SOCIAL DETERMINANTS OF LIFE EXPECTANCY AT BIRTH IN THE CITY OF MADRID: A PRE-PANDEMIC ANALYSIS

ABSTRACT

The purpose of this article was to analyze the relationship of socioeconomic and educational determinants on life expectancy at birth in the 21 districts of the city of Madrid in 2019. An ecological and cross-sectional study was conducted. The independent variables studied were economic situation, educational level and being a user of public social resources for family care in the city of Madrid. Mean comparison, correlation and multivariate linear regression analysis were performed with the aim of estimating the relationship between these variables and life expectancy at birth in the districts of Madrid. The results show evidence of how the social determinants analyzed by district obtained high levels of association and predictive capacity with respect to life expectancy at birth in Madrid. In this sense, the regression model was able to explain 80.2% of the variance of life expectancy at birth. The study shows that socioeconomic determinants are associated and linearly related to life expectancy in periods prior to the COVID-19 pandemic in the city of Madrid. These results indicate that health policy planning should address social determinants as a starting point to reduce health inequalities and, therefore, to achieve actions aimed at improving the health of all citizens.

Keywords*: economy, education, health, life expectancy at birth, social determinants of health, social services.*

INTRODUCTION

Life expectancy at birth (LEB) has made significant progress during the last century in Spain. From 69.11 years in 1960, it rose to 83.58 years in 2019 (in 2020 and 2021 life expectancy slightly decreased due to the impact of the pandemic caused by SARS-CoV-2), a fact that reflects the evolution and continuous improvement of the health and social protection systems in the country (Díaz Cano et al., 2020; Ranabhat et al., 2018). Despite the favorable evolution, the strengthening of public health requires a permanent search for all those biological, psychological, and/or social determinants (Alfaro, 2018) that can facilitate the identification of factors that can improve or compromise health.

Health is usually and historically linked to the rigorous study of biological and/or psychological conditioning factors, and the inclusion of data on social determinants is very rare (Espelt et al., 2016). According to what was stated by the Commission in relation to the Social Determinants of Health established by the World Health Organization (WHO), these should be understood as the sociocultural circumstances in which people are born, grow, live, develop, and age (Hernández et al., 2017; Vega Romero, 2009). Economic, social, and cultural inequalities are an intrinsic part of our society and, therefore, they should also be considered as key elements in the increase in health inequalities (Comision, 2012; Islam, 2019). Eikemo & Oversveen (2019) define health inequalities as systematic differences that exist between classes, ethnicities, genders, socio-economic statuses, or other markers of social difference, which generate differential access to material and non-material resources.

On a different note, social inequalities should be understood as situations that are: a) unfair and unrelated to individual meritocracy and b) alterable through coordinated actions among all the actors present in community and social life. As these situations are mutable, a scenario emerges in which, first of all, it is urgent to identify the social factors

linked to health, in order to subsequently implement measures that seek to overcome these inequalities (Mújica & Moreno, 2019).

In addition to the aforementioned, the concept of social reproduction of poverty (Gutiérrez, 2015; McEwan & McEwan, 2017) should be considered, which usually involves the grouping in environments, neighborhoods and/or districts of large population niches with relevant social, economic, family and/or educational needs. Therefore, in addition to the analysis of the social determinants of health at the individual level, it is important to understand their relationship with health in specific geographical settings. The quality of people's health is directly linked to their position in a social structure within a geographical context (Amoah & Afoakwah, 2023).

In this sense, it should be noted that in Spain districts are local administrative divisions, that is, territorial spaces into which a certain geographical space is divided, with the aim of distributing and ordering the exercise of civil and/or political rights, as well as public functions or administrative services. In the case of the city of Madrid, there is a territorial division of 21 districts, and based on the Municipal Register of Madrid (2019) there were 3,334,730 people registered in the city of Madrid.

On the other hand, as it has been observed during the year 2020, and related to the COVID-19 social and health crisis, there are studies that show evidence that the decline of the LEB in Madrid was more pronounced in the southern districts, being directly related to socioeconomic factors present in each district (Díaz-Olalla et al., 2022). However, regarding such connection, is this a specific situation linked to the particularities of COVID-19 itself? Were socioeconomic determinants existing as factors with explanatory capacity in the years prior to the pandemic and, therefore, the pandemic did nothing more than evidence a pre-existing reality? It is therefore relevant to delve deeper into these issues and understanding that social inequalities can have a concrete

impact on health. This forces one to rethink that the increase in public welfare must inevitably be linked to the reduction of social inequalities (Braveman, Krieger & Lynch, 2000).

