

## ADOLESCENT MATERNITY IN PERUVIAN DISTRICTS: A SPATIAL ANALYSIS OF CENSUS DATA

### MATERNIDAD ADOLESCENTE EN DISTRITOS PERUANOS: UN ANÁLISIS ESPACIAL DE DATOS CENSALES

### MATERNIDADE NA ADOLESCÊNCIA EM DISTRITOS PERUANOS: UMA ANÁLISE ESPACIAL DE DADOS CENSITÁRIOS

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#### ABSTRACT

**Objective:** The aim of this study was to perform a spatial analysis of the prevalence of adolescent maternity in different districts of Peru and determine the spatial correlation with socioeconomic and sociodemographic characteristics. **Material and Method:** An ecological study was carried out through a spatial analysis based on the prevalence of adolescent maternity, registered in the 2017 National Census, of different districts of Peru. The global and local Moran's Indexes were used to establish clustering patterns. A spatial lag model was performed to correlate district sociodemographic and socioeconomic characteristics with adolescent maternity. **Results:** Data from 1874 districts were analyzed. Of all the adolescents, 122.144 (10.1%) had been mothers. Some districts showed a prevalence of adolescent maternity above 40%. Ucayali, Loreto, and San Martín were the administrative regions with the highest proportion of districts with adolescent pregnancies, surrounded by districts with also a high prevalence of adolescent pregnancies. The spatial lag model analysis showed a significant and positive association for illiteracy, single marital status, rurality, and location in the Jungle natural region of the district with adolescent maternity; access to drinking water showed a negative association. **Conclusion:** One in ten adolescents between 15 and 19 in Peru has been a mother. The districts with the highest prevalence of adolescent maternity are located in the Peruvian jungle region. Sociodemographic and socioeconomic factors at the district level such as illiteracy, rurality, single marital status, and location in the Jungle natural region were positively associated with adolescent maternity. A higher prevalence of access to drinking water at the district

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level is associated with a lower prevalence of adolescent maternity at the district level.

**Key words:** Pregnancy in Adolescence; Geographic Information Systems; Census; Spatial Analysis; Peru.

## RESUMEN

**Objetivo:** Realizar un análisis espacial de la prevalencia de maternidad adolescente en diferentes distritos del Perú y determinar la correlación espacial con características socioeconómicas y sociodemográficas. **Material y Método:** Estudio ecológico mediante un análisis espacial con base en la prevalencia de maternidad adolescente registrada en el Censo Nacional del 2017 de diferentes distritos de la población peruana. El índice local y global de Moran se utilizó para establecer patrones de agrupamiento. Se realizó un modelo de rezago espacial para correlacionar las características sociodemográficas y socioeconómicas del distrito con la maternidad adolescente. **Resultados:** Se analizaron datos de 1.874 distritos. Del total de adolescentes, 122.144 (10,1%) habían sido madres. Algunos distritos mostraron una prevalencia de maternidad adolescente superior al 40%. Ucayali, Loreto y San Martín fueron las regiones administrativas con la mayor proporción de distritos con embarazos adolescentes rodeados de distritos también con alta prevalencia de embarazos adolescentes. El modelo de rezago espacial mostró una asociación significativa y positiva para el analfabetismo, el estado civil soltero, la ruralidad y la ubicación en región natural Selva del distrito con la maternidad adolescente; el acceso al agua potable mostró una asociación negativa. **Conclusión:** Una de cada diez adolescentes de 15 a 19 años en Perú ha sido madre. Los distritos con mayor prevalencia de maternidad adolescente pertenecen a la región selva peruana. Los factores sociodemográficos y socioeconómicos a nivel distrital como el analfabetismo, la ruralidad, el estado civil soltero y la ubicación del distrito en la región natural Selva se asociaron positivamente con la maternidad adolescente. Una mayor prevalencia de acceso a agua potable a nivel distrital se asocia a una menor prevalencia de maternidad adolescente a nivel distrital.

