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Rentabilidad privada de la educación en la zona urbana y rural del Estado de México, 2020 y 2022

Private profitability of education in urban and rural areas of the State of Mexico, 2020 and 2022

Rentabilidade privada da educação nas áreas urbanas e rurais do Estado do México, 2020 e 2022

Esther Figueroa Hernández
Universidad Autónoma del Estado de México, Centro Universitario UAEM Texcoco, México
esther.f.her@gmail.com, efigueroah@uaemex.mx
https://orcid.org/0000-0001-9680-8984

Rebeca Alejandra Pérez Figueroa
Trabajador independiente (freelance), México
rebeca.pzfa@gmail.com
https://orcid.org/0000-0002-7634-5385

Resumen

El objetivo del estudio fue estimar la rentabilidad privada de la educación para las zonas, rural y urbana del Estado de México. Para ello, se utilizó el modelo de Mincer con datos de la ENIGH 2020 y 2022 de los jefes del hogar separadas por género. Los principales resultados fueron que las tasas de rentabilidad de la educación para el sexo femenino y masculino fueron menores para la rural (4.7%, 6.5%) que para la urbana (7.6%, 8.8%). Los Modelos *Spline* (2020), la rentabilidad de educación primaria fue mayor para la zona urbana de las madres (7.01%) que para los padres (6.8%), la secundaria fue mayor para las jefas (9.48%) de la urbana. Para la universidad fue alto para ambas zonas, excepto para las mujeres de la urbana. Para 2022, la primaria fue menor para las madres que para los hombres de la rural y la urbana, la secundaria fue mayor para ambos géneros de la rural y negativos para la urbana. Para la

universidad fue mayor para las mujeres (45.3%) que los hombres de la urbana (22.8%) y para la rural fue mayor para mujeres (44.6%). Los resultados presentados mostraron concordancia con lo que plantea la teoría del capital humano.

Palabras clave: aprendizaje, eficiencia de la educación, escolaridad, género, población rural y urbana, productividad, rendimiento escolar.

Abstract

The objective of the study was to estimate the private profitability of education for rural and urban areas of the State of Mexico. To do this, the Mincer model was used with data from the ENIGH 2020 and 2022 of the heads of the household separated by gender. The main results were that the profitability rates of education for females and males were lower for rural (4.7%, 6.5%) than for urban (7.6%, 8.8%). The Spline Models (2020), the return on primary education was higher for mothers in the urban area (7.01%) than for fathers (6.8%), secondary education was higher for female heads (9.48%) in the urban area. For the university it was high for both areas, except for women in the urban area. By 2022, primary school was lower for mothers than for men in rural and urban areas, secondary school was higher for both genders in rural areas and negative for urban areas. For the university it was higher for women (45.3%) than for men in the urban (22.8%) and for the rural it was higher for women (44.6%). The results presented showed agreement with what the theory of human capital proposes.

Keywords: efficiency of education, gender, learning, productivity, school performance, rural and urban population, schooling.

Resumo

O objetivo do estudo foi estimar a rentabilidade privada da educação para áreas rurais e urbanas do Estado do México. Para tal, foi utilizado o modelo Mincer com dados do ENIGH 2020 e 2022 dos chefes de agregado familiar separados por género. Os principais resultados foram que as taxas de rentabilidade da educação para mulheres e homens eram mais baixas nas zonas rurais (4,7%, 6,5%) do que nas urbanas (7,6%, 8,8%). Nos Modelos Spline (2020), o retorno do ensino primário foi maior para as mães na zona urbana (7,01%) do que para os pais (6,8%), o ensino secundário foi maior para as mulheres chefes (9,48%) na zona urbana. Para a universidade foi elevado para ambas as áreas, exceto para as mulheres da zona urbana.

Em 2022, o ensino primário era mais baixo para as mães do que para os homens nas zonas rurais e urbanas, o ensino secundário era mais elevado para ambos os géneros nas zonas rurais e negativo nas zonas urbanas. Para a universidade era maior para as mulheres (45,3%) do que para os homens na zona urbana (22,8%) e para a rural era maior para as mulheres (44,6%). Os resultados apresentados mostraram concordância com o que propõe a teoria do capital humano.

Palavras-chave: aprendizagem, eficiência da educação, escolaridade, género, população rural e urbana, produtividade, desempenho escolar.

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Introduction

Academic training has a margin of profitability, in the same way as other types of investment, whose estimated rate of return, whether private or social, can be calculated according to the cost-benefit principles or through the Mincer model (1974).

In addition to the level of education, there are other parameters or aspects of life that are considered as investments for oneself, such as health care, experience gained at work, the search for better living conditions, as well as any aspect that leads to an increase in skills, productivity and coexistence, which are also part of the theory of human capital (Pantoja, 2010).

The main interest of this paper is to analyze the impact of education on an individual basis and for society as a whole. School education is considered one of the most convenient means to estimate the level of human capital, as well as the impact of education on the quality of life of the population. It also allows for the obtaining of benefits, whether individually or collectively. In this way, education is an essential part of obtaining maximum well-being, but it is not a sufficient element in itself, since the fact of seeking schooling does not ensure the absence of market failure.

The expected return on education is directly affected by location issues (e.g., geographic location, choice of educational institution), as well as by the country's economic situation. If there is an imbalance in the supply-demand of personnel with academic training, it will encourage society not to educate itself (Pantoja, 2010). The importance of education is unquestionable, therefore, it is evident that a larger budget is allocated to it through public spending. It is due to this that, for several years, Mexico has expanded the coverage of basic education to the population (preschool, primary and secondary levels). Carrying out a

comparison, in 1990 the enrollment of students was 21.3 million, which rose to 25.2 million for the 2019-2020 cycle. Academic places grew from 810 thousand to a little more than 122 thousand, as well as the total number of campuses rose from 148 thousand to 230.4 thousand (CEESP , 2006; SEP, 2020).