In this regard, it is interesting to note that although previous studies have used economic, social, and educational variables as determinants in situations of health inequalities, there are no precedents of research with variables linked to people or families who are users of Social Services. In this sense, this study has attempted to analyse, specifically and among others, the variables of being recipients of unpaid pensions and being families in need of social support as social determinants of LEB in the districts of Madrid.

Based on the considerations made regarding studies during the COVID-19 pandemic that showed that the decrease in LEB in the districts of Madrid was related to socioeconomic determinants, and taking into account that there are no previous studies before the pandemic that estimated whether these socioeconomic and educational determinants previously acted as predictor variables of LEB by districts in the city of Madrid, the objective of the present study was to analyze the relationship of socioeconomic and educational determinants on LEB in the districts of the city of Madrid in the year 2019.

MATERIAL AND METHODS

An ecological and cross-sectional study was conducted, in which the unit of analysis was the 21 districts of Madrid city. The LEB in the year 2019 was considered as the dependent variable of the study; these data were obtained from the Department of Statistics of the Madrid City Council as of December 31. The choice of year was made with the intention of avoiding possible biases caused by the COVID-19 pandemic, as well as with the interest of establishing comparisons with analogous studies that have analyzed social

determinants during COVID-19 with the same geographic units of analysis (Díaz-Olalla et al., 2022).

The independent variables selected were: rate of people receiving the Minimum Insertion Income (MII) in Madrid, rate of unemployed people who do not receive economic benefits, rate of people who have not completed compulsory secondary education, rate of users of Child Care Centers (CCC) and rate of beneficiaries of the Social Education service. The data relating to the independent variables indicated were obtained from the statistical databank of the Madrid City Council as of December 31, 2019 for each of the 21 districts. The choice of these variables is based on the interest of delving deeper into three relevant dimensions related to the social determinants of health:

1- *Economic determinants*: "recipient of MII" or "being unemployed without economic benefit". The MII are final benefits, i.e., they are received when the person is not entitled to any other benefit, and it is an indispensable requirement to be registered in the Community of Madrid for a continuous year prior to the date of application. In addition to the rates of MII recipients, the rate of unemployed people without economic benefits was included. The purpose of these determinants was to include the rates of the two population strata with the most unfavorable economic situations, and, in this way, to be able to provide a grouped perspective of the district on the basis of economic precariousness.
2- *Socio-educational determinants:* people with low educational levels. The rates of people who had not completed secondary education (Compulsory Secondary Education) were included. This determinant provides data grouped by district on the number of people with low educational levels.
3- *Social and family determinants related to municipal public social care*: rates of people assisted in ChildCare Centers (CCC) and rates of users of the Social

Education Service (SES). The Spanish CCC is a specialized care service for children and their families, and the SES is a service that offers support and counselling for the upbringing and education of children. Both resources aim to support families and minors in difficult or vulnerable situations in order to reduce their social and relational problems and, thus, improve their coexistence and, therefore, their welfare. In summary, being users of the CCC and the SES provides data grouped by district on the number of people in need of social and family support.

All the variables present in the study have been expressed as gross rates per 100,000 inhabitants based on the total number of residents per district. This is in an attempt to homogenize the data and, thus, be able to draw inferences at the aggregate level by district.

Analysis

First, a *paired samples t-test* was used to determine deductively whether there were significant differences by district among the rates of the variables of educational level, people receiving MII, unemployed people without economic benefits, people belonging to families using the CCC, and people belonging to families using the SES (independent variables), and the mean rates of the LEB in each district (dependent variable). The use of this test is common in ecological studies that analyze social determinants in the form of rates and/or percentages (Cabello-Rangel et al., 2022; Scruzzi et al., 2021). Then, the linear dependence analysis was conducted, i.e., the degree of relationship between the dependent variable and the independent variables by means of *Pearson's correlation coefficient.*

Finally, a multivariate linear regression using the stepwise calculation method was conducted (y = ax+b), to estimate the value of the relationship between the dependent variable and the independent variables. Thus, the p-value of each independent variable evaluated the existence of the null hypothesis (no effect on the dependent variable), and a p-value of less than .05 indicated the rejection of the null hypothesis. With the stepwise calculation method, the variables that are less significant for the model are eliminated.

