What is the condition of social vulnerability of older adults in Colombia?
A social vulnerability index for elderly people in Colombia
Team #148

Members: David Patarroyo, Moises Herrera, Andrés Leyva, Edgar Monsalve, Jenny Rivera, Diana Aribel Guzmán

Business Problem

Social vulnerability is the result of the impacts caused by the current development pattern, but it also expresses the inability of the weakest groups in society to confront them, neutralize them or obtain benefits from them. The condition of poverty is often identified with vulnerability. However, the insecurity |and helplessness that characterize vulnerability are not necessarily attributable solely to insufficient income, typical of poverty. In contrast, the vulnerability approach, accounting for the "helplessness, insecurity, exposure to risks, shocks and stress" (Chambers, 1989), caused by extreme socioeconomic events, provides a more comprehensive view of living conditions and, at the same time, it considers the availability of resources and the strategies of the families themselves to face the impacts that affect them, leaving broad layers of the middle- and low-income population exposed to insecurity and defenselessness in the countries of the region.

Why a vulnerability index in adults over 60 years of age?

Although it is complex to establish why one age group is more vulnerable than another, it is evident that, specifically in old age, conditions appear that generate disadvantages or weaknesses to face unfavorable situations, such as: decrease in work capacity, motor capacity and in the perception of their income, among other factors. In this sense, the deterioration of aging causes the loss of physical, motor, mental and even work capacities, which is why older people have fewer internal and external resources (income, studies, employment, retirement, support networks, coverage social and medical, among others) to face unexpected changes in their lives.

This leads us to think about the need to create an index that, based on the socioeconomic characteristics of each individual, can help determine their condition of social vulnerability. To achieve the above objective, we will take into consideration the integrated household survey for the year 2021. Based on the proposed index, it will be possible to categorize the population of older adults in Colombia, identify trends, attributes and characteristics, and establish a model through from which it is possible to understand how what are the conditions of vulnerability of Colombian older adults, what variables are more determining and how that vulnerability is distributed at the regional level.

Some key questions to answer will be:
- What are the most vulnerable departments and regions with older adults in Colombia?
- What biological group (male or female) of older adults is the most vulnerable in Colombia?
- What educational, labor, disability, material or social conditions of older adults are the ones that best explain the vulnerability of this age group?
- Is there a difference between the vulnerability rates of older adults before and after the covid-19 pandemic?

Business Impact

This project will allow visualizing, through an index, the level of social vulnerability in the population of older adults in Colombia. Additionally, it could contribute to the monitoring of public policy since the definition of the chosen variables determines who is, at the governmental level, the entity responsible for compliance. This index of social vulnerability could become an instrument that allows policy to focus on the population group of older adults with multiple deficiencies, exalting its usefulness to the extent that it makes it possible to highlight the gaps faced by the most vulnerable people.

The above will imply:

- Spatial and categorical description of the Colombian elderly population.
- Identification of historical trends
- Generation of a diagnostic model (classification) through which the population that is in conditions of vulnerability can be identified.
- Creation of an index per individual based on dimensions of human, social, physical, economic capital, among others (pending defining variables to be used)
- Generation of segments in which we can identify similar characteristics that allow us to establish what quality of life conditions older adults have and how these are related to greater or lesser exposure to social vulnerability.

The foregoing will be very useful in studying the results of public policies aimed at this age group, such as old-age pension programs, soup kitchens for older adults, and integration programs for older adults, in a way that allows them to contribute to reduce poverty and vulnerability.

Data

The source of information used was the National Quality of Life Survey (Encuesta Nacional de Calidad de Vida - ENCV). The ENCV is an investigation carried out by DANE with the aim of collecting information on the well-being of Colombian households, including: a) access to public, private or communal goods and services, b) health, c) education, d) care for children under 5 years of age, among others. This ENCV has demographic, social and economic information about Colombian people. The ENCV is applied during a month of the third quarter of the year, usually October, and is representative for the national total, capital-rest and for 9 large regions: Antioquia, Valle del Cauca, Atlántico, Pacifica, Central, Oriental, only capital for Orinoquía-Amazonía; for Bogota D.C. total and San Andres.

