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Analysis of the funding of social services from a spatial approach in Andalusia (Spain)

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In Andalusia, Community Social Service Centres (CSSCs) are funded by regulations following demographic, geographic, economic, and social disadvantage criteria. This study aims to analyse the geographical distribution of funding per inhabitant of CSSC by catchment area in Andalusia in 2019, and to study the statistical associations between funding and a range of demographic and socioeconomic indicators. The study spatial units ($n = 184$) included the catchment areas of CSSCs and, in the case of intramunicipal areas in large municipalities, they were grouped at the municipal level. Spatial autocorrelation measures were used to identify spatial clusters of high/low funding rates per inhabitant. Later, nonspatial and spatial regressions were applied to search for associations with different indicators (sex ratio, ageing index, dependency index, emigration rate, immigration rate, unemployment rate, population density, and employment rate in the primary sector). The geographical distribution of the funding of social services in Andalusia was not random since the analyses identified several spatial clusters with significantly high (hot spots) and low (cold spots) funding per inhabitant ($p < 0.05$). The funding rates were significantly ($p < 0.05$) and directly associated with the ageing index and the percentage of primary sector employees, and indirectly with the proportion of foreigners in the population and the population density. The hot spots were mainly located in rural and deprived areas, while the cold spots were in urban areas. The variables related to the regulated funding distribution criteria were not fully associated with higher financing. Instead, other additional variables showed significant associations ($p < 0.05$), such as primary-sector workers and foreign populations. The results showed that spatial analyses may support service assessment and decision-making in social policy.

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Introduction

The Andalusian Social Service System includes a series of services, resources, and benefits that aim to guarantee the right of the population to social protection to achieve or improve their well-being. The Community Social Service Centres (CSSC) are the primary entities, or the gatekeeper, for the public to locate specialized social services, and they are managed by local and supra-local entities (grouping smaller local entities) (Jaraíz Arroyo and González Portillo 2020).

The state, regional governments, and local entities hold competencies in social protection and funding for social services. The overall funding is distributed between the local entities according to their population (90%), dependent population (people aged under 16 years and over 64 years) (2%), surface area (2%), scattered population (number of population centres) (3%), and the existence of larger cities (greater than 100,000 inhabitants) (3%) (Consejería de Asuntos Sociales 2002). A relative poverty index corrects this distribution with a weighting of 33.34% of the total, which is defined by law as the difference between the ratio of the population of the local entities to the regional population and the ratio of the gross domestic product (GDP) of local entities to the regional GDP.

This fund distribution is mainly focused on the population size (90%) and geographical characteristics (8%) and considers the social disadvantage directly, with an ad hoc poverty index, and indirectly, with the population age structure (2%). The poverty index is a poor indicator since it is only based on GDP and does not consider other capability deprivation, such as education, health care, employment, and social assistance (Sen 1999).

The geographical distribution of the funds for CSSCs is not expected to be territorially homogeneous due to the different population and geographic characteristics throughout Andalusia, as well as the uneven geographic distribution of deprivation, as a previous study revealed in the region (Rodero-Cosano et al. 2014). Moreover, literature has found a spillover effect in the spatial distribution of public expenditure (López et al. 2017; Gallego Valadés et al. 2023). Neighbouring territories tend to have similar public expenditure policies. The analysis of the spatial distribution of funding for CSSCs may provide valuable information to inform resource allocation and social policies in the region.

Spatial data analysis has traditionally been applied to scientific fields interested in geographical space, such as epidemiology, criminology, and economics (Anselin and Rey 2010). Its use on public service financing or benefit data is not so common. Some examples include school funding in China (Xiao and Liu 2014), expenditures on disability in Italy (Agovino and Parodi 2016), social expenditure in EU members (Miśkiewicz-Nawrocka and Zeug-Żebro 2019), welfare and housing benefit expenditure in the UK (Hamnett 2009), and public expenditures (López et al. 2017), social services spending (Gallego Valadés et al. 2023) and entrepreneurship promotion (Rodero-Cosano et al. 2021) in Spain.

This study aims to analyse the geographical distribution of funding per inhabitant of CSSCs by catchment area in Andalusia in 2019. The analysis includes Exploratory Spatial Data Analyses to identify spatial clusters of high/low funding rates and spatial regressions to study relationships between funding and demographic and socioeconomic indicators.