The global phenomenon of the COVID-19 pandemic had among its most notable characteristics the complete disruption of daily life and the health of the population, and the impacts were not limited only to the daily life of society worldwide. In this way, education is no exception, since it is one of the sectors that has been most documented to have suffered the negative effects of the health crisis. On the one hand, the closure of schools affected millions of students who lost not only learning opportunities, but also the creation of an educational community. Likewise, important disruptions were created in the areas of family dynamics, economic relations and social ties (Acevedo et al. , 2020).

The consequences of the health crisis (COVID-19) on education have exacerbated the increase in school dropout rates. The Ministry of Public Education (SEP, 2020) indicates that, in basic education, 10.0% of students for the 2019-2020 school year (two million 525 thousand 330 preschool, primary and secondary school students) did not return to school. Consequently, in addition to the better-known effects of the pandemic, social isolation can become another cause that leads children and adolescents to abandon their education. In relation to the Upper Secondary level, it is estimated that around 800 thousand students (aged 15 to 17) have significant limitations in their education, called disinterest derived from the post-pandemic economic situation. An estimate by the United Nations Educational, Scientific and Cultural Organization (UN) predicts a post-pandemic situation of a very significant decrease in access to education for the lowest-income students compared to their peers with better economic conditions. It is estimated that Mexico will be the second country where students between six and 17 years old will show the highest school dropout rates, 16.0% will do so for economic reasons and 9.0% for purely academic reasons (CEFP, 2021).

Education in rural and urban areas

According to Herrera Arias and Rivera Alarcón (2020), they found that among the main causes that determine school dropout at the higher level or the completion of secondary education are the low economic level and low academic performance, in accordance with the errors reported in the Colombian rural educational model. It is considered important that the government provide strategies or ways to help youth, with the aim of fostering the desire to

complete secondary education and continue towards higher education, since it will generate the possibility of obtaining better economic returns and a greater probability of being able to obtain a secure work and academic future, reducing the possibility of dropping out of education to enter a job and cooperate in their homes.

Echavarría et al . (2019) mention that in rural education in Colombia and in Latin America, the importance of sociodemographic factors (levels of education, dedication and social mobility) stands out towards the quality of education or the challenges around teaching that the area presents, according to access to technology, the economic and productive level. In summary, Colombian education in rural areas requires collaboration between the educational, productive and social sectors, in order to impact more efficiently from planning to the evaluation of school policy in these areas.

Human capital theory, as part of the literature on the economics of education, defines education as an investment that provides future economic returns to those who invest in it. Using the assumption that education is considered an investment, the aforementioned theory seeks to evaluate the level of return on education. One of the most widely used models in the literature – which is applied with the objective of estimating the returns on education – is the Mincer model (1974), which seeks to maximize individual income earned during a person's life (Morales Ramos, 2011). For their part, Hanushek and Wößmann (2010) show that the quality of education is directly reflected in economic growth because the academic preparation of workers allows them to increase their productivity, provides them with tools for the generation of new technologies and innovative processes. In this way, education must be considered a fundamental axis for the development of any country. Society will be able to improve economically, both jointly and individually based on the improvement of education (Martínez Chapa, 2019).

In literature there is a large amount of analysis among whose objectives are found to a greater or lesser extent To a lesser extent, the estimation of the economic profitability of education in multiple countries; likewise, one of the most used methodologies to obtain this objective is the simple linear regression or Ordinary Least Squares (OLS) using the Mincer equation (1974). This model is an exponential function of two variables, the level of education and experience. This model relates income to the level of schooling, work experience and the square of this as a function of the logarithm of income (Ordaz, 2007; Pantoja, 2010). Mathematically, it can be expressed as follows:

$$lnY_i = \Upsilon + \phi ESC_i + \delta_1 EXP + \delta_2 EXP^2 + \varepsilon \quad (1)$$

Where: lnY : is the logarithm of income; ESC: years of schooling; EXP: work experience and EXP^2 : the square of work experience.

The quadratic variable EXP^2 can be interpreted as the decreasing variability over time of an individual's economic returns , seeking the inflection point when the maximum income is reached according to the level of experience throughout an individual's working life (Pantoja, 2010; Teijeiro and Freire, 2010). The theory of age-income profiles tells us that at the beginning experience and economic income show a positive correlation, but at some point, this relationship is reversed. The coefficient associated with schooling in the Mincer model is ϕ, which can be interpreted as the estimate of the profitability of education; that is, the variability of income in percentage terms as a response to each unitary variation in the level of education. In other words, it explains the effect of an extra year of education on the rate of return, without making reference to a particular educational level. The contribution of experience to the individual's income is represented by δ_1. According to the theory, the coefficients ϕ and δ_1 must show a positive sign, while δ_2 should result in a negative sign, thereby implying that the inflection point is found, from which the function shows a decreasing behavior as assumed in the theory (Ordaz, 2007; Pantoja, 2010).

Once the above has been explained, this work seeks to estimate the private profitability of education for two areas, rural and urban, within the State of Mexico. To do so, the Mincer model will be used, and the economic information of the people classified as heads of household will be shown separated by gender. This information will be divided into three parts in order to make comparisons and show if there are differences in the results of the gender separation , and finally, that without gender discrimination. The expected result was to be able to demonstrate a higher average profitability of the education of the person designated as head of household in the urban area of the State of Mexico than in the rural area, making the gender differentiation and without said differentiation. In the same way, the hypothesis also contemplated finding that the profitability was higher for male heads of household compared to female heads of household, regardless of the geographic area. The following hypothesis was to find that the return on education shows a positive trend in relation to the increase in the level of studies, regardless of the geographic area or the sex of the head of household. And finally, more generally, it was expected to be able to show that there is greater profitability for urban areas in the State of Mexico, this due to the fact that the majority of the population has a higher level of education than in rural areas.