All calculations were performed with SPSS 25.0 statistical software.

RESULTS

The results first show the total rates by district of the variables analyzed (Table I). As can be seen, there are differences of approximately 2 years in life expectancy at birth among districts such as Chamartín, Chamberí or Retiro, with respect to Villa de Vallecas, Villaverde or Vicálvaro. In turn, observing the data relating to economic, social, and educational determinants, it can be seen how the districts with lower LEB have higher rates in all the independent variables under analysis.

Table I. Characteristics of the study population: total rates per district for each analysis variable

District	LEB in 2019 (years)	People with low educational attainment (per 100,000 inhab.)	MII recipients (x100,000 inhab.)	People assisted in a CCC (x100,000 inhab.)	Users of the SES (x100.000 inhab.)	Unemployed people without benefits (x100,000 inhab.)
Centro	86,50	9817,50	560,31	57,45	148	2870
Arganzuela	88,50	9946,48	147,26	33,29	106	2196
Retiro	88,40	7841,00	74,45	40,53	80	1820
Salamanca	88,10	6394,19	71,42	28,30	75	1633
Chamartín	88,50	5941,74	79,03	27,01	71	1520
Tetuán	87,40	12651,30	454,34	86,42	157	2576

Chamberí	88,50	6800,06	86,28	36,77	66	1671
Fuencarral-El Pardo	88,20	10691,32	186,32	52,26	140	1835
Moncloa-Aravaca	87,80	8839,62	189,90	49,93	156	1697
Latina	87,90	19649,79	470,51	95,09	308	2927
Carabanchel	87,40	18146,98	690,10	94,59	253	3841
Usera	87,20	21439,69	1003,73	113,69	199	4280
Puente de Vallecas	87,30	23086,06	1252,14	118,34	225	3026
Moratalaz	88,40	17808,61	506,74	74,03	87	3136
Ciudad Lineal	88,70	14631,59	233,00	49,86	184	2398
Hortaleza	88,20	11284,62	181,59	38,17	143	2063
Villaverde	86,80	20527,51	934,06	108,44	294	4251
Villa de Vallecas	86,20	14078,26	1092,03	46,15	175	3852
Vicálvaro	87,00	15806,90	955,07	74,08	143	3668
San Blas-Canillejas	87,70	16164,38	436,68	90,92	130	2822
Barajas	87,90	8898,14	141,55	49,84	60	1694

After observing the general data, a comparison of means was made using the *paired samples t-test* to determine whether the differences in means between the rates of the selected variables were statistically significant (Table II).

Table 2. Paired samples t-test between life expectancy at birth and the rates of the social determinants of analysis

	Comparison pair	T	Bilateral significance
1-	**Life expectancy – Low educational attainment**	*-11,458*	*<,001*
2-	**Life expectancy – MII recipients**	*-4,508*	*<,001*
3-	**Life expectancy – People assisted in a CCC**	*3,495*	*,002*

4-	**Life expectancy – Users of the SES**	*-4,078*	*<,001*
5-	**Life expectancy – Unemployed without benefits**	*-12,866*	*<,001*

The *paired samples t-test* showed that all the variables were significant at the bilateral level. The results indicated that all the rates of the socioeconomic variables by district included in the present study remained statistically significant in relation to the rates of LEB by district in Madrid.

Having observed the significance of the measures of the socioeconomic variables in relation to the measures of life expectancy by district, an analysis was made of the possible linear dependence and, therefore, the degree of relationship between the rates of the variables under analysis was quantified by means of Pearson's Correlation Coefficient (Table III).

Table 3. Pearson's Correlation Coefficients for the variables of analysis

	1	2	3	4	5	6
1. Life expectancy at birth	-	**-,433 (,50)**	**-,796** (<,001)**	**-,491** (0,24)**	**-,483** (0,27)**	**-,721** (<,001)**
2. Low educational attainment		-	,813**	,915**	,778**	,832**
3. MII recipients			-	,755**	,624**	,885**
4. CCC users				-	,735**	,754**
5. People assisted by the SES					-	,683**
6. Unemployed without benefits						-

**. Correlation is significant at 0.01 level (bilateral).

*. Correlation is significant at 0.05 level (bilateral).