Methods

Analysis units and dataset. Andalusia is an Autonomous Community located in Southern Spain. It is a disadvantaged region with a per capita income of 17,747 euros (Spain = 23,693 euros) and a notable unemployment rate of 22.74% in 2020 (Spain = 16.13%). Both macroeconomic figures are among the worst in the Spanish regions. Thus, social policies, benefits and services have a prominent role in supporting populations at social risk.

The Andalusian Public Social Service System holds 250 CSSCs. Their property and management correspond to municipalities or supra-municipal authorities, which group smaller municipalities in the framework of regional planning. Overall, in 2019, CSSCs were funded by the Andalusian government (70%), municipal and supra-municipal governments (27%), the Spanish government (2%), and by users directly for a few services (1%). CSSCs aim to assess needs, planning, intervention, follow-up, care assessment, and coordination with other agents of the Andalusian Public Social Service System. Access is universal and close to users, families, cohabitation units, and community groups. CSSCs are geographically organized in catchment areas called Social Service Zones (SSZ). They can be constituted by a district in large cities or towns ($n = 77$), a large municipality ($n = 72$), or a set of close small municipalities ($n = 101$). SSZ are the analysis units of the present study.

Information was collected from two sources for 2019. The Andalusian Equality, Social Policies and Reconciliation Department provided the funding data for each SSZ, while demographic and socioeconomic data were collected from the Institute of Statistics and Cartography of Andalusia (Institute of Statistics and Cartography of Andalusia 2019). The latter data were only available at the municipal level, so the smallest SSZ (covering districts) were aggregated at the municipality level ($n = 12$). The smallest municipalities were aggregated in their respective SSZ. Unfortunately, the funding information for one SSZ was missing, and the area was removed from the analyses. Thus, the total number of study units was 184.

The funding data of CSSC per SZZ is not publicly available in Andalusia. Data for 2019 were specifically provided in 2021 by the social policy administration for the development of a research project aimed at studying the organisational model, the human resources, and the funding of CSSC (González Portillo et al. 2022). This article is one of the outcomes of this project.

The study variables are displayed in Table 1. The dependent variable was the funding per capita of SSZ (€). The explanatory variables included indicators of the demographic context, such as the sex ratio (women per 100 men), the ageing index (older people per 100 children), the dependency index (children and older people per 100 adults), the emigration rate (% emigrants over inhabitants), and the immigration rate (% nonnationals over inhabitants); the socioeconomic context, such as the unemployment rate (unemployed people per 100 adults); and the rural context, such as the population density (inhabitants per square kilometre) and the employment rate in the primary sector (employees in the primary sector per 100 adults).

Two variables were transformed to be included in the linear model. The population density presented a large value dispersion ($cv = 2.46$) that recommended its previous logarithmic transformation be included in the multivariate models. In addition, the direct use of funding per inhabitant (dependent variable) was the cause of nonnormal residuals in the first tests of the regression models. Therefore, the dependent variable was also logarithmically transformed to fulfil linear regression requirements.

Statistical analyses. The spatial dependency of the funding of CSSC per capita by SSZ was analysed by using the Global Moran's *I* index (Moran 1950; Getis 2007). This is a measure of the existence of spatial autocorrelation in a dataset where the observations are georeferenced. A statistically significant high value of Global Moran's *I* indicates that the observations' values

Table 1 Descriptive statistics of the study variables ($n = 184$).

Indicator	Description	Arithmetic mean	Standard deviation
Funding of the Community Social Service Centres per capita	Euros per resident	120.36	49.57
Funding of the Community Social Service Centres per capita (logarithmic)	Log(euros per resident)	2.05	0.17
Population density	Inhabitants per square kilometre	568.4	1,400.3
Population density (logarithmic)	Log(inhabitants per square kilometre)	2.09	0.71
Immigration rate	% nonnationals	5.6	6.82
Employment rate in the primary sector	% employees in the primary sector (18–64 years old)	44.79	52.79
Ageing index	Older people per 100 children	119.55	48.47
Dependency index	Children and older people per 100 adults	49.03	4.58
Unemployment rate	% unemployed people (18–64 years old)	13.54	3.42
Sex ratio	Women per 100 men	100.11	4.48
Emigration rate	% emigrants over inhabitants	3.46	1.45

Source: Institute of Statistics and Cartography of Andalusia (2019).