**Palabras clave:** Embarazo en Adolescencia; Sistemas de Información Geográfica; Censos; Análisis Espacial; Perú.

## RESUMO

**Objetivo:** O objetivo deste estudo foi realizar uma análise espacial da prevalência da maternidade adolescente em diferentes distritos do Peru e determinar a correlação espacial com as características socioeconômicas e sociodemográficas. **Material e Método:** Um estudo ecológico foi realizado através de uma análise espacial com base na prevalência da maternidade adolescente, registrada no censo nacional de 2017, de diferentes distritos do Peru. Os índices de Moran globais e locais foram usados para estabelecer padrões de agrupamento. Um modelo espacial lag foi realizado para correlacionar as características sociodemográficas e socioeconômicas do distrito com a maternidade na adolescência. **Resultados:** Foram analisados os dados de 1874 distritos. Do total de adolescentes, 122.144 (10,1%) foram mães. Alguns distritos apresentaram prevalência de maternidade na adolescência acima de 40%. Ucayali, Loreto e San Martin foram as regiões administrativas com a maior proporção de distritos com gravidez na adolescência, rodeados por distritos com também alta prevalência de gravidez na adolescência. A análise de modelo espacial lag mostrou uma associação significativa e positiva para analfabetismo, estado civil solteiro, ruralidade e localização na região natural Selva do distrito com maternidade na adolescência; acesso à água potável mostrou associação negativa. **Conclusão:** Um em cada dez adolescentes de 15 a 19 anos no Peru já foi mãe. Os distritos com maior prevalência de maternidade adolescente estão localizados na região natural Selva. Fatores sociodemográficos e socioeconômicos em nível distrital, como analfabetismo, ruralidade, estado civil solteiro e localização na região natural Selva, foram associados positivamente com a maternidade na adolescência. Uma prevalência mais alta de acesso a água potável no nível distrital está associada a uma prevalência mais baixa de maternidade adolescente no nível distrital.

**Palavras-chave:** Gravidez na Adolescência; Sistemas de Informação Geográfica; Censos; Análise Espacial; Perú.

## INTRODUCTION

The adolescent population (1.2 billion) represents 16% of the entire world population<sup>(1)</sup>. About 80% of adolescents live in developing countries<sup>(1)</sup>, with almost half of them being sexually active, 40% married, and about 20% having children<sup>(1)</sup>. Adolescent pregnancy limits the educational development of people, generating economic inequalities that have long-term consequences for childhood development.

In developing countries, adolescent pregnancy is a public health problem, with nearly 21 million adolescents aged 15 to 19 becoming pregnant, and 12 million becoming mothers in 2016<sup>(2)</sup>. In Latin America and the Caribbean, it is reported that almost half of adolescent pregnancies are unwanted, and 49% end in abortion<sup>(1)</sup>. Adolescent pregnancy also affects the health status of adolescents, as it represents an increased probability of maternal mortality due to complications related to pregnancy and childbirth, as well as complications for the health status of the newborn<sup>(3,4)</sup>.

Despite the overall reduction in the total fertility rate in the Latin American and Caribbean region each year, during the period from 1980 to 2015 (from 4.0 to 2.2 children per woman), approximately 16 million adolescents aged 15 to 19 became pregnant<sup>(5)</sup>. This region ranks second in the world's fertility rate with an estimated 66.5 births for every thousand adolescents aged 15 to 19 during the period from 2010-2015<sup>(6)</sup>. With regards to Peru, there have been no improvements in adolescent fertility rates, with the adolescent fertility rate in 2017 being around 60 births for every 1000 women aged 15 to 19, a similar value to that reported for 1991-1992<sup>(7)</sup>.

The medical literature reports that socio-demographic and health factors at the individual and territorial level are associated with adolescent pregnancy, including living in rural or outlying areas of cities, poverty, ethnicity, educational level and sex education, marital status, religion, access to basic services, substance abuse and risk behaviors, among others<sup>(8-10)</sup>. In Peru, it has been reported that individual factors such as a low educational level, living in the natural jungle region and nutritional status are associated with adolescent pregnancy<sup>(11)</sup>. However, no factors influencing adolescent maternity have been identified among

territorial divisions.