Methodology

To calculate the profitability of education in urban and rural areas of the State of Mexico, the Mincer model was used, which estimated the average profitability of the level of education (Laguna and Porta, 2004). This model is specified below:

$$lnY_i = \beta_{0+} \beta_1 ES + \beta_2 EXP + \beta_3 EXP^2 + \varepsilon \quad (2)$$

Where: lnY is the logarithm of the income of the head of the household, ES represents years of schooling of the head of the household, EXP is work experience and EXP ^{2} is the quadratic variable. The analysis will be carried out according to the geographic area, distinguishing by gender and regardless of the gender of the head of the household. Years of schooling (ES) is the exact level of schooling of the head of the household, defined as between primary and postgraduate. For further details on the calculation of the variables or the model in general, it is recommended to read, for example, the work of Laguna and Porta (2004).

The literature also mentions the limitations of the Mincer model, for example, the assumption of linearity of the profitability of education, which Laguna and Porta (2004) report that the profitability of the years of education presents a significant variability for the different levels of education. Taking the above into account, the estimation of the private profitability of education for rural and urban areas of the State of Mexico will be done through both models, Mincer and the Spline model (Laguna and Porta, 2004), which can be considered as a variation of the original model proposed by Mincer (1974). The Spline model is defined as follows:

$$lnY_i = \beta_{0+} \beta_1 ES + \beta_2 EXP + \beta_3 EXP^2 + \beta_4 D1(Edu - 9) + \beta_5 D2(Edu - 16) + \varepsilon (3)$$

To estimate the coefficients of these models, simple linear regression was used with the R Statistical Package (R Core Team, 2020). The information used to carry out the study was obtained from the ENIGH 2020 and 2022, generated by the National Institute of Statistics and Geography (INEGI, 2022 and 2022). According to the survey classification, rural areas were considered to be those households in strata three and four; that is, localities with a maximum of 14,999 inhabitants; the urban area included households in strata one and two; that is, localities with a population exceeding 15 thousand inhabitants. With the results obtained, the statistical and economic analysis was carried out, which is presented in the following sections.

Results

This section presents the results of the Mincer model estimates and analyses them from a statistical and economic perspective.

Table 1. Analysis of variance of the Mincer Model of the State of Mexico, 2020 and 2022 **.**

2020						2022					
lnY	Estimator	Estimated error	Value of t	Pr > |t|		*lnY*	Estimator	Estimated error	Value of t	Pr > |t|	
IS	0.08247	0.062332	25.537	<2e-06	***	IS	0.07773	0.001123	27.113	<2e-06	***
EXP	0.02391	0.003229	9.368	<2e16	***	EXP	0.02352	0.006414	10.269	<2e16	***
EXP2	-0.0001832	0.00003115	-5.883	4.41e-09	***	EXP2	-0.00001851	0.000277	-6.665	3.07e-11	***
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual standard error: 0.6567 with 3564 degrees of freedom						Residual standard error: 0.5915 with 3523 degrees of freedom					
R^2: 0.1678, adjusted R^2: 0.1671, F-statistic: 239.5, with 3 and 3564 DF, p-value: <2.2e-16						R^2: 0.1915, adjusted R^2: 0.1908, F-statistic: 278.2, with 3 and 3523 DF, p-value: <2.2e-16					

Source: Prepared by the authors with the release of the R Package.

Table 1 shows the results obtained from the estimation of the Mincer model, applied to the general population of the State of Mexico. According to this global test, it was found that the Profitability of State education (when the dependent variable was the monthly income of the head of the household without discrimination by gender and geographic area) was statistically significant. On the other hand, the individual test indicated that in the case of these models, the explanatory variable years of schooling (ES) presented a higher level of significance; that is, years of schooling and experience influenced the monthly monetary income for heads of household regardless of their gender. The results of the 2020 ENIGH compared to that of 2022 when the COVID-19 Pandemic was in place do not show statistically significant differences.

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Table 2. Analysis of variance of the Mincer Model for urban and rural areas, 2020

Urban Zone						Rural Area					
Female gender						Female gender					
	Estimator	Standard error	Value of t	Pr > |t|			Estimator	Standard error	Value of t	Pr > |t|	
lnY	4.400E+00	1.836E-01	51.198	< 2e-16	***	lnY	9.50264403	0.2143397	44.334	< 2e-16	***
IS	7.668E-02	9.204E-03	8.331	7.75E-16	***	IS	0.0477706	0.0110431	4.326	1.88E-05	***
EXP	1.096E-02	6.822E-03	1,592	0.112		EXP	0.0158803	0.007692	2.065	0.0396	*
EXP2	-2.236E-05	8.1100E-05	-0.276	0.783		EXP2	-0.000158	0.0000805	-1.963	0.0503	.
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual Standard Error = 0.6621 with 3 and 501 degrees of freedom						Residual standard error = 0.6954 with 3 and 443 degrees of freedom					
R^2 = 0.1281, Adjusted $R^{2 = 0.1228}$ **,** p-value: <1.021e-06						R^2 = 0.06672 **, adjusted** R^2 = 0.0604 F-statistic = 10.56, p-value: <1.021e-06					
Male gender						Male gender					
	Estimator	Standard error	Value of t	Pr > |t|			Dear **r**	Standard error	Value of t	Pr > |t|	
lnY	9.224E+00	1.073E-01	85.93	< 2e-16	***	lnY	9.155E+00	9.953E-02	91,577	< 2e-16	***
IS	8.800E-02	5.657E-03	16	< 2e-16	***	IS	6.575E-02	5.591E-03	11.761	< 2e-16	***
EXP	1.663E-02	4.521E-03	4	0.000246	***	EXP	3.134E-02	4.125E-03	7.597	5.43E-14	***
EXP2	-5.782E-05	6.036E-05	-0.958	0.338247		EXP2	-3.127E-04	5.069E-02	-6.168	8.97E-10	***
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual standard error = 0.6474 with 3 and 1171 degrees of freedom						Residual standard error = 0.6335 with 3 and 1437 degrees of freedom					
R^2 = 0.1763, **Adjusted** R^2 = 0.1742 F-statistic= 83.56, p-value: < .2e-16						R^2 = 0.111, adjusted R^2 = 0.1092 F-statistic = 59.82, p-value: <2.2e-16					
Independent sex						Regardless of gender					
	Estimator	Standard error	Value of t	Pr > |t|			Estimator	Standard error	Value of t	Pr > |t|	
lnY	9.265E+00	9.195E-02	100.76	< 2e-16	***	lnY	9.202E+00	8.961E-02	102.689	< 2e-16	***
IS	8.540E-02	4.819E-03	17.72	< 2e-16	***	IS	6.221E-02	4.975E-03	12.504	< 2e-16	***
EXP	1.548E-02	3.695E-03	4.19	2.94E-05	***	EXP	2.741E-02	3.537E-03	7.749	1.50E-14	***
EXP2	-5.746E-02	4.710E-05	-1.22	0.223		EXP2	-2.685E-04	4.141E-05	-6.483	1.14E-10	***
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual standard error = 0.6525 with 3 and 1676 degrees of freedom						Residual standard error = 0.649 with 3 and 1884 degrees of freedom					
R^2 = 0.1632, adjusted R^2 = 0.1617 F-statistic = 108.9, p-value: <2 .2e-16						R^2 = 0.1005, **Adjusted** R^2 = 0.0991 F-statistic=70.19, p-value: <2.2e-16					
Source: Prepared by the authors with the release of the R Package.											