(high and/or low) are spatially clustered and a negative value means dispersion, while a non-significant value shows a random pattern. The inference for Global Moran's I is based on repeatedly recalculating the statistic through random permutations to generate a reference distribution. The obtained I index is compared to this distribution to compute a pseudo p-value.

This global index analyses whether there is spatial dependence or not in a dataset. When it exists, the following step is to identify the spatial clusters on the map through Local Indicators of Spatial Association (LISA). In this study, Local Moran's I and Local Getis & Ord's G^* at the local level (Anselin 1995; Ord and Getis 1995) were used to identify spatial clusters of CSSC funding. Local Moran's I provides the specific geographical location of high/low clustered or dispersed values, while G^* only indicates the location of high/low clustered values (hot spots and cold spots).

Regarding the multivariate analyses to explain the relationships between funding per inhabitant and the explanatory variables in SSZ, an exploratory model (ordinary least squares - OLS) was built with all the variables to determine the direction of their relationships. In the second stage, a step-by-step iterative procedure was applied to build a regression model fulfilling assumptions and conditions.

Later, several diagnostics for spatial dependence were applied to the OLS model, such as Global Moran's I and Lagrange multiplier tests, to check possible bias by spatial dependence in the variables and residuals of the OLS model. If present, spatial regression models are recommended to remove or reduce these biases and improve the overall model performance (Anselin and Bera 1998). Lag and error spatial regressions are two common spatial multivariate models (Anselin 1988). Both consider the geographical location of the observations, through a distance weight matrix, when analysing associations between the independent and explanatory variables. Spatial lag regression is convenient when the dependent variable of one region is affected by the values of the dependent variable in nearby places (spillover effect), and spatial error regression is convenient when the errors are correlated in nearby places. The specification of the spatial regression (lag or error) was determined using the selection decision rule proposed by Anselin (1988). The rule utilises the Lagrange Multiplier tests (LM-Lag, robust LM-Lag, LM-Error and robust LM-Error) to guide the specification process. The appropriate spatial regression is selected based on the statistical significance of the test results.

The relationships between the spatial units were considered in all the spatial data analyses through a distance matrix with second-order queen contiguity weights. This analysis focused on the effects of neighbouring spatial units in the first two rows in any direction. The global and local autocorrelation indexes, OLS, and spatial regressions were computed using GeoDa 1.22. Further methodological explanations and statistical formulas can be found on the online GeoDa Documentation (Anselin Luc 2023).

Results

The geographical distribution of the CSSC funding is shown in Fig. 1. The Global Moran's I gave a value of 0.261 (pseudo $p < 0.01$), so the funding presented positive spatial autocorrelation where similar values (high or low) appeared clustered. Local indices allow the identification of spatial clusters of higher (hot spots) or lower (cold spots) funding values ($p < 0.05$). Their results consistently identified similar areas (Figs. 2 and 3). Hot spots of funding were in northern Huelva Province, the centre of Cordova Province, north-western Almeria Province, and northern Granada Province. In contrast, cold spots were around major regional cities such as Seville, Malaga, Granada, and Cadiz.

To relate funding with the demographic, socioeconomic, and rurality indicators, Model 1 was built including the whole set of independent variables (Table 2). Now, the dependent variable was the logarithmic CSSC funding per capita. Its assessment indicated the existence of collinearity with a high condition index. Several indicators were not significant ($p > 0.05$), such as the unemployment rate, the emigration rate, the population density, and the dependency index. The high collinearity was attributed to moderate to high correlation ($r > 0.5$) between the dependency index and the ageing index ($r = 0.82$, $p = 0.00$), the unemployment rate and the employment rate in the primary sector ($r = -0.61$, $p = 0.00$), and the logarithmic population density and the ageing index ($r = -0.54$, $p = 0.00$). The coefficients of the remaining variables were either below $r = 0.5$ or not statistically significant ($p > 0.05$).

Then, Model 2 aimed to avoid nonsignificant variables ($p > 0.05$) within the model and to reduce collinearity problems by removing nonsignificant variables ($p > 0.05$) (Table 2). Only four independent variables remained in this model: the ageing index, people working in the primary sector, the immigration rate and the population density. The condition index was much lower, although the ageing index and the logarithmic population density remained in the model. This model presented a better diagnosis than Model 1, and its adjusted R-squared was over 0.5. However, the regression showed problems of spatial autocorrelation, which encouraged the application of a spatial regression.