This survey has been applied annually since 2010 and one of its most important uses is for the calculation of the national multidimensional poverty index. This database generates information about the size and structure of the labor force (employment, unemployment and inactivity). In addition, it allows obtaining data on other variables of the population such as: sex, age, marital status, education etc. It also makes it easier to measure household income both in money and in kind, general characteristics of the population, housing, access to public services, access to programs public or private, social protection system and provides information on job quality.

Methods:

For this analysis we use the 2018, 2019, 2020 and 2021 data and, taking into account our focus in elderly population, we only use data for people 60 years or older. Thus, our final sample size is 37,928, which factors out to approximately 6 or 7 million of elder adults each year. Additionally, not all the variables are useful for the characterization and construction of our index, thus we reduced our variables to the 66 that according to literature[1] and our knowledge might help define better vulnerability among this population. Most of our variables are categorical.

Clean dataset:

After an information depuration process, which consisted of an exhaustive analysis of the type of variables that we were going to use for the purpose of building our index of social vulnerability in older adults. This implied, for example, eliminating all information related to childcare and child labor. Additionally, we group the variables to be used in their different dimensions (Household composition, Living place, Education, Work force, Health, Home services, Technology and, Life conditions) and transform the variables into their respective categories through python dictionaries.

Diagram 1. Cleaning dataset process. Own elaboration

Methodology:

For the construction of the multidimensional vulnerability index, the 2018, 2019, 2020 and 2021 Quality of Life Survey (ECV) will be used as a source of information, which is carried out by the National Administrative Department of Statistics (DANE) in 9 main regions of Colombia such as Antioquia, Valle del Cauca, Atlántico, Pacifica, Central, Oriental, only in headwaters in Orinoquia-Amazonía, Bogotá D.C and San Andrés, with the objective of obtaining information on the quality of life of Colombians and includes variables related to living conditions, education , health, expenses and income.
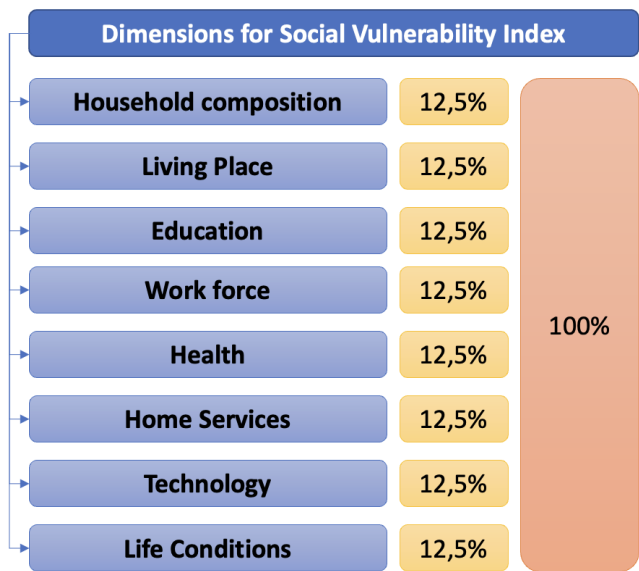
Additionally, as a reference in the construction of our Social Vulnerability Index, we use the methodology established by the National Planning Department (DNP) in the calculation of the Multidimensional Poverty Index for Colombia (MPI) in its article entitled "Algorithm for the

---

[1] DANE. Algoritmo para la construcción de Índice de Pobreza Multidimensional.2010