Table 2 shows the results obtained from the estimation of the Mincer model, applied to the models of the urban and rural areas of the State of Mexico. According to the global test, the statistical results indicated that the models used to estimate the profitability of education in the urban and rural areas of the State (when the dependent variable was: the monthly monetary income of the female head of household, for the male sex and for the regardless of sex), turned out to be significant at 95.0% reliability; that is, that of all the estimated parameters at least one of them was different from zero, since the $F_{calculated}$ in all cases turned out to be greater than the $F_{tables.}$

On the other hand, the individual test indicated that in the case of these three models, the explanatory variable years of schooling (ES) presented a higher level of significance with t values (8.33, 15.55 and 17.72) >1 respectively; in the case of experience (EXP) t values (1.59, 3.67 and 4.19) |>1, that is, years of schooling and experience influenced the monthly monetary income for female and male heads of household and for heads of household regardless of sex. For the rural area models, in the three models, the explanatory variables (ES and EXP) were highly significant with t values (4.32, 11.76, 12.5) and (2.06, 7.59 and 7.74)>1 for female and male heads of households and heads of household regardless of sex, in the case of female household income, both in terms of schooling and experience were lower. That is, years of schooling and experience did influence the monthly monetary income of heads of household in the rural area of the State of Mexico. It is important to mention that these values turned out to be similar to those reported in the literature regarding studies of the same type.

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Table 3. Analysis of variance of the Mincer Model for urban and rural areas, 2022.

Urban area						Rural area					
Female Gender						Female Gender					
l *nY*	Estimator	Estimated error	Value of t	Pr > |t|		*lnY*	Estimator	Estimated error	Value of t	Pr > |t|	
IS	7.564E-02	8.125E-03	9.31	<2E-16	***	IS	6.067E-02	8.639E-03	7.023	6.96E-12	***
EXP	2.079E-02	6.391E-03	3.253	0.00121	**	EXP	2.764E-02	5.912E-03	4.675	3.76E-06	***
EXP ^{2}	-9.997E-05	7.512E-05	-1.331	0.1838		EXP ^{2}	-2.885E-04	6.293E-05	-4.585	5.71E-06	***
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual standard error: 0.6376 with 547 degrees of freedom						Residual standard error: 0.5868 with 512 degrees of freedom					
R^2: 0.1426, adjusted R^2: 0.1379, F-statistic: 30.31, p-value: <2.2e-16						R^2: 0.1678, adjusted R^2: 0.163, F-statistic: 34.42, p-value: <2.2e-16					
Male gender						Male gender					
lnY	Estimator	Estimated error	Value of t	Pr > |t|		*lnY*	Estimator	Estimated error	Value of t	Pr > |t|	
IS	6.604E-02	5.008E-03	13.186	<2E-16	***	IS	6.604E-02	5.008E-03	13.186	<2E-16	***
EXP	2.608E-02	3.723E-03	7.005	3.87E-12	**	EXP	2.608E-02	3.723E-03	7.005	3.87E-12	***
EXP ^{2}	-2.470E-04	4.598E-05	-5.372	9.17E-08		EXP ^{2}	-2.470E-04	4.598E-05	-5.372	9.17E-08	***
Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1						Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
Residual standard error: 0.5768 with 1361 degrees of freedom						Residual standard error: 0.5768 with 1361 degrees of freedom					
R^2: 0.1336, adjusted R^2: 0.1317, F-statistic: 69.98, p-value: <2.2e-16						R^2: 0.1336, adjusted R^2: 0.1361, F-statistic: 69.98, p-value: <2.2e-16					
Regardless of gender						Regardless of gender					
lnY	Estimator	Estimated error	Value of t	Pr > |t|		*lnY*	Estimator	Estimated error	Value of t	Pr > |t|	
IS	7.647E-02	4.243E-03	18.022	<2E-16	***	IS	6.589E-02	4.329E-03	15.219	<2E-16	***
EXP	1.416E-02	3.418E-03	4.145	3.58E-05	***	EXP	2.742E-02	3.064E-03	8.952	<2E-16	***
EXP ^{2}	-3.422E-05	4.291E-05	-0.798	0.425		EXP ^{2}	-2.760E-04	3.603E-05	-7.661	2.94E-14	***
Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1						Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
Residual standard error: 0.5888 with 1642 degrees of freedom						Residual standard error: 0.5819 with 1877 degrees of freedom					
R^2: 0.1703, adjusted R^2: 0.1688, F-statistic: 112.4, p-value: <2.2e-16						R^2: 0.1507, adjusted R^2: 0.1493, F-statistic: 111, p-value: <2.2e-16					
Source: Own elaboration with the release of the R Package.						Source: Prepared by the authors with the release of the R Package.					

Table 3 shows the results obtained from the estimation of the Mincer model, applied to the models of the urban and rural areas of the State of Mexico. According to the global test, the statistical results turned out to be significant with a reliability of 95.0%; that is, all the estimated parameters had at least one of them different from zero, since the $F_{calculated}$ in all cases turned out to be greater than the F_{tables}.