The assessment of spatial dependence in Models 1 and 2 through Lagrange Multipliers recommended using the Spatial Lag

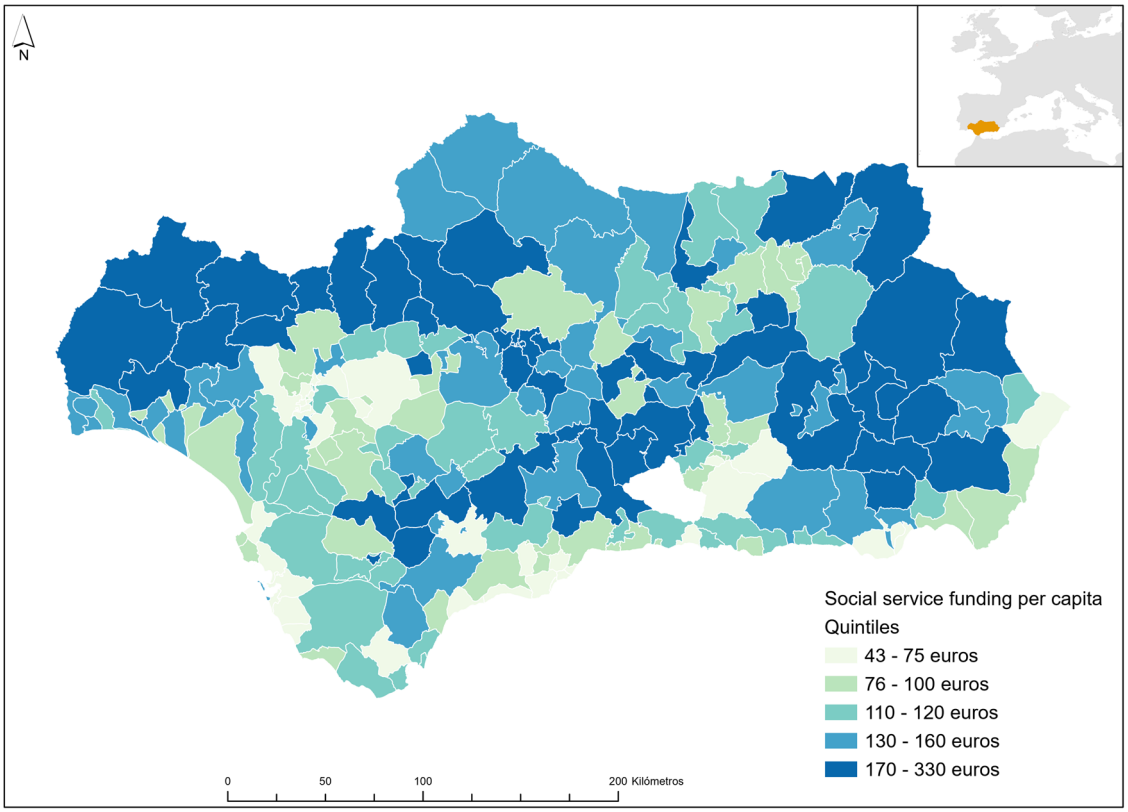

Fig. 1 Geographical distribution of funding per inhabitant of the Community Social Service Centres of Andalusia by catchment areas, 2019 (quintile map).