Thus, it was possible to observe how the LEB by district in Madrid maintained a significant correlation at the 0.01 level with the rate of people who were recipients of

RMI or those who were unemployed without economic benefits. In addition, significant levels (0.05) were found with the rate of CCC users, and also with the rate of people who were SES users; no correlation was found with the rate of people with a low level of education (despite this, having shown statistical significance in the comparison of measures previously made, it was incorporated into the next step of analysis). Likewise, all the determinants indicated presented significant negative linear correlations, that is, the higher the rate of people receiving MII, the rate of unemployed people without economic benefits, the rate of people assisted in a CCC, and the rate of people using the SES in each district, the lower the life expectancy at birth.

Finally, based on the significance in the comparison of measures between the rates of the variables present in the study, and the existence of a significant negative level of linear relationship, a *multivariate linear regression using the stepwise calculation method* (y = ax+b) was performed to evaluate the effect of the rates of the socioeconomic variables (independent variables) on the LEB by district in Madrid (dependent variable) (Table IV).

Table 4. Regression model 3. Dependent variable: LEB per district in Madrid city.

		t	Sig.	Tolerance	VIF
R= ,912 **R^2= ,832** **Adjusted R^2 =,802**	Low educational attainment	4,478	<,001	,219	4,567
	MII recipients	-7,725	<,001	,339	2,953
Sig. ANOVA of the model 3 = <.001	Users Madrid City Council's SES	-2,525	,022	,395	2,533
Durbin y Watson: 1,951					

* p<0,05. ** p<0.01 ***p<0,001

The 3rd regression model shows an adjusted r^2 of .802, i.e., the rates of the independent variables of the study explained 80.2% of the variance in the LEB by district in Madrid in 2019. This data indicated a high predictive capacity of the model presented.

In addition to the above, the use of the stepwise method made it possible to adjust a model with predictive capacity in which the least significant variables were eliminated. Based on the above, 3 models were estimated in which the variables "unemployed without benefits" and "persons attended in a CCC" were excluded because they were not statistically significant. For the rest of the variables, the results of the t-statistic and sig. indicated that they were consistent and had a notable predictive capacity for the dependent variable. The tolerance indices (all greater than ,1) and the VIF values (less than 10) indicated the non-collinearity of the independent variables. In addition, the values yielded by the Durbin and Watson statistic corroborated the assumption of independence in the model analyzed.

DISCUSSION

The objective of the present study was to estimate the relationship of socioeconomic and educational determinants in the LEB in the districts of Madrid in the year 2019. The aggregated information by districts of the present study has allowed an ecological approach to relate social, economic, and educational determinants to the LEB, considering its capacity to formulate causal hypotheses. In this sense, data have been obtained that show high correlation indexes and predictive capacity between the rates of the social variables analyzed and the LEB by districts in Madrid during the period of time analyzed.

The results obtained allow the incorporation of new units of analysis in the social determinants of health: the users of the Municipal Specialized Social Services of social care, and, therefore, with social and family support needs (Aguilar Hendrickson, 2013). In summary, this is a precedent in the study of data referring to users of Social Services as social determinants of health. In this sense, the analysis of the social determinants of health helps to understand the structural factors that influence health-illness-care

processes. The need for a holistic approach that appeals to the notion of multidimensionality arises. On the other hand, it must be considered that the study started with the uncertainty of knowing whether it was possible to construct an explanatory model with variables that could present incompatible indices of collinearity. This uncertainty was based on the clear relationship that may exist between them; and despite effectively showing high correlation indices between the explanatory variables, data regarding collinearity and significance endorsed the possible use of these dimensions in the analysis of the LEB by district in Madrid (all the independent variables showed tolerance levels above ,1 and the VIF indicator below 10).

The adjusted r^2 stood at ,802, which means that the rates of the social determinants of the model explain 80,2% of the variance in LEB by district in Madrid in the year 2019. This data is highly relevant, and shows that the social, economic, family, and educational characteristics of a given geographic location reliably determine life expectancy at birth in that location (Holt-Lundstad, 2022). In this regard, it should be noted that the results of this study should not be understood as an indicator of the ineffectiveness of social and economic protection services with respect to the health of the beneficiaries, but rather as indicators that establish the existence of population groups with socioeconomic needs that are located in specific geographic locations (spatial distribution of inequality) (García-Carro & Sánchez-Sellero, 2019). This issue is at the core of the present study, in the sense that it aims to demonstrate the relationship between social needs and health (Treacy, 2021), emphasizing the social, economic, and educational characteristics of the place of residence as a key factor in determining LEB (Behm, 2014).