On the other hand, the individual test indicated that in the case of these three models, the explanatory variable years of schooling and experience (ES and EXP) presented a higher level of significance with t values (9.31, 13.18 and 18.02) and (3.25, 7.0, 4.14)> 1, respectively; that is, years of schooling and experience influenced the monthly monetary income for female and male heads of household, and heads of household regardless of sex. For the models in the rural area, the individual test indicated that, in the three models, the explanatory variables (ES and EXP) were highly significant with a t value (7.0, 13.18, 15.21) and (4.6, 7.0, 8.9)> 1. That is, years of schooling and experience did influence the monthly monetary income of heads of household in the rural area of the State of Mexico. It is important to mention that these values turned out to be similar to those reported in the literature of studies of the same type.

When comparing the results of the 2020 and 2022 analyses of variance, in the case of experience for female heads of household in urban areas there was a change (3.22 to 1.59); in the case of schooling in rural areas for female heads of household (4.32 to 6.94) and experience (2.06 to 5.09) it was the opposite.

Disaggregation by education levels of the Spline Model

Table 4. Analysis of variance of the Spline model for urban and rural areas, 2020.

Urban Zone						Rural Area					
Female gender						Female gender					
	Estimator	Standard error	Value of t	Pr > |t|			Estimator	Standard error	Value of t	Pr > |t|	
lnY	9.439E+00	1.951E-01	48.389	<2E-16	***	lnY	9.557E+00	2.177E-01	43.908	<2E-16	***
IS	7.011E-02	1.268E-02	5.527	5.24E-08	***	IS	3.455E+01	1.403E+01	2.462	0.0142	*
EXP	1.133E-02	6.994E-03	1.620	0.106		EXP	1.668E+01	7.707E+00	2.165	0.0309	*
EXP2	-3.090E-05	8.477E-05	-0.364	0.716		EXP2	-1.759E+01	8.145E-02	-2.16	0.0313	*
D1	2.473E-02	6.968E-02	0.355	0.723		D1	6.715E+01	9.224E+01	0.728	0.4671	
D2	1.110E-01	1.398E-01	0.794	0.427		D2	3.357E+02	2.179E+02	1,541	0.1241	
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual standard error = 0.663 with 3 and 449 degrees of freedom						Residual standard error = 0.6951 with 3 and 441 degrees of freedom					
R^2 = 0.1292, adjusted R^2 = 0.1205 F-statistic = 14.81, p-value: <1.473e-13						R^2 = 0.07176 **, adjusted** R^2 = 0.06124 F-statistic = 6.819, p- value: <3.851e-06					
Male gender						Male gender					
	Estimator	Standard error	Value of t	Pr > |t|			Estimator	Standard error	Value of t	Pr > |t|	
lnY	9.380E+00	1.167E-01	80.356	<2E-16	***	lnY	9.162E+00	1.028E-01	89.128	<2E-16	***
IS	6.856E-02	8.125E-03	8.439	<2E-16	***	IS	5.385E+01	7.351E+00	7,937	4.14E-15	***
EXP	1.883E-02	4.583E-03	4.108	4.27E-05	***	EXP	3.184E+01	4.133E+00	7,703	2.45E-14	***
EXP2	-1.039E-04	6.231E-05	-1.668	0.0956		EXP2	-3.260E-01	5.119E-02	-6,368	2.57E-10	***
D1	-2.810E-02	4.465E-02	-0.629	0.5293		D1	2.377E+00	4.148E+01	0.057	0.9543	
D2	2.442E-01	7.767E-02	3.145	0.0017	**	D2	1.778E+02	1.041E+02	1,709	0.0877	.
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual standard error = 0.6449 with 3 and 1169 degrees of freedom						Residual standard error = 0.6332 with 3 and 1435 degrees of freedom					
R^2 = 0.1841, adjusted R^2 = 0.1806 F-statistic = 52.76, p-value: <2.2e-16						R^2 = 0.1131, adjusted R^2 = 0.1100 F-statistic = 36.59, p-value: <2.2e-16					
Regardless of gender						Regardless of gender					

	Estimator	Standard error	Value of t	Pr > |t|			Estimator	Standard error	Value of t	Pr > |t|	
lnY	9.385E+00	9.918E-02	94.630	<2E-16	***	lnY	9.251E+00	9.211E-02	100.426	<2E-16	***
IS	6.989E-02	6.821E-03	10.245	<2E-16	***	IS	5.352E+01	6.475E+00	8,266	2.59E-16	***
EXP	1.725E-02	3.756E-03	4.593	4.69E-06	***	EXP	2.799E+01	3.543E+00	7.899	4.74E-15	***
EXP2	-9.470E-05	4.901E-05	-1.932	0.05351	.	EXP2	-2.831E-01	4.187E-02	-6.76	1.83E-11	***
D1	-1.560E-02	3.742E-02	-0.417	0.67670		D1	1.645E+01	3.805E+01	0.432	0.66550	
D2	2.074E-01	6.782E-02	3.058	0.00226	**	D2	2.108E+02	9.410E+01	2.240	0.0252	*
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual standard error = 0.6509 with 3 and 1674 degrees of freedom						Residual standard error = 0.6485 with 3 and 1882 degrees of freedom					
R^2 = 0.1683, adjusted R^2 = 0.1658 F-statistic = 67.75, p-value: <2.2e-16						R^2 = 0.103, adjusted R^2 = 0.1006 F-statistic = 43.23, p-value: <2.2e-16					

Source: Prepared by the author with the release of the R package .

Source: Prepared by the author with the release of the R package .

The results obtained from the *Spline models* that were used in the estimation of the profitability of education by levels achieved, of the models for the urban and rural areas, the following were obtained: the monthly monetary income, whether performing discrimination or categorization by gender or not, were significant with a reliability of 95.0%, since the $_{\text{calculated F}}$ was greater than the F_{tables} for each of the models for the urban and rural areas. In relation to the coefficient of determination (R^2), the variables ESC, EXP, EXP2, D1 and D2, explain each of the models for the urban and rural areas by 12.92%, 18.41%, 16.83% and 7.17%, 11.31%, 10.3% respectively. Regarding the individual test, with the exception of the EXP and EXP^2 of the female head of household model from the urban area, the variables ESC, EXP, EXP^2 were found to be significant in all models of both areas, since the *t value* was >1 for each model and each variable (Table 4).