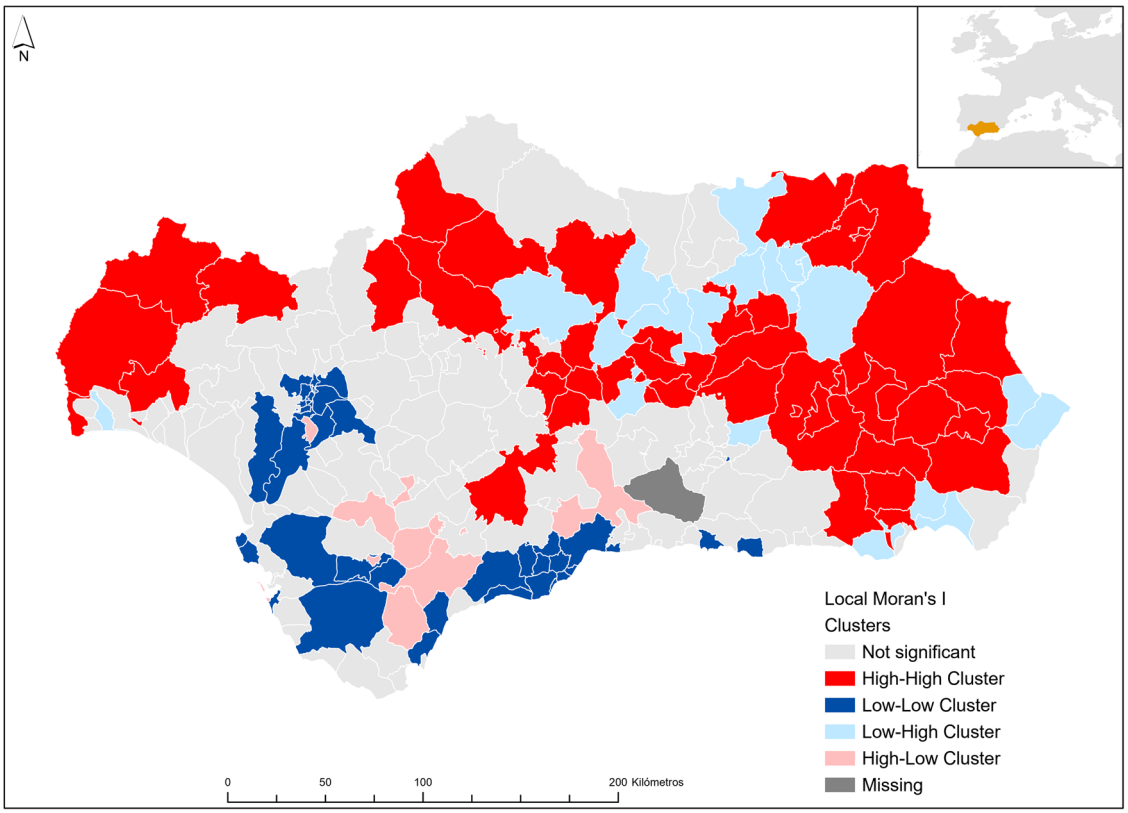

Fig. 2 Spatial clusters identified through Local Moran's *I* of funding per inhabitant of the Community Social Service Centres of Andalusia by catchment areas, 2019.