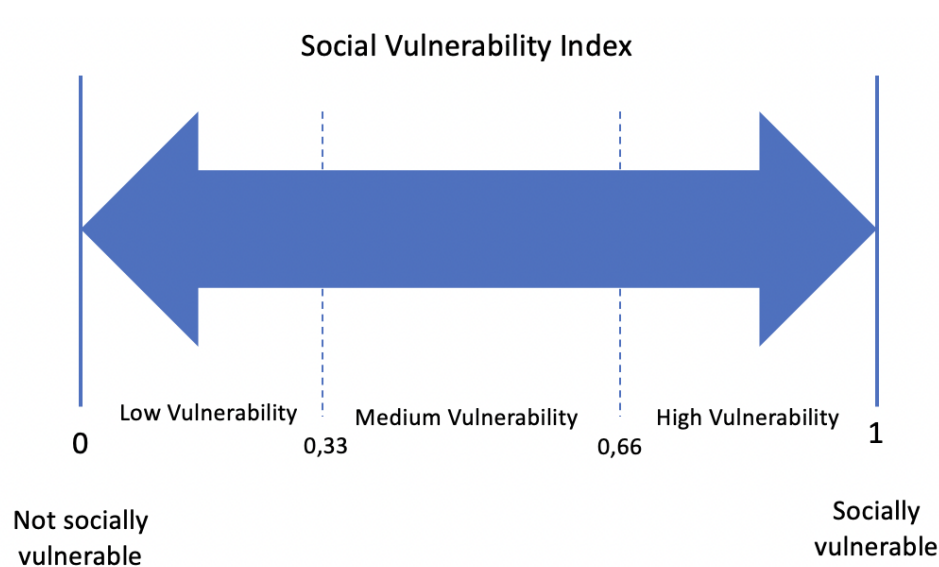construction of the Multidimensional Poverty Index - MPI".

The calculation of the Social Vulnerability Index (IVS) requires the definition of: (i) variables for its calculation, (ii) weightings of the variables to be calculated and (iii) the delimitation of a threshold, which determines if a person, in this case, an older adult, is in conditions of social vulnerability. In our case, we chose a total of 66 variables, assigned to one of the eight chosen dimensions of the survey. These dimensions are equally weighted, as are each of the variables within them (See Diagram 1).

Diagram 2. Dimensions considered for building a Social Vulnerability Index for Elder People in Colombia. Own elaboration

Dimensions for Social Vulnerability Index		
Household composition	12,5%	
Living Place	12,5%	
Education	12,5%	
Work force	12,5%	100%
Health	12,5%	
Home Services	12,5%	
Technology	12,5%	
Life Conditions	12,5%	

The choice of variables was linked to their availability in the ENCV and their direct relationship with vulnerability, among other criteria like availability each year analyzed. In this order of ideas, we proceed to build a matrix from 1 to 0 (including average values such as 0.25, 0.5, or 0.75), where 1 represents deprivation and 0 does not deprivation.

Diagram 3. Conceptual explanation of the Social Vulnerability Index. Own elaboration

Social Vulnerability Index

Low Vulnerability   Medium Vulnerability   High Vulnerability

0   0,33   0,66   1

Not socially
vulnerable

Socially
vulnerable

Within each dimension, it happens that the variables contemplated weigh equally. Each of the 66 variables considered will take a value between 0 and 1, being 1 in case it is deprived of the condition that the variable represents (that is, it is considered vulnerable) and 0 otherwise (that is, it is not considered vulnerable). In table 1, the rows represent the variables measured per person and the columns the 8 dimensions evaluated in this case.

Table 1. Variables measured per person for building a Vulnerability Social Index for Elderly People in Colombia. Own elaboration

Household Composition	
variable	%
P6051	1,14%
P5502	1,14%
P6087	1,14%
P6088	1,14%
P6080	1,14%
P1895	1,14%
P1896	1,14%
P1897	1,14%
P1898	1,14%
P1899	1,14%
P1927	1,14%
Total	**12.5%**

Life Conditions	
variable	%
P9010	1,39%
P9025S1	1,39%
P9025S2	1,39%
P5230	1,39%
P9090	1,39%
P784S1	1,39%
P784S2	1,39%
P1075	1,39%
P5095	1,39%
Total	**12,5%**