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Table 5 . Analysis of variance of the Spline model of the urban and rural areas, 2022 **.**

Urban area						Rural area					
Female Gender						Female Gender					
lnY	Estimator	Estimated error	Value of t	Pr > |t|		*lnY*	Estimator	Estimated error	Value of t	Pr > |t|	
IS	0.05051	0.01123	4.5	0.00001	***	IS	0.04897	0.01074	4.56	0.00001	***
EXP	0.02514	0.00641	3.919	0.0001	**	EXP	0.02750	0.00589	6.671	0.00000	***
EXP2	-0.00017	0.00008	-2.272	0.02349		EXP2	-0.00030	0.00006	-4.827	0.00000	***
D1	-0.07133	0.06389	-1.117	0.26468		D1	0.04341	0.06851	-0.634	0.5267	
D2	0.40250	0.13090	3.074	0.00222		D2	0.39800	0.17920	2.221	0.0268	*
Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1						Significance: 0'***' 0.001'**' 0.01'*' 0.05 '.' 0.1 " 1					
Residual standard error: 0.6299 with 545 degrees of freedom						Residual standard error: 0.5839 with 510 degrees of freedom					
R^2: 0.166, adjusted R^2: 0.1583, F-statistic: 21.69, p-value: <2.2e-16						R^2: 0.1793, adjusted R^2: 0.1712, F-statistic: 22.28, p-value: <2.2e-16					
Male gender						Male gender					
lnY	Estimator	Estimated error	Value of t	Pr > |t|		*lnY*	Estimator	Estimated error	Value of t	Pr > |t|	
IS	0.05813	0.00754	7.722	2.58E-14	***	IS	0.06594	0.00660	9.998	<2E-16	***
EXP	0.01319	0.00411	3.208	0.00137	**	EXP	0.02604	0.00374	6.969	0.00000	***
EXP2	-0.00004	0.00005	-0.764	0.44528		EXP2	-0.00025	0.00005	-5.288	0.00014	***
D1	-0.08232	0.04013	-2.051	0.4049	*	D1	0.00563	0.03777	0.149	0.881	
D2	0.17000	0.06752	2.517	0.01197	*	D2	-0.00019	0.09338	-0.002	0.998	
Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1						Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
Residual standard error: 0.5592 with 1089 degrees of freedom						Residual standard error: 0.5772 with 1359 degrees of freedom					
R^2: 0.1885, adjusted R^2: 0.1848, F-statistic: 50.59, p-value: <2.2e-16						R^2: 0.1337, adjusted R^2: 0.1305, F-statistic: 41.93, p-value: <2.2e-16					
Regardless of gender						Regardless of gender					
lnY	Estimator	Estimated error	Value of t	Pr > |t|		*lnY*	Estimator	Estimated error	Value of t	Pr > |t|	
IS	0.05802	0.00613	17.162	<2E-16	***	IS	0.06305	0.00561	11.245	<2E-16	***
EXP	0.01676	0.00344	4.215	0.00000	***	EXP	0.02761	0.00307	8.998	<2E-16	***
EXP2	-0.00009	0.00004	-1.386	0.049217	*	EXP2	-0.00028	0.00004	-7.743	0.00000	***
D1	-0.08937	0.03374	-2.649	0.008149	**	D1	-0.01038	0.03321	-0.313	0.755	
D2	0.21090	0.06013	3.508	0.000464	***	D2	0.07626	0.08282	0.921	0.357	
Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1						Significance: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
Residual standard error: 0.5848 with 1640 degrees of freedom						Residual standard error: 0.582 with 1875 degrees of freedom					
R^2: 0.1826, adjusted R^2: 0.1801, F-statistic: 73.28, p-value: <2.2e-16						R^2: 0.1513, adjusted R^2: 0.149, F-statistic: 66.85, p-value: <2.2e-16					

Source: Prepared by the author with the release of the R package .

The results obtained by the MCO method for the Spline models are shown in Table 5. According to the global test of the Spline models used to estimate the profitability of education by levels achieved, the following was obtained: both the models for the urban and rural areas (considering in both areas as dependent variables the following cases: the monthly monetary income of the head of the household, female, male and independent of sex) were significant with a reliability of 95.0%. Regarding the individual test, the variables ES, EXP, EXP ^{2}, were significant, since the value of t> 1 for each model and each variable and each area, except for EXP ^{2} for the male sex in the urban area (-0.764 < 1).

The results obtained from the MCO estimation are presented below:

Mincer models: Urban and rural areas, 2020

Urban area

Model 1. Of the monthly monetary income of the female head of household:

$$lnY = 9.400 + 0.07668ES + 0.01096EXP - 0.00002236EXP^2 (4)$$

Model 2. Of the monthly monetary income of the male head of household:

$$lnY = 9.224 + 0.08800ES + 0.01663EXP - 0.00005782EXP^2 (5)$$

Model 3. Monthly monetary income of the head of household, regardless of sex:

$$lnY = 9.265 + 0.08540ES + 0.01548EXP - 0.00005746EXP^2 (6)$$

Rural area

Model 1. Of the monthly monetary income of the female head of household:

$$lnY = 9.5026403 + 0.0477706ES + 0.0158803EXP - 0.0001580EXP^2 (7)$$

Model 2. Of the monthly monetary income of the male head of household :

$$lnY = 9.11500 + 0.06575ES + 0.03134EXP - 0.0003127EXP^2 (8)$$

Model 3. Monthly monetary income of the head of household, regardless of sex:

$$lnY = 9.20200 + 0.06221ES + 0.02741EXP - 0.0002685EXP^2 (9)$$

According to economic theory, the estimated coefficients ES, EXP, EXP ^{2} are significant and have the expected sign, the contributions of education and experience to income are positive, compared to the coefficient of the square of experience which is negative, which indicates that experience has positive effects on labor income, but if it is not updated with new technologies it becomes obsolete and income will decrease. Years of education have a positive and significant impact on wages, the rate of return on education for female heads of household was 7.6% for urban areas and 4.7% for rural areas, 8.8% and 6.5% for males and 8.5% and 6.2% regardless of sex for urban and rural areas respectively, which implies that income will grow as the number of years of schooling increases. In this case,

regarding years of experience, it is assumed that on average for each year of experience that the female head of household increases, income will increase by 1.09% and 1.5%, 1.6% and 3.1% for the male head of household, and 1.5% and 2.7% for both sexes in urban and rural areas. In almost all cases, the rural area presents lower values for 2020 .