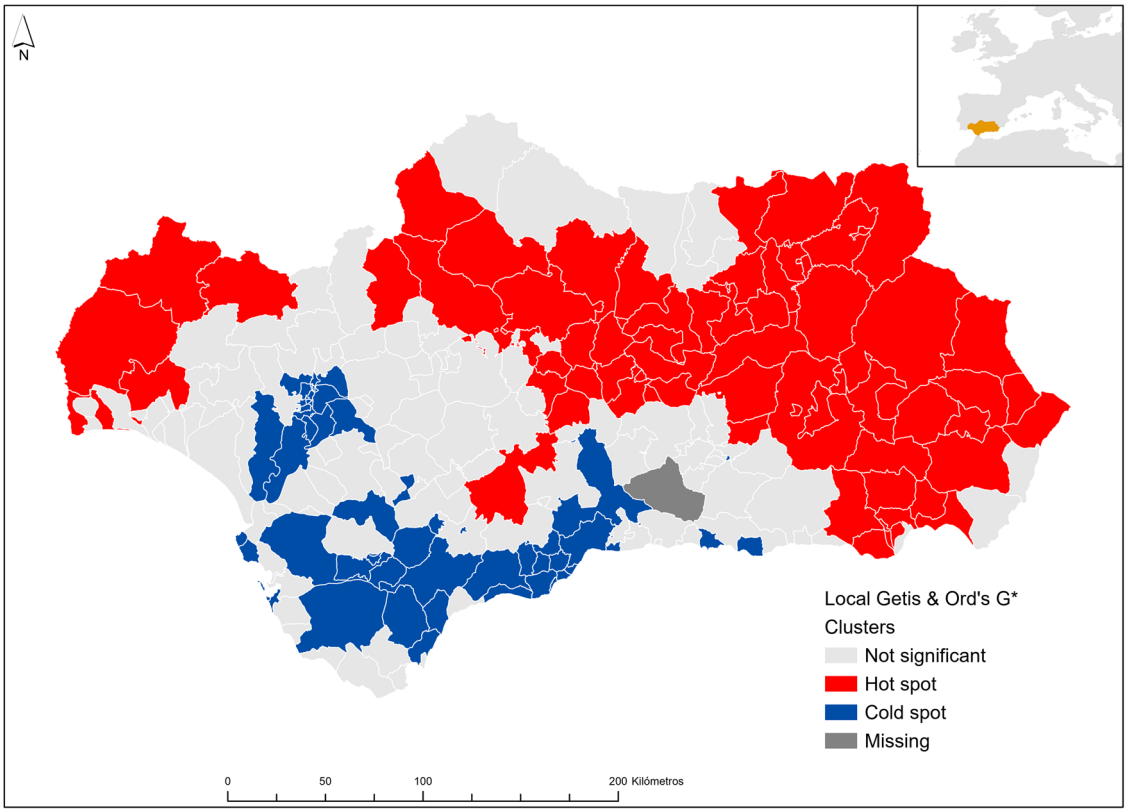

Fig. 3 Spatial clusters identified through Local Getis & Ord's *G** of funding per inhabitant of the Community Social Service Centres of Andalusia by catchment areas, 2019.

Regression according to Anselin's model selection decision rule (1988). Thus, Models 3 and 4 (Table 2) were built by applying this spatial regression on the same variables as Models 1 and 2.

Both spatial models maintained the same significance of the variables as the nonspatial models. Although R-squared was greater in Models 3 and 4, these values are pseudo R-squared and are not directly comparable with the OLS models. Instead, the Akaike information criterion index and the Schwarz criterion can be directly used to compare models. In this case, they were slightly smaller in both spatial models, suggesting an improvement in the fitting for the spatial lag specification. The spatial models solved the problems of spatial dependency since the spatial autocorrelation of the residuals was not significant in both cases.

All models explained that CSSC funding was directly associated with the ageing index and the percentage of primary sector employees and indirectly associated with the foreign population and the population density. Checking the nonsignificant variables in Models 1 and 3 ($p > 0.05$), the associations were direct with the unemployment rate, the emigration rates, and the dependency index. In contrast, the relationship was indirect with the sex ratio.

Model 4 (i.e., the Spatial Lag Regression without nonsignificant variables) showed that one-unit increase in the ageing index and the percentage of employees in the first sector results in a 0.14% and 0.05% increase, respectively, in CSSC funding per capita. Conversely, one-unit increase in the percentage of foreign population and the population density leads to a decrease of 0.31% and 0.06%, respectively, in funding per capita.

Discussion

This piece of research studied the geographical distribution of governmental investment in social services in Andalusia, a deprived region in Spain, through geo-statistics techniques. To our knowledge, the application of spatial data analysis techniques to social service financing had only been addressed in a recent study prior to this research (Gallego Valadés et al. 2023).

The regulation of the distribution of expenditures in social services considers the population size as a criterion for increased funding. However, no hot spots were identified in major cities, but cold spots were identified in or around four of them. The minimum study unit at the municipal level could hide intramunicipal differences. Indeed, Seville and Malaga hold some of the neighbourhoods with relatively low incomes in Spain (National Statistics Institute 2022), but it has not produced hot spots or low-high/high-low areas in these cities, but cold spots.

The distribution of the hot and cold spots showed, therefore, an urban/rural pattern (with small exceptions such as the hot spot identified in Cordova city). This pattern in spatial clusters of funding may reflect differences in the organizational models and professional practices in urban and rural SSZs. A recent study has highlighted differences in the practice of social workers in urban and rural areas of Andalusia (Ruiz-Ballesteros et al. 2023).

The suitability of the funding distribution could be approximated through the comparison between the spatial clusters identified in this study and the distribution of the deprivation index applied in a previous study in Andalusia (Rodero-Cosano et al. 2014). This deprivation index was developed through structural equations and a range of socioeconomic indicators considering six deprivation domains: education, employment, income, housing, infrastructure and health. Thus, this deprivation index is more methodologically advanced and comprehensive than the one based on income used to weigh the funding distribution between SSZs. In this previous study, the mountain ranges of the Subbaetic System in the southeast (Almeria, Granada and Jaen Provinces) and the Sierra Morena in the north (Huelva and Cordova Provinces), with rural and poorer

Table 2 Nonspatial and spatial regression analyses of funding of the Community Social Service Centres of Andalusia, 2019 ($n = 184$).