Health	
variable	%
P6090	0,89%
P6100	0,89%
P6127	0,89%
P1930	0,89%
P1930S1	0,89%
P1906S1	0,89%
P1906S2	0,89%
P1906S3	0,89%
P1906S4	0,89%
P1906S5	0,89%
P1906S6	0,89%
P1906S7	0,89%
P1707	0,89%
P6133	0,89%
Total	**12,5%**

Home Services	
variable	%
P5666	2,08%
P5022	2,08%
P5041	2,08%
P5047	2,08%
P5069	2,08%
P8536	2,08%
Total	**12,5%**

Living Place			
variable	%		
CLASE	0,96%		
P1070	0,96%		
P4005	0,96%		
P4015	0,96%		
P4567	0,96%		
P8520S1	0,96%		
P8520S5	0,96%		
P4065 *	P4065S1	0,24%	0,96%
	P4065S2	0,24%	
	P4065S3	0,24%	
	P4065S4	0,24%	
P5661S2	0,96%		
P5661S3	0,96%		
P5661S4	0,96%		
P5661S9	0,96%		
P5661S7	0,96%		
Total	**12,5%**		

Technology	
variable	%
P1910	3,13%
P1911	3,13%
P1912	3,13%
P1082	3,13%
Total	**12,5%**

Work Force			
variable	%		
P6240	1,79%		
P6270	1,79%		
P6440	1,79%		
P8622	1,79%		
VTOTAL *	P8624	0,45%	1,79%
	P8642S1	0,45%	
	P8644S1	0,45%	
	P8646S1	0,45%	
P415	1,79%		
P6920	1,79%		
Total	**12,5%**		

Education	
variable	%
P6160	6,25%
P8587	6,25%
Total	**12,5%**

Once the weights are established, a weighted sum is made for each person over 60 years of age, and it is determined if they are vulnerable according to the established threshold.

Diagram 4. Mathematical representation for the calculation of the Social Vulnerability Index. Own elaboration

Sum product to calculate the social vulnerability index

$$\sum_{i=1}^{n} \sum_{j=1}^{k} a_i \times b_j$$

a = variables in deprivation scale considered for each dimensión
b = estimated weight for each variable by dimension

Table 2. Question per dimension and deprivation scale explanation. Own elaboration

Dimension	Question	deprivation scale	Explanation
Household Composition	5. How is ___ related to the male or female head of this household? 1 Head of household 2 Partner, spouse, spouse, partner 3 Son/daughter/stepson 4 Grandson/daughter 5 Father, mother, stepfather and stepmother 6 Father-in-law or mother-in-law 7 Brother (a), stepbrother (a) 8 Son-in-law, daughter-in-law 9 Other relative of the head 10 Domestic service employee 11 Relatives of domestic service 12 Worker 13 Pensioner 14 Other relative	1 -2 = private 3-14= Not private	If the older adult is a head of household or their partner, there is a risk of vulnerability given the burden that this role entails for them and their family.
Household Composition	6. Currently…: 1 Not married and living with a partner for less than two years 2 Not married and living with a partner for two years or more 3 Widowed 4 Separated or Divorced 5 Single 6 Married	3 4 5 = private 1 2 6 = not private	If the older adult does not live with a partner, there is a risk of vulnerability because they don't have support.
Household Composition	15. What is or was the highest level of education achieved by the father of …? 1 Some years of elementary school 2 All of elementary school 3 Some years of high school 4 All of high school 5 One or more years of technical or technological 6 Complete technical or technological 7 One or more years of university 8 Complete university 9 None 10 Don't know	From 1 to 3, 9 and 10 = 1 (private) From 4 to 8 = 0 (not private)	If the father of the older adult did not graduate from high school or does not have any studies, the risk of vulnerability of the older adult is considered high since it reduces his own chances of achieving a higher level of education
Household Composition	17. What is or was the highest level of education achieved by the mother of …? 1 Some years of elementary school 2 All of elementary school 3 Some years of high school 4 All of high school 5 One or more years of technical or technological 6 Complete technical or technological 7 One or more years of university 8 Complete university 9 None 10 Don't know	1 to 3, 9 and 10 = 1 (private) 4 to 8 = 0 (not private)	If the mother of the older adult did not graduate from high school or does not have any studies, it is considered that the risk of vulnerability of the older adult is high since it reduces their own chances of achieving a higher level of education