Currently, geographic information systems (GIS) are used as a tool for public health and maternal-child health to describe, explain or predict data obtained in a given geographical context and clearly visualize the differences and health inequities between the various regions, in addition to correlating different variables at the population level<sup>(12,13)</sup>. These systems have been used in Peru for the study of maternal-child health<sup>(14,15)</sup>.

Adolescent pregnancy is a global health problem, which affects to a greater extent low- and middle-income countries such as Peru, where a pregnant adolescent is more likely to have complications during childbirth, to be socially discriminated against, and to suffer gender violence<sup>(16-18)</sup>. Since adolescent pregnancy is a public health problem in Peru and, considering factors at the population level that can influence adolescent pregnancy, the objective of this study was to carry out a spatial analysis of the prevalence of adolescent maternity in different districts of Peru and determine the spatial correlation with socioeconomic and socio-demographic characteristics.

## MATERIALS AND METHODS

**Study design:** An ecological study was carried out involving a spatial analysis of secondary data from different districts obtained from the XII Census of Population, VII of Housing, and III of Indigenous Communities of Peru, conducted by the National Institute of Statistics and Informatics (INEI) in 2017. In Peru, a census is carried out every 10 years to provide statistical information on the composition, geographical distribution, growth as well as other sociodemographic characteristics including marital status, fertility, mortality, internal and international migration of the Peruvian population, allowing the formulation, evaluation, and monitoring of public policies and the administration of the economic resources of the Peruvian State<sup>(19)</sup>. The last national census conducted on Peruvian population in 2017, included a total of 29 381 884 people, where 14 931 127 were women of all ages, being 1 204 959 women aged 15 to 19 years old<sup>(19)</sup>.

The territory of Peru is divided into 25 administrative regions including 1874 districts (territorial subdivision of administrative regions)

throughout the national territory<sup>(20)</sup>. Similarly, Peru is divided into three natural regions: the coast, covering a long narrow territory between the Pacific Ocean and the Andes, including the capital of Peru (Metropolitan Lima), the Sierra or highlands, which occupy a central position circumscribing the Andes mountain range and the jungle, made up of the Peruvian Amazon<sup>(20,21)</sup>.

**Unit of analysis:** For the purpose of this study, information on adolescent mothers available from the national census data was evaluated. The unit of analysis was the districts where adolescent mothers reside in Peru. The data from the National Census analyzed in this study were obtained using REDATAM (Retrieval of Data for Small Areas by Microcomputer)<sup>(22)</sup>.

The main study variable was the prevalence of adolescent maternity between the ages of 15 and 19 at the district level. This variable was constructed based on the following questions from the national census: How old are you now?, which specifies the number of years completed up to the time of the survey, and how many live-born children have you had in total?, which specifies the total number of living children the woman has at the time of the survey, without considering stillbirths or abortions. An adolescent mother was considered as such when women reported to be between 15 and 19 years old and to have at least one child. To calculate the district percentage of adolescent maternity, the number of women aged 15 to 19 residing in the district, who had at least reported a live birth, was considered the numerator, and the denominator was all those women residing in the district aged 15 to 19. It should be noted that the main variable, sociodemographic and socioeconomic variables were constructed according to the location of the district where the house was located, according to the district code and number<sup>(23)</sup>.

**Statistical Analysis:** The Stata 14 software (StataCorp LP, College Station, TX, USA) was used to determine the prevalence of adolescent maternity in the administrative regions (N = 25) and districts (N = 1874) of Peru. These results were exported to an Excel 2016 spreadsheet (Microsoft Corporation, USA). Spatial analysis was then carried out to determine district clusters with a high prevalence of adolescent maternity, linking the spreadsheet to the district mapping. To perform the spatial