	Model 1 - OLS	Model 2 - OLS	Model 3 - spatial lag	Model 4 - spatial lag
Coefficients (standard errors in parentheses)				
Intercept	2.3855*** (0.3053)	2.0367*** (0.0539)	1.6305*** (0.3692)	1.3741*** (0.2372)
Ageing index	0.0015*** (0.0004)	0.0014*** (0.0002)	0.0014*** (0.0004)	0.0014*** (0.0002)
% Employees in the primary sector	0.0007*** (0.0003)	0.0006*** (0.0002)	0.0006*** (0.0002)	0.0005*** (0.0002)
% Foreign population	−0.0042** (0.0018)	−0.0030** (0.0013)	−0.0042** (0.0017)	−0.0031** (0.0012)
Log(Population density)	−0.0656*** (0.0205)	−0.0838*** (0.0155)	−0.0439** (0.0204)	−0.0627*** (0.0160)
% Unemployment	0.0014 (0.0036)	-	0.003 (0.0035)	-
% Emigrants	0.0005 (0.0087)	-	0.001 (0.0083)	-
Sex ratio	−0.0042 (0.0030)	-	−0.0044 (0.0028)	-
Dependence index	0.0002 (0.0037)	-	0.0012 (0.0036)	-
Spatial term	-	-	0.3211*** (0.1083)	0.3061*** (0.1097)
Model diagnosis				
R^2	0.5861	0.5805	-	-
Pseudo R^2	-	-	0.6058	0.5990
F-statistic	30.9778*** ($p = 0.000$)	61.9291*** ($p = 0.000$)	-	-
Akaike information criterion index	−265.175	−270.703	−270.874	−275.837
Schwarz criterion	−236.24	−254.628	−238.725	−256.547
Normality of errors test (Jarque-Bera)	0.5482 ($p = 0.760$)	0.3684 ($p = 0.832$)	-	-
Heteroscedasticity tests (Breusch-Pagan)	5.5334 ($p = 0.699$)	3.6042 ($p = 0.462$)	5.4417 ($p = 0.709$)	2.8135 ($p = 0.590$)
Multicollinearity Condition Index	130.9871	15.0827	-	-
Spatial dependence tests				
Global Moran's I for residuals	0.0559*** ($p = 0.001$)	0.0685*** ($p = 0.001$)	0.0019 (pseudo $p > 0.10$)	0.0121 (pseudo $p > 0.10$)
Lagrange Multiplier (lag)	9.3179*** ($p = 0.002$)	8.8224*** ($p = 0.003$)	-	-
Robust LM (lag)	4.7992** ($p = 0.028$)	2.8695* ($p = 0.090$)	-	-
Lagrange Multiplier (error)	4.5956** ($p = 0.032$)	6.8880*** ($p = 0.009$)	-	-
Robust LM (error)	0.0770 ($p = 0.781$)	0.9351 ($p = 0.334$)	-	-
Likelihood Ratio Test	-	-	7.6992*** ($p = 0.006$)	7.1335*** ($p = 0.008$)

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

accessibility characteristics, showed a higher deprivation in contrast to the Guadalquivir River Valley and the longest section of the seacoast, characterized by larger populated and urban areas and better accessibility. A similar pattern is observed in the distribution of the funding clusters, both for high and low values, which could indicate the suitability of the financing distribution. Looking at the geographical distribution of the values of the domains of this deprivation index, the funding distribution pattern is closer to the distribution of the unemployment, income, and housing deprivation domains.

The use of spatial regression to explain funding rates through the socioeconomic indicators allowed us to correct the spatial autocorrelation issues found in the OLS model. Anselin's selection decision rule recommended the use of spatial lag regression to analyse the variables, which may point to the existence of spillover effects in the funding per capita of CSSC as expected. The model only defined the ageing index, the percentage of primary sector employees, the immigration rate, and the population density as significant independent variables ($p < 0.05$). Population density and ageing are clearly related to two criteria for fund distribution defined by law: the population size and the dependency rate, respectively. Interestingly, the dependency index is considered in the regulation of the distribution of funds, but it was not a significant variable in the statistical models ($p > 0.05$). Instead, the primary sector employees and foreign population ratio introduce two new factors associated with the distribution of funding.