Mincer models: Urban and rural areas, 2022

The results obtained from the regression are presented below, by geographical area:

Urban area

Model 1. Of the monthly monetary income of the female head of household:

$lnY = 9.402 + 0.07564ES + 0.02079EXP - 0.00009997EXP^2$(10)

Model 2. Of the monthly monetary income of the male head of household:

$lnY = 9.479 + 0.06604ES + 0.02608EXP - 0.000247EXP^2$(11)

Model 3. Monthly monetary income of the head of household, regardless of sex:

$lnY = 9.583 + 0.07647ES + 0.0172EXP - 0.00003422EXP^2$(12)

Rural area

Model 1. Of the monthly monetary income of the female head of household:

$lnY = 9.403 + 0.06067ES + 0.02764EXP - 0.0002885EXP^2$(13)

Model 2. Of the monthly monetary income of the male head of household:

$lnY = 9.479 + 0.06604ES + 0.02608EXP - 0.000247EXP^2$(14)

Model 3. Monthly monetary income of the head of household, regardless of sex:

$lnY = 9.443 + 0.06589ES + 0.02742EXP - 0.000276EXP^2$ (15)

Similarly, in relation to economic theory, the estimated coefficients ES, EXP, EXP ^{2} are significant and have the expected sign, the contributions of education and experience to income are positive , compared to the coefficient of the square of experience which is negative, which indicates that there is a maximum point at which individuals maximize their income and then it decreases. The years of education have a positive and significant impact on wages, the rate of return on education was 7.5% and 6.0% for female heads of household, 6.6% and 6.6% for male heads of household and 7.6% and 6.5% regardless of sex, which implies that income will grow as the number of years of schooling increases. In this case, regarding years of experience, it is noted that on average for each year of experience that the female head of household increases, income will increase by 2.0% and 2.7%, 2.6% and 2.6%

for the male, 1.7% and 2.7% for both sexes in the urban area, both in the urban and rural areas, respectively, for each of the variables.

Estimation from Spline Models , *2020*

Urban area

Model 1. Monthly monetary income of the female head of household:

$$lnY = 9.439 + 0.07011ES + 0.01133EXP - 0.00003090EXP^2 + 0.02473D1 + 0.111D2 \quad (16)$$

Model 2. Of the monthly monetary income of the head of the household, male:

$$lnY = 9.380 + 0.06856ES + 0.01883EXP - 0.0001039EXP^2 - 0.02810D1 + 0.2442D2 \quad (17)$$

Model 3. Of the monthly monetary income of the head of the household, regardless of sex:

$$lnY = 9.38500 + 0.06989ES + 0.01725EXP - 0.00009470EXP^2 - 0.01560D1 + 0.2074D2 \quad (18)$$

Rural area

Model 1. Monthly monetary income of the female head of household:

$$lnY = 9.557 + 0.03455ES + 0.01668EXP - 0.0001759EXP^2 + 0.06715D1 + 0.3357D2 \quad (19)$$

Model 2. Of the monthly monetary income of the head of the household, male:

$$lnY = 9.162 + 0.05835ES + 0.03184EXP - 0.0003260EXP^2 + 0.002377D1 + 0.1778D2 \quad (20)$$

Model 3. Of the monthly monetary income of the head of the household, regardless of sex:

$$lnY = 9.251 + 0.05352ES + 0.02799EXP - 0.0002831EXP^2 + 0.01645D1 + 0.2108D2 \quad (21)$$

The results for the urban area show that the expected signs were obtained according to economic theory. On the other hand, the rate of return for an additional year of primary education was 7.01%, 6.85%, 6.98% and 3.45%, 5.83% and 5.35%, respectively for urban and rural areas; being higher for female heads of household in urban areas and male heads of household in rural areas. For the case of an additional year of secondary education it was (the sum of the coefficients of ES and D_1) of: 9.4%, 4.04%, 5.4% and 10.17%, 6.07%, 6.99% respectively for both areas. The coefficients 0.02473, -0.02810, -0.01560 and 0.01645, 0.002377 and 0.01645 represent a premium on secondary education for both zones, which in the second and third cases were negative for the urban zone . For the rate of return on an additional year of university is represented by the sum of the parameters of the variables ES and D_2: 18.11%, 31.27%, 27.73% and 37.02%, 23.61%, 26 .40, for each model of the two zones. In addition, the coefficients 0.111, 0.2442, 0.2074 and 0.3357, 0.1778, 0.2108 represent a premium on university education for both zones.