analysis, adolescent maternity prevalence for each district was calculated. The global and local Moran indexes were calculated to explore the district spatial autocorrelation between the prevalence of adolescent maternity at the district level. The calculation of the global Moran index started with the construction of a neighborhood matrix or matrix of geographic weights based on a 1:1 Queen-type relationship of closeness between the studied units, which allowed us to evaluate whether the units of analysis presented a tendency of clustering, dispersion or randomization through values ranging from -1 to +1. Values greater than zero (positive) indicate a distribution of similar units of analysis, while a value less than zero (negative) indicates that the units of analysis are different from each other. Additionally, to perform the spatial representation the local Moran index was calculated. This is a local indicator of spatial association (LISA) and expresses the local instability among the units of analysis<sup>(24)</sup>. Spatial representation of the local Moran index was reported in five types of clusters: 1) "high-high" district clusters: districts with a high prevalence of adolescent maternity surrounded by districts with also a high prevalence; 2) "high-low" district clusters: high-prevalence districts surrounded by districts with a lower-than-average prevalence; 3) "low-high" district clusters: districts with low prevalence surrounded by districts with higher-than-average prevalence; 4) "low-low" district clusters: districts with low prevalence surrounded by districts with similar prevalence, and 5) "non-significant" district clusters: districts with no spatial correlation with the surrounding districts. It should be noted that the global and local Moran indexes have previously been used in similar population-based studies in Peru<sup>(1,25)</sup>.

Finally, after identifying the spatial autocorrelation between the adolescent maternity prevalence among the units of analysis, a spatial lag model was applied to learn how the prevalence of adolescent maternity in a district is affected by the socioeconomic characteristics (urban or rural district, district by natural jungle region, percentage of single marital status, access to health insurance, and access to drinking water) of the neighboring districts<sup>(26)</sup>.

Estimates were calculated with a confidence level of 95% and a coefficient with a p-value < 0.05 was considered statistically significant. The

spatial analysis and spatial lag model were carried out with the GeoDa1.12 software (GeoDa Center for Geospatial Analysis and Computation, Arizona State University, Tempe, AZ, USA). The maps were created with the software QGIS v3.18.3 (OSGeo, Beaverton, OR, USA).

**Ethical considerations:** This study was evaluated and approved by the Institutional Ethics Committee of the Universidad Científica del Sur, Lima, Peru (IRB code 1912019-PRE15).