The rate of employees in the primary sector is linked to rurality, and it was associated with higher funding. In contrast, higher ratios of the foreign population were associated with lower funding of social services. Migrants from developed countries, such as highly qualified professionals or retired people, mainly live in larger cities or coastline tourist areas, and they usually do not use social services. Migrants from developing countries, in some cases illegal, usually settle in larger cities, the coastline, and areas of intensive agriculture. In these economically dynamic areas, the native population could use fewer social services, while most illegal migrants are outside the social system. The foreign population is often associated with employees in the first sector, particularly when referring to people from developing countries who are typically employed in agriculture in Andalusia. This study included immigrants from various countries since the immigrants' countries of origin were not completely disaggregated in the public statistics. The correlation between both variables was low and not significant ($r = 0.04$, $p = 0.58$) and did not result in collinearity in the models. In contrast, there was a moderate negative correlation between the ageing index and the logarithmic population density, which may be linked to the ageing of the rural population, but it did not result in excessive collinearity in the model.

This study provides local evidence that could support evidence-informed social service policy and planning (Lewin et al. 2009; Oxman et al. 2009). The existence of clusters of higher/lower funding of social services per capita identified areas where funding allocation and its relationships with social context should be specifically assessed to know if it is adequate to social needs and if it is effective. For instance, the cold spots in Cadiz Province (southwest), a particularly disadvantaged jurisdiction, warrant further analysis, as these SZZ may require additional economic resources or specific social programmes.

This study has some limitations that must be stated. The data were only available for 2019 when formally requested in 2021.

Longitudinal analyses would allow assessment of the economic figures and spatial clusters across time for steadiness and if the investment in social services is improving the overall population's well-being or only those in specific areas. Furthermore, the economic situation has been greatly affected since 2019 by the COVID-19 pandemic and the Ukraine war. However, their effects on social services funding have been smaller than in the previous crisis because the Spanish economic policy has not been based on dramatic cuts in social spending on this occasion. Secondly, submunicipal areas could not be studied given the lack of sociodemographic data. Thus, it was not possible to study the funding of districts within larger cities. This is relevant considering that Andalusia holds many of the poorest districts in the country according to the National Statistics Institute's urban indicators (National Statistics Institute 2022). Finally, the spatial analysis of other planning-related variables could give a more comprehensive view of the Andalusian social system, such as professional ratios or beneficiary rates that were already used in a recent technical report commissioned by the regional social service ministry (González Portillo et al. 2022). Moreover, the unavailability of financial data for the municipalities under 50,000 inhabitants did not allow the inclusion of relevant variables, such as tax revenues and current transfers, which were studied in two previous articles on social expenditure in Spain (López et al. 2017; Gallego Valadés et al. 2023).

Conclusion

This study has revealed that the geographical distribution of the funding of social services in Andalusia is not random. Two LISA have identified several hot spots or clusters of SSZ with significantly high funding ($p < 0.05$), and cold spots with significantly low funding ($p < 0.05$). The hot spots were mainly associated with rural areas, while the cold spots were associated with urban areas. Their location coincided with overall deprivation and, specifically, with unemployment, income, and housing deprivation found in a previous study. The relationship between social services funding and a range of socioeconomic indicators analysed through spatial regression showed that the distribution criteria defined by regulation were not fully associated with higher financing, such as the dependency index, which was not significant ($p > 0.05$), while other variables were actually significant ($p < 0.05$), such as the employees in the primary sector, indicating the effect of rurality again, and the foreign population ratio, identifying populations outside the social system, such as wealthy and illegal migrants. The scientific evidence on the funding distribution of social services throughout Andalusia provided in this study may support service assessment and decision-making in social policy. This study is a demonstration of the potential of spatial analyses in the field of social services that could be replicated in other territories.

Data availability

The data that support the findings of this study are available from Consejería de Igualdad, Políticas Sociales y Conciliación, Junta de Andalucía (Spain), but restrictions apply to the availability of these data, which were used under licence for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Consejería de Igualdad, Políticas Sociales y Conciliación, Junta de Andalucía.

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Author contributions
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Competing interests
The authors declare no competing interests.

Ethical approval
Ethical approval was not required as the study did not involve human participants.

Informed consent
Informed consent was not required as the study did not involve human participants.

Additional information
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