the value of 2.52 in 2021, a rate that has been decreasing from 2014 to the present day. The percentage of people with chronic morbidity is made up of people with long-term illnesses or health problems, the national value was 38.1% in 2021. Finally, spending on hospital care per capita was 1226.61 euros in 2021.

Figure 5 presents the Correlation Network plot from the results of Spearman's rho correlations. The blue colour indicates a positive correlation and the red one a negative type. When the colour fades, it implies that the intensity of the relationship is lower, values closer to zero. All resources, both human and material, correlate positively with each other and with respect to health outcomes, except for chronic morbidity. Chronic morbidity only has a statistically significant positive correlation

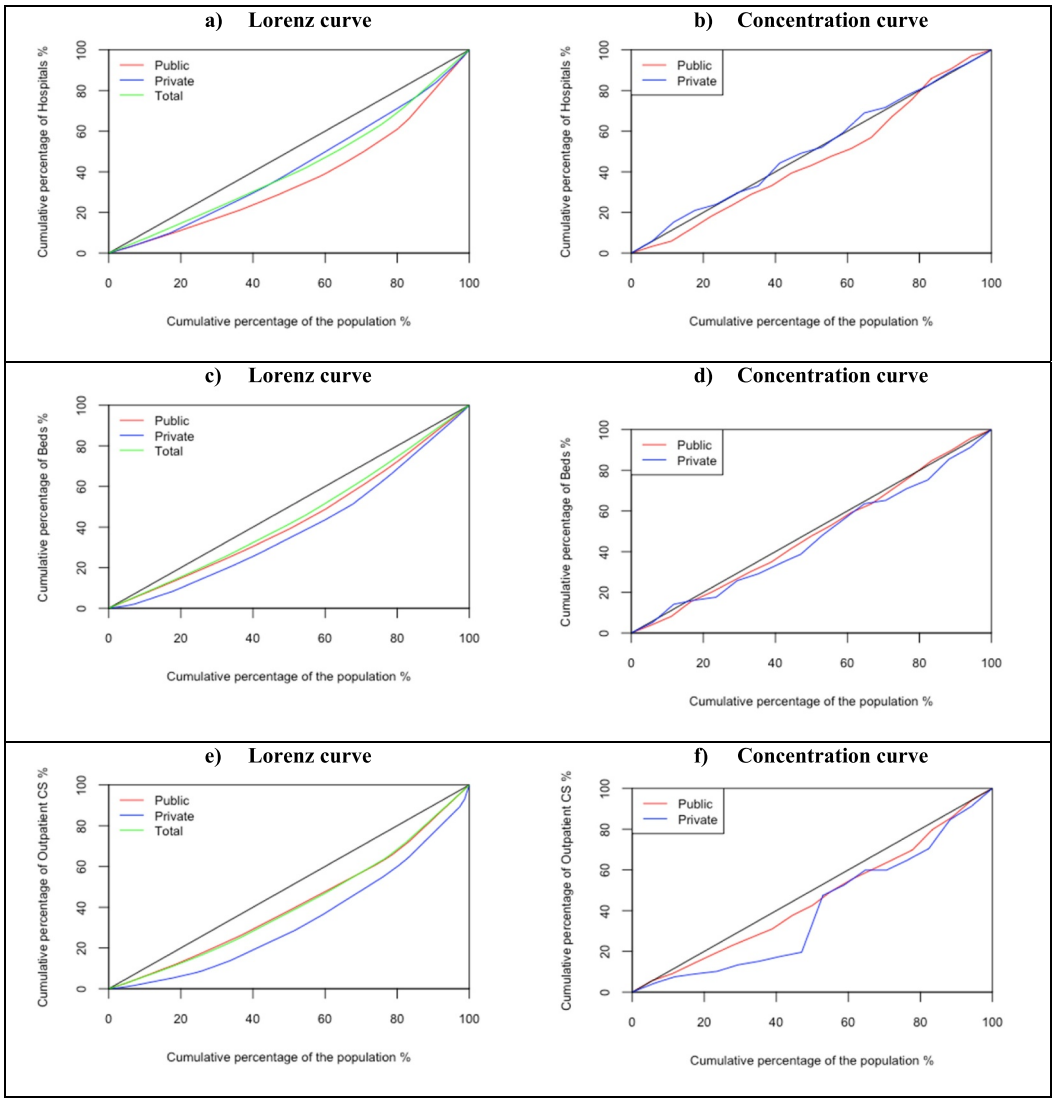

FIGURE 4 | Lorenz and concetration curves of material resources in public and private sectors. Authors' own elaboration.

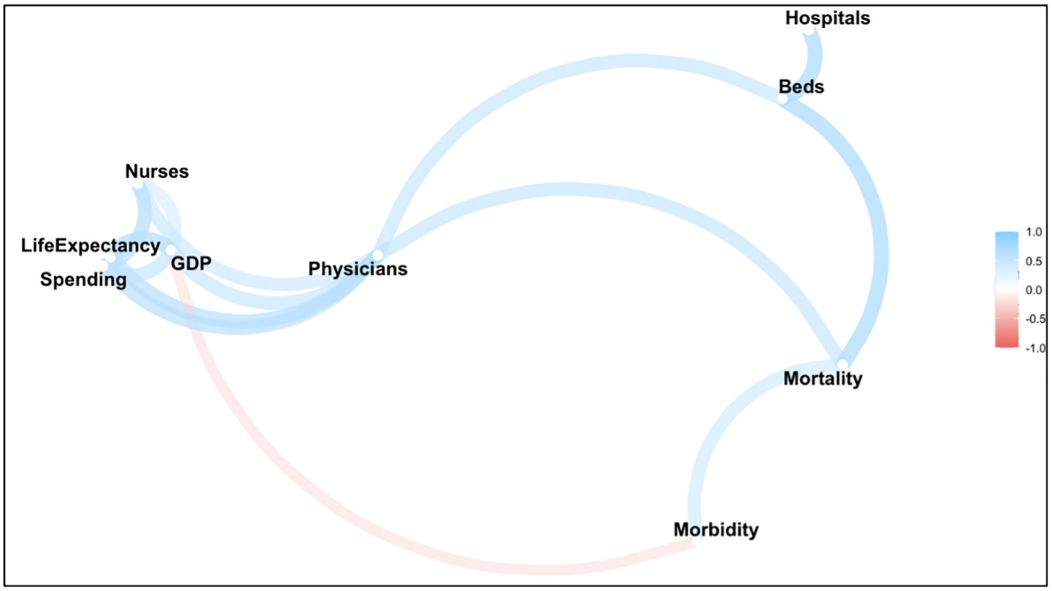

FIGURE 5 | Correlation network plot. Authors' own elaboration using INE and SIAE data.

with the mortality rate and not significant with Physicians. Physicians significantly correlated with life expectancy (p-value < 0.01) and mortality rate (p-value < 0.05). Beds also correlates significantly with the mortality rate (p-value < 0.01). On the other hand, the relationships between Hospitals and Nurses with respect to health outcomes are not statistically significant, the number of Nurses only correlates positively with spending on hospital care. On the left side of the graph, we can see the variables with which chronic morbidity is negatively correlated, these are Nurses, life expectancy, GDP per capita and hospital expenditure per capita, although the intensity of the relationship is very low, values less than 0.5, in absolute value. A joint vision shows that the higher the GDP per capita, the higher health spending in hospitals, which entails a greater amount of health human resources (Physicians and Nurses). The positive, statistically significant relationship between human resources and material resources (Hospitals and Beds) stands out, as well as between Physicians and Beds. Based on the relationships between GDP and spending on hospital care with health resources, it is expected that the regions with the highest value of such indicators will have a greater allocation of human and material resources. Figure 6 shows the maps of healthcare spending per capita in the 17 regions and the cities of Ceuta and Melilla (joint data) for the public and private sectors. In general, in the public sector, regions such as Andalusia, Canary Islands and Balearic Islands, southern and eastern Spain, are more deficient in most of the resources analysed, however, the situation is reversed from the private sector.