## RESULTS

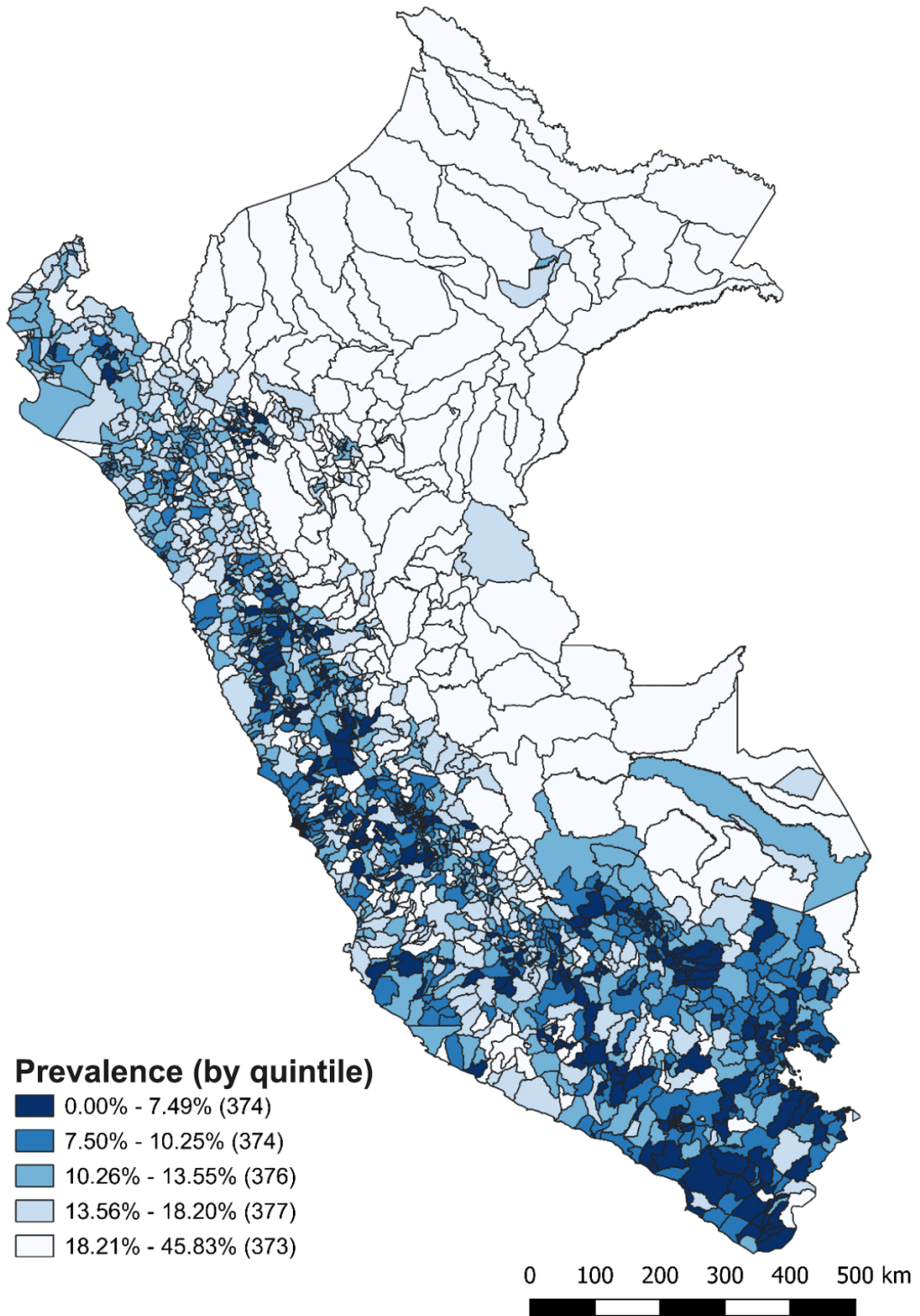
Among all the adolescents included in the study (15 to 19 years old, N= 1 204 959 in 1874 districts of Peru), 122 144 reported having given birth to at least one live child, obtaining a national prevalence of adolescent maternity in Peru of 10.1%. The prevalence of adolescent maternity at the district level ranged from no cases (n = 58) to 40% or more (n = 7). The districts with the highest prevalence of adolescent maternity belonged to the Ucayali, Loreto, and San Martín administrative regions, which are located in the natural jungle region. The districts with the lowest prevalence of adolescent maternity were clustered in the south of the country (Figure 1).

The spatial analysis showed a global Moran index for the prevalence of adolescent maternity

of 0.46 ( $p = 0.001$ ), indicating that in the 1874 districts evaluated there are clusters of districts with higher adolescent maternity. The local Moran index identified 224 districts considered “high-high”, indicating the presence of districts with a high prevalence of adolescent maternity surrounded by districts with also a high prevalence (Figure 2). Most of these “high-high” districts for adolescent maternity are located in the natural jungle region. The regions with the highest number of “high-high” districts were Ucayali (with 100% of its districts in this category), followed by Loreto (98.1%) and San Martín (75.3%) (Table 1).