Estimation from *Spline Models, 2022*

Urban area

Model 1. Monthly monetary income of the female head of household:

$$lnY = 9.562 + 0.05051ES + 0.02514EXP - 0.00017EXP^2 - 0.07133D1 + 0.40250D2 \quad (22)$$

Model 2. Of the monthly monetary income of the head of the household, male:

$$lnY = 9.882 + 0.05813ES + 0.01319EXP - 0.00004EXP^2 - 0.08232D1 + 0.1700D2 \quad (23)$$

Model 3. Of the monthly monetary income of the head of the household, regardless of sex:

$$lnY = 9.745 + 0.05802ES + 0.01676EXP - 0.00009EXP^2 - 0.08937D1 + 0.21090D2 \quad (24)$$

Rural area

Model 1. Monthly monetary income of the female head of household:

$$lnY = 9.513 + 0.04897ES + 0.02750EXP - 0.00030EXP^2 + 0.04341D1 + 0.39800D2 \quad (25)$$

Model 2. Of the monthly monetary income of the head of the household, male:

$$lnY = 9.478 + 0.06594ES + 0.02604EXP - 0.00025EXP^2 + 0.00563D1 - 0.00019D2 \quad (26)$$

Model 3. Of the monthly monetary income of the head of the household, regardless of sex:

$$lnY = 9.466 + 0.06305ES + 0.02761EXP - 0.00028EXP^2 - 0.01038D1 + 0.07626D2 \quad (27)$$

The results for the urban area show that the expected signs were obtained according to economic theory. On the other hand, the rate of return for an additional year of primary education was 5.05%, 5.8%, 5.8% and 4.8%, 6.5% and 6.3%, respectively for the urban and rural areas; being higher for male heads of household in the rural area. The rate of return for an additional year of secondary education was the sum of the coefficients of the variables ES and D_1 for each case, being: -2.08%, -2.41%, 3.13% and 9.23%, 7.15%, 5.26% respectively for both areas. The coefficients -0.07133, -0.08232, -0.08937 and 0.04341, 0.00563, -0.01038 represent a premium on secondary education for both zones, which in all three cases were negative for the urban zone and for the female sex in the rural zone. For the higher level, the rate of return on an additional year of university is represented by the sum of the parameters of the variables ES and D_2: 45.3%, 22.81%, 26.89% and 44.69%, 6.57%, 13.93% for each model for the two zones. The coefficients 0.40250, 0.1700, 0.2109 and 0.3980, -0.00019, 0.07626 also represent a premium on university education for both zones.

Discussion

In the previous section, the differences found between school profitability for urban and rural areas were pointed out, whether or not a categorization by gender is carried out, which agrees with the results presented in general terms by Ordaz (2008); however, in the present research, used information for the period of the COVID-19 pandemic and immediately after the pandemic, which showed that urban areas tended to be more profitable, with both genders benefiting from different levels of education, which is the opposite of what Ordaz (2008) found. A very important factor to explain these differences could be the period in which the study was carried out, since education patterns (e.g. gender and highest level of education) have changed since the beginning of the 21st century.

Similarly, the results presented here show concordance with what is proposed by the theory of human capital ; that is, that, when there is an increase in the educational level of individuals, greater productivity can be obtained and consequently an improvement in income or economic remuneration is achieved (Becker, 1962 ; Becker and Chiswick, 1966). Similarly, the theory proposed by Mincer, where the rate of return on education generates an additional income per extra year of schooling (Marina Clemente et al., 2018), coinciding with the analyses carried out in this work, even when a separation by gender is carried out for the heads of the household .

Another factor that significantly affects education is school discrimination, meaning that the quality of education or access to it is not equitable, making it an issue of utmost importance, particularly in post-COVID-19 pandemic times. Regarding this, Murillo and Graña (2021) mention that decreasing the quality of education has a negative impact on learning, as well as on student expectations.

According to the research of Graña and Murillo (2023), it is reported that, in Latin America, Mexico is a country that presents one of the highest levels of school segregation at each socioeconomic level, and more so at the secondary level than at the primary level.

Conclusions

The results obtained in this research showed us that the profitability rates obtained with the information from the ENIGH 2020 were higher for urban areas (regardless of gender categorization) , while the profitability was lower for female heads of household in rural areas. However, according to the ENIGH 2022 data, school profitability grew approximately 2.5% in both areas.

School profitability by educational level also showed interesting results. In the case of primary education (2020), rural areas showed higher values regardless of gender, while for 2022, the highest values were again obtained for rural areas (both genders) and for heads of households regardless of the area where they live. For the secondary level, in 2020 the highest values were obtained for female heads of households in urban areas and male heads of households in rural areas. On the contrary, for 2022 it was found that profitability was higher for rural areas and that rural areas presented negative returns. For the university level (2020), high returns were obtained in both areas, with the exception of female heads of households in urban areas. In 2022 the pattern was reversed, female heads of households in urban and rural areas showed the highest values, and the lowest were for heads of households in rural areas.

Therefore, it can be concluded that the educational level has a positive and significant impact on income, that is, the rate of return on education for heads of household in all three cases (female, male and without discrimination by gender) will grow as the number of years of schooling and experience increases. Likewise, in the analysis where the profitability of education is contrasted for rural and urban areas, it was found that in general urban areas show higher returns than in rural areas, from which it can be deduced that the quality of education is a factor that significantly impacts the future of the educated population.

Future lines of research

Various studies have been conducted on school segregation by socioeconomic level in primary and secondary education in Mexico and its states, where they mention that there is a high segregation in Mexico and greater in students from families with lower incomes than in families with more resources, and higher in secondary education than in primary education. In addition, large differences were found between the states, with Chiapas and Oaxaca standing out for their high segregation, and the State of Mexico and Tlaxcala for a lower

segregation index. Therefore, this research proposes incorporating school segregation as another variable in the Mincer model and in the *Spline* model for primary, secondary, high school, undergraduate and graduate levels for the State of Mexico and three of the municipalities of Texcoco, Chimalhuacán and Ecatepec.

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Contribution Role	Author(s)
Conceptualization	Esther Figueroa
Methodology	Rebecca A. Perez
Software	Rebecca A. Perez
Validation	Esther Figueroa (same), Rebeca A. Perez (same)
Formal Analysis	Rebecca A. Perez
Investigation	Esther Figueroa
Resources	Esther Figueroa (same), Rebeca A. Perez (same)
Data curation	Rebecca A. Perez
Writing - Preparing the original draft	Esther Figueroa (main), Rebeca A. Perez (supporting)
Writing - Review and editing	Esther Figueroa (same), Rebeca A. Perez (same)
Display	Esther Figueroa (main), Rebeca A. Perez (supporting)
Supervision	Esther Figueroa (same), Rebeca A. Perez (same)
Project Management	Esther Figueroa (main), Rebeca A. Perez (supporting)
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