6 | Discussion

This study shows that, despite the existence of disparities in the allocation of health resources between regions, according to the Gini and Concentration index, inequity remains in the range of absolute to relative equity. Nevertheless, notable differences can be seen if these indicators are analysed according to public or private financing of the hospitals. Likewise, the concentration curves and indices show a slight tendency towards a pro-rich concentration in health resources, both in the public and private sectors. Some concentration curves reveal that for some resources, such as Physicians and Hospitals, there are parts of the population with a slight pro-poor inequity in the allocation of the resource. Analysing inequalities based on the Dissimilarity index, we find substantially higher values than those obtained from Gini and Concentration indices. Specifically, to achieve equal distribution of health resources among the Spanish regions, the study shows that 35%–44% of the resources need to be redistributed between the regions in the public sector, compared to 34%–49% in the private one. An alternative to redistribution would be to create favourable conditions for the development of individual regions. Therefore, D measures the compensation or imbalance, in relative terms, of the existing resources in a region with respect to the population that it possesses. Similarly, the correlation analysis shows a positive, statistically significant relationship between Physicians with respect to health outcomes such as life expectancy at 65 years and mortality rate, and economic variables such as GDP per capita and hospital spending per capita. This reveals that the Spanish regions that have higher levels of Physicians also have better levels in such indicators, an aspect that can be verified in Supporting Information S1: Tables A.1 and A.3 in the supplemental material.

Similar results to the ones obtained in this study are that health resources were equitably distributed among the administrative regions in Saudi Arabia [47], that the distributions of healthcare resources based on population were adequate, but the distributions of these resources based on geographic areas were unequal in Mongolia [48], and that the distribution of physicians based on population was relatively equal at the provincial level in Fiji [49]. However, horizontal equity should be adequately evaluated, that is, distinguishing between the public and private sectors. Analysing the socioeconomic position of the Spanish population through regression models differentiating between the public and private use of health resources, inequity was found in outpatient consultations and hospitalizations, favouring lower socioeconomic groups, and equity in the use of specialist physicians [29, 50].

The geographical analysis shows that regions with the lowest levels of public health coverage, Madrid Autonomous Community, Balearic Islands and Catalonia have the highest percentages of population with mixed coverage. This evidence is in line with the slightly pro-rich distribution of health resources analysed in this study since the regions with higher levels of GDP per capita are the most likely to have greater volumes of resources. On the other hand, regions such as Extremadura and

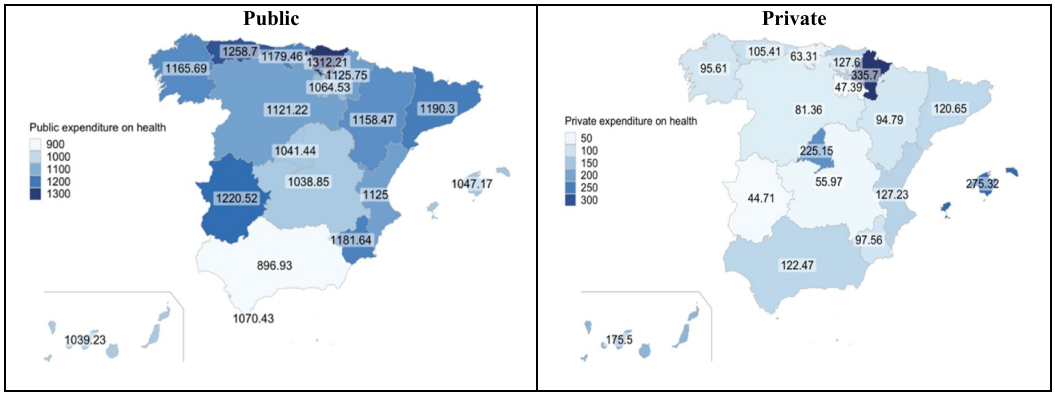

FIGURE 6 | Healthcare spending per capita in public and private sectors. Authors' own elaboration. SIAE data.