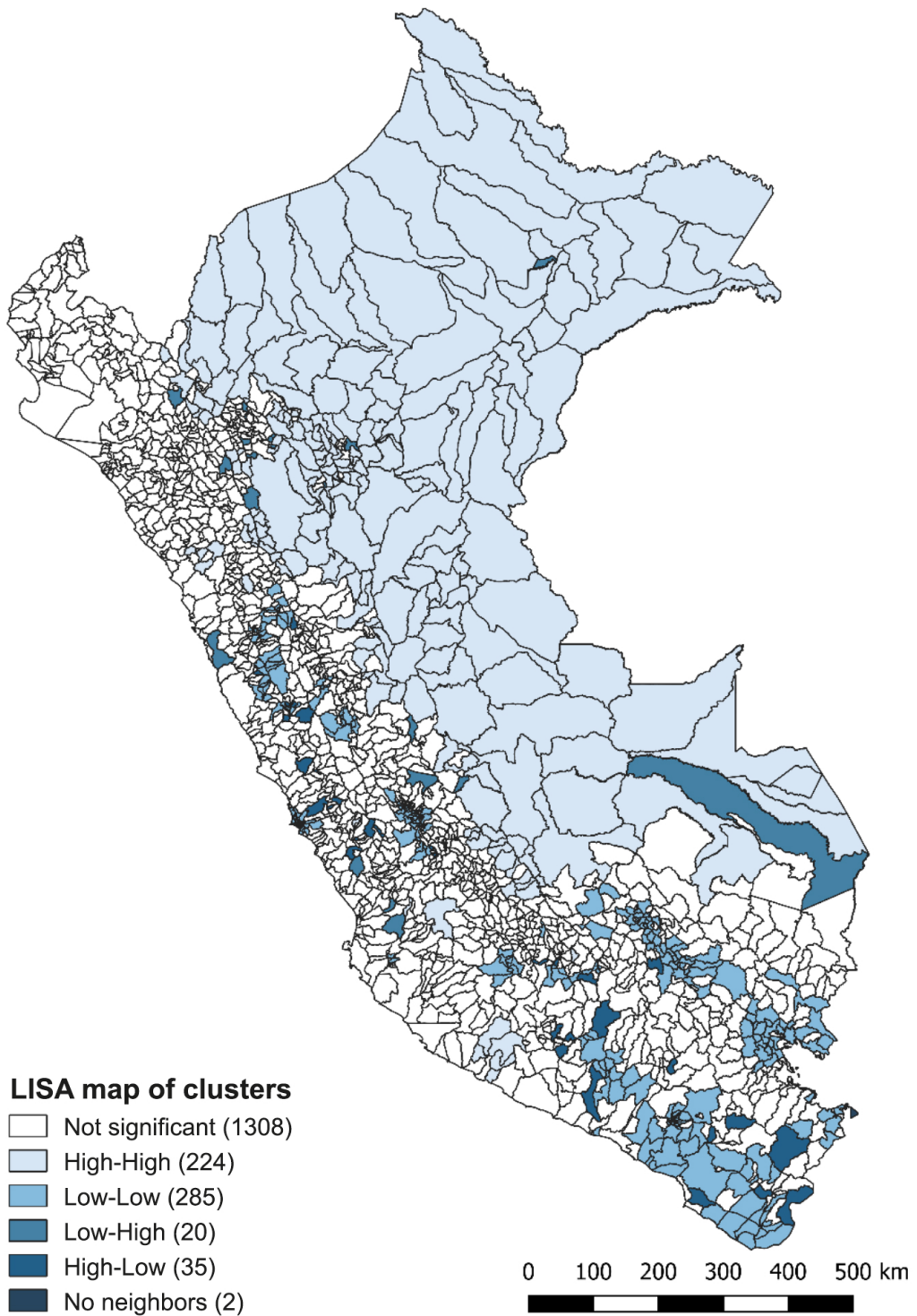
The spatial lag model analysis shows a determination coefficient of 0.55, which indicates that population and housing characteristics at the district level are associated with adolescent maternity. In this regard, a higher prevalence of socioeconomic characteristics such as illiteracy ( $p < 0.001$ ), single marital status ( $p = 0.03$ ), and rurality ( $p < 0.001$ ), or that the district is located in the natural jungle area ( $p < 0.001$ ), are associated with a higher prevalence of adolescent maternity at the district level. On the other hand, a higher prevalence of access to drinking water is associated with a lower prevalence of adolescent maternity at the district level ( $p < 0.001$ ). The percentage of population without health insurance was not found to be associated with adolescent maternity in the different districts (Table 2).





**Figure 1.** Prevalence of adolescent maternity by district, classified by quintiles, Peru 2017.

**Source:** Map developed by the authors using QGIS software v3.18.3. To obtain the quintiles, the number of districts was divided into equal parts according to their prevalence.