Health, understood as a state of physical, mental, and social well-being, should be understood as a compendium of interactions between the individual, the body, and the environment. To this end, it is essential to analyze and understand how social

determinants can be a de facto barrier to the enjoyment of this full state of well-being (Islam, 2019). This requires a multidisciplinary dialogue involving a holistic and flexible approach, including social determinants as intrinsic to life (Dooley et al., 1996).In line with the results obtained in the present research, over the last few decades it has been shown that economic capacity and the level of education are key factors in the prediction of the development of diseases (Gumá et al., 2019; Regidor et al., 1999) there is a proven relationship between economic capacity and access to health (Moral et al., 2014). Factors as random as place of birth may be a variable with great explanatory capacity for understanding the health and general well-being of any population.

The social situation of individuals has always been linked to the possibilities of suffering problems of a biological and/or psychological nature (Garbarski, 2010; Gómez-García et al., 2023; Kwate & Goodman, 2014). This study allows for evidence confirming that the differences in LEB by district are related to the social and economic conditioning factors present in each geographical area, i.e., the spatial distribution of inequality, which was previously mentioned, translates into a spatial distribution of LEB. At this point, it is worth adding the construct of intersectionality located in the social determinants of health, since the various inequalities are not related in the form of a sum but are related in terms of the exponential nature of inequality (Davidson & McGinn, 2019). It is not surprising that in health inequality research, most researchers have opposed biological and individual explanations, and as Smith et al. (2016) point out, the best research in this area must combine both scientific rigour and political engagement.

In relation to the aforementioned, in periods of economic crisis, such as the one suffered a decade ago, it was observed that there were slight declines in LEB in Spain (Díaz-Cano et al., 2020) and a generalized worsening of health (Pérez et al., 2014), which increased to a greater extent in places where there was greater social and economic inequality. This

is not a trivial issue, but is related to a little explored but increasingly relevant binomial: a) social and economic inequality and b) health. In order to conduct an exhaustive review that groups together the social determinants and health, Pérez et al. (2014) made a list of useful indicators for analyzing the issues already raised ; despite the existence and free access to these data, studies are still scarce or too far apart in time, which hinders a real follow-up on the impact of these determinants on the health of the population (Cortés-Meda & Ponciano-Rodriguez, 2021).

Recent studies conducted in Madrid, and in other countries around the world, have determined that mortality in the year 2020 (the year of impact of the pandemic caused by COVID-19), was clearly determined by social inequalities, and it was found to be related to income level, unemployment, individuals' background, and level of education (Díaz-Cano et al., 2020). In summary, in the same way that social and economic determinants impacted health during the economic crisis, they also impacted it during the COVID-19 pandemic (Cortés-Meda & Ponciano-Rodriguez, 2021; Gómez et al., 2023). In this regard, the present research shows that these determinants were also associated in intermediate periods with health, more specifically with the LEB.

Finally, the limitations of this study are linked to the nature of its design. Ecological studies do not have the capacity to draw inferences at the individual level, so it is important to emphasize that the obtained results establish a relationship between social, economic, and educational determinants and the LEB by district, i.e., the predictive capacity of the model should be understood in aggregate form at the level of analysis (district), never at the individual level. In future studies, it would be very interesting to be able to conduct comparative research with the capacity to draw inferences at the individual level. Likewise, one of the main limitations is linked to the fact that the present

study has not conducted an analysis disaggregated by sex, which should be considered for future similar studies.

CONCLUSIONS

This research provides relevant causal evidence explaining health inequalities using the city of Madrid as a case study. Specifically, the present study corroborates that the socioeconomic variables that were determinant in the spatial analysis of mortality during the pandemic COVID-19, in 2019, already indicated (and to a greater extent) the relationship between LEB and place of residence by districts in the city of Madrid. Based on this, it is important to build a dialogic relationship among the processes of health-illness-care, and it is recommended that public policies in the field of health operate in coordination with social protection systems. On the other hand, it is worth highlighting the innovative analysis of social and economic variables located in the individuals and/or families attended by the Social Services, and their possible usefulness in future studies. It is key to consider that one of the main issues associated with the relevance of research into socio-economic determinants of health is the political and social commitment to operate in policies aimed at mitigating situations of inequality in health.

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Declarations

Conflict of interest. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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