Cantabria with the highest levels of public healthcare coverage have very low levels of both private and mixed healthcare. In general, when the regions are ranked based on GDP per capita, resources are more concentrated around the richest territories. Keeping in mind that our study analyzes the existing inequities in specialised care resources, which is what exists in hospitals, our results are in line with studies that show a larger inclination of specialised care towards a pro-rich distribution of services. Some of the reasons that have been put forward to explain the inequity in favour of the rich in access to specialised services are the existence of complementary private health insurance companies and direct payments for health services [51–53].

We also find that material resources play a fundamental role, since the correlations between human and material resources found in this study show that both types of resources go hand by hand. Furthermore, according to the Gini index, Hospitals and Outpatient care stations have shown the greatest inequities between Spanish regions in the public sector.

As mentioned, healthcare in Spain is a responsibility of each region, which means that each one can manage the allocation of healthcare resources that considers appropriate within its community, and there may be regions with deficits or over-allocation of some healthcare resources, and regions with a balanced situation. The Dissimilarity index can help in making resource redistribution policies between communities, since human resources from the public sector can work without distinction in any region. This redistribution is difficult to occur in the case of material resources such as Hospitals and Beds. Nevertheless, there should not be any major problems in technological equipment if the principle of solidarity between the different regions prevails, a fact that became evident during the pandemic.

7 | Conclusion

The use of different methodologies in the study of inequity shows that the Gini and Concentration indices show a relative equity in health resource allocation between Spanish regions. In this regard, it should be noted that the inequity analysed without distinguishing between public or private sectors tends to underestimate existing inequities, which are much more pronounced in the private sector. Similarly, we found a slight pro-rich distribution of healthcare resources in specialised hospital care.

The fact that Spain is a decentralised health country in 17 regions requires greater coordination between them at the national level, with proposals for the future and recommendations for a better functioning of the healthcare system [26]. For example, in the case of human resources, regions should offer sufficiently attractive working or economic conditions for a physician or nurse to move to another region more deficient, or not to go abroad, given the high rate of ageing that Spanish healthcare will have to face in the very near future. The study carried out can be of great help in planning the economic endowment that each region allocates to public health expenditure.

Regions located from Madrid Autonomous Community to the north of the peninsula have better levels of public resources, in general terms, than those of the rest of the country, in addition to being those with the highest health expenditure and, therefore, GDP per capita. Annalyzing the private sector, the situation is reversed and regions with the worst situation in public health, such as Andalusia, Canary Islands and Balearic Islands, have the largest endowments in the private sector. In the later case, the existence of public-private partnership could be more necessary, as the public sector can access the resources of the private sector, contributing to reduce waiting lists. Adding the high rates of life expectancy at 65 in Spain, the situation of the NHS would be greatly affected.

One of the limitations of the present work is that Gini and Dissimilarity indices are based on population size and not on geographic size. In the later scenario, the inequities would probably be greater than those obtained in this study, as is often the case in developed countries. In future works it would be important to see the evolution of the indices obtained to see if health policies have managed to reduce the disparities found.

We should not forget that private healthcare is part of the Spanish healthcare system 'and can play' a complementary role to the public system if a good public-private partnership is established [54], and fighthing for global inequality requires collaboration between the government, the private sector, and organiations [55]. Finally, we highlight the complementary role that private health resources constitute towards the NHS, as a factor to be considered when achieving horizontal equity in the public health system.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data underlying this article are available in the Specialized Care Information System (SIAE) of the Spanish Ministry of Health, at https://pestadistico.inteligenciadegestion.sanidad.gob.es/PUBLICOSNS, and in its online supplemental material.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.