**Figure 2.** District clusters with district spatial autocorrelation in the prevalence of adolescent maternity, Peru 2017.

**Table 1.** Number of districts in high-high and low-low clusters for adolescent maternity, according to the administrative region of Peru, 2017.

	Administrative region	Number of districts	High-High		Low-Low	
			fr	%	fr	%
1	Amazonas	84	22	26.19	0	0.00
2	Ancash	166	1	0.60	32	19.28
3	Apurimac	84	1	1.19	13	15.40
4	Arequipa	109	3	2.75	43	39.40
5	Ayacucho	119	11	9.24	8	6.70
6	Cajamarca	127	3	2.36	0	0.00
7	Callao	7	0	0.00	5	71.40
8	Cuzco	112	5	4.46	44	39.20
9	Huancavelica	100	4	4.00	3	3.00
10	Huanuco	84	15	17.86	4	4.76
11	Ica	43	0	0.00	2	4.65
12	Junin	124	6	4.84	38	30.65
13	La Libertad	83	15	18.07	0	0.00
14	Lambayeque	38	0	0.00	0	0.00
15	Lima	171	1	0.58	29	26.96
16	Loreto	53	52	98.10	0	0.00
17	Madre de Dios	11	6	54.55	0	0.00
18	Moquegua	20	0	0.00	4	20.00
19	Pasco	29	4	13.79	7	24.14
20	Piura	65	0	0.00	0	0.00
21	Puno	110	0	0.00	37	33.64
22	San Martín	77	58	75.32	0	0.00
23	Tacna	28	0	0.00	16	57.14
24	Tumbes	13	0	0.00	0	0.00
25	Ucayali	17	17	100.00	0	0.00
<b>Total</b>		1,874	224		285	

**Table 2.** Results of the spatial lag model of adolescent maternity at the district level, according to socioeconomic and sociodemographic variables, Peru, 2017.

Variables	Coefficient	SE	p
% Rural population	0.029	0.003	<0,001
% Illiterate population	0.165	0.037	<0,001
% Single women	0.014	0.006	0.032
% Households with access to drinking water	-0.023	0.005	<0,001
% Population without health insurance	0.004	0.008	0.569
District located in the natural jungle region	1.312	0.19	<0,001
Spatial lag term (Wy)	0.55	0.025	<0,001
Intercept	2.238	0.686	0.001
R <sup>2</sup>	0.446		
Spatial lag coefficient: 0.550278 / SE: Standard error / p: p value			



## DISCUSSION

It was found that one-in ten adolescent girls aged 15 to 19 in Peru had given birth to at least one live child. According to the different regions, the districts with the highest prevalence of adolescent maternity were found in the administrative regions of Ucayali, Loreto and San Martín, which belong to the natural jungle region. These regions showed the highest number of district clusters with a high prevalence of adolescent maternity surrounded by districts with also a high prevalence of this health problem. Likewise, a higher prevalence of illiteracy, single marital status, rurality, and less access to drinking water was associated with a higher probability of adolescent maternity in the different districts.

While one in ten adolescents has been a mother at least once in Peru, it has been reported that the prevalence of maternity among women less than 20 years of age in countries of the Latin America and Caribbean region was between 27% and 41% in 2008<sup>(27)</sup>, being 15% in 2015<sup>(5)</sup>, which is close to the value found in the present study. Despite the reduction in adolescent pregnancies in the Latin American region, the high risk of complications and higher mortality of women in this age group, due to pregnancy, requires the need for greater efforts to further reduce adolescent pregnancy rates in these regions. In this sense, in 2016, the Pan American Health Organization/World Health Organization (PAHO/WHO), the United Nations Population Fund (UNFPA) and the United Nations Children's Fund (UNICEF) raised strategies for a reduction of adolescent maternity around the world, with multisectoral programs for the most vulnerable groups as well as sex education and greater access to contraceptive methods<sup>(5)</sup>.

In the present study, most of the districts with the highest rates of adolescent maternity were found to be in the natural jungle region, mainly in the Ucayali, Loreto, and San Martín regions. These findings are similar to those of a previous study which described that being from the natural jungle region was associated with a higher probability of adolescent pregnancy<sup>(11)</sup>. Similarly, data from the Demographic Health Survey of Peru, show that the jungle region presents the highest rates of adolescent fertility in Peru, with rates of 26.7% in 1992 and 27.5% in 2012<sup>(28)</sup>. These results suggest the need

to study the factors that influence adolescent maternity in this population and the development of strategies focused on this health problem in this area of the country.

A higher prevalence of illiteracy at the district level was associated with an increase in adolescent maternity. These results coincide with various studies worldwide that describe an inverse relationship between a lower educational level and a higher prevalence of adolescent maternity<sup>(8-10)</sup>. Likewise, our results were similar to those described in countries of the Latin American and Caribbean region, which also report higher rates of pregnancy among adolescents with a lower educational level<sup>(5)</sup>.

Single marital status was associated with a higher probability of adolescent pregnancy at the district level in Peru. In this regard, several studies have shown that marital status influences adolescent pregnancy<sup>(8,10)</sup>. In Peru, while one in five adolescents gets married, the majority of adolescent mothers are single<sup>(7,29)</sup>, which could explain our findings. Therefore, the WHO has promoted a strategy to reduce marriages before the age of 18, many of which are forced and increase the likelihood of adolescent pregnancy and the probability of complications to the woman's health during this process<sup>(30)</sup>. This emphasizes the need to study the influence of marital status, including early marriage in Peru, and adolescent pregnancy, since this population is vulnerable to health problems related to pregnancy.

Rurality, which was another factor associated with adolescent pregnancy at the district level, is also found in the scientific literature<sup>(8, 31)</sup> and has been described in Peru as being associated with adolescent pregnancy<sup>(11)</sup>. In the Latin American and Caribbean region, there is also evidence of a higher proportion of adolescent pregnancies in rural areas<sup>(5)</sup>. This situation highlights the need for the development of strategies focused on reducing fertility rates in this population. Additionally, greater access to drinking water at the district level showed a lower probability of district adolescent maternity. This finding may be explained by the fact that the lack of access to drinking water is an indicator of socioeconomic inequality, which would lead to a higher probability of adolescent pregnancy<sup>(32)</sup>. Thus, improved access to drinking water and health care services would facilitate hygiene and school attendance by adolescents, which, in turn, would

reduce the likelihood of dropping out of school, leading to a higher educational level, which is a protective factor against adolescent pregnancy<sup>(33,34)</sup>.

Regarding the limitations of this study, the use of a secondary data source (National Census) may not ensure the accuracy of some of the data analyzed. On the other hand, some variables of interest in the study of adolescent maternity were not collected by the National Census, thereby limiting better characterization of the phenomenon under study. Likewise, due to the design characteristics of an ecological type study, there is the limitation of being able to extrapolate the findings to an individual level. However, it should be noted that the data from the last National Census of Peru underwent a review process regarding the quality of the data collected and provided data at the district level. This allows an initial approach to the study of adolescent maternity and its associated factors at the district level, in addition to the identification of district clusters with a high prevalence of this health issue. All of this information is useful for the development of programs aimed at reducing adolescent pregnancy.

## CONCLUSION

One in ten adolescent girls aged 15 to 19 in Peru has given birth to at least one child. The districts with the highest prevalence of adolescent maternity in Peru are located in parts of the Amazon region, with districts clusters showing a high prevalence of adolescent maternity surrounded by districts that also present a high prevalence. Additionally, sociodemographic and socioeconomic factors such as illiteracy, rurality and district "single" marital status were positively associated with adolescent maternity.

The development of strategies to manage this public health problem should be aimed at reducing the socioeconomic inequalities associated with adolescent maternity, in addition to focusing the efforts of governments and local health authorities on adolescent pregnancy in population groups where this problem is most concentrated.

**Conflicts of interest:** The authors declare no conflicts of interest.

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