Household Composition	18. According to their culture, people or physical features, _____ is or is recognized as: 1 Indigenous 2 Gypsy (a) (Rom) 3 Raizal from the archipelago of San Andrés, Providencia and Santa Catalina 4 Palenquero (a) from San Basilio 5 Black, mulatto (afro-descendant), Afro-Colombian 6 None of the above	1 to 5 = 1 (private) 6 = 0 (not private)	If the older adult identifies with an ethnic minority, it is considered to be at risk of vulnerability due to the existing socioeconomic gaps with respect to the other population.
Household Composition	The following questions are about the satisfaction that you feel, on a scale from 0 to 10. Where 0 means that you feel "totally dissatisfied" and 10 means that you feel "totally satisfied". 23. In general, how satisfied are you... with your life right now? 10 Completely satisfied 9 8 7 6 5 4 3 2 1 0 Completely dissatisfied	0 - 1 (private) 1 - 0.9 2 - 0.8 3 - 0.7 4 - 0.6 5 - 0.5 6 - 0.4 7 - 0.3 8 - 0.2 9 - 0.1 10 - 0 (not private)	Since the answers to these questions are expressed on an ordinal scale, we have considered a deprivation scale with gradients (decimals) between 0 and 1, where 1 and the closest numbers would be deprived. The questions refer to a level of satisfaction with their life, work, income, etc., allowing psychosocial risk to be measured
Household Composition	The following questions are about the satisfaction that you feel, on a scale from 0 to 10. Where 0 means that you feel "totally dissatisfied" and 10 means that you feel "totally satisfied". 24. Overall, how satisfied are you... with your current income? 10 Completely satisfied 9 8 7 6 5 4 3 2 1 0 Completely dissatisfied	0 - 1 (private) 1 - 0.9 2 - 0.8 3 - 0.7 4 - 0.6 5 - 0.5 6 - 0.4 7 - 0.3 8 - 0.2 9 - 0.1 10 - 0 (not private)	Since the answers to these questions are expressed on an ordinal scale, we have considered a deprivation scale with gradients (decimals) between 0 and 1, where 1 and the closest numbers would be deprived. The questions refer to a level of satisfaction with their life, work, income, etc., allowing psychosocial risk to be measured

Household Composition	The following questions are about the satisfaction that you feel, on a scale from 0 to 10. Where 0 means that you feel "totally dissatisfied" and 10 means that you feel "totally satisfied". 25. In general, how satisfied are you... with your health today? 10 Completely satisfied 9 8 7 6 5 4 3 2 1 0 Completely dissatisfied	0 - 1 (private) 1 - 0.9 2 - 0.8 3 - 0.7 4 - 0.6 5 - 0.5 6 - 0.4 7 - 0.3 8 - 0.2 9 - 0.1 10 - 0 (not private)	Since the answers to these questions are expressed on an ordinal scale, we have considered a deprivation scale with gradients (decimals) between 0 and 1, where 1 and the closest numbers would be deprived. The questions refer to a level of satisfaction with their life, work, income, etc., allowing psychosocial risk to be measured
Household Composition	The following questions are about the satisfaction that you feel, on a scale from 0 to 10. Where 0 means that you feel "totally dissatisfied" and 10 means that you feel "totally satisfied". 26. Overall, how satisfied are you... with your level of security today? 10 Completely satisfied 9 8 7 6 5 4 3 2 1 0 Completely dissatisfied	0 - 1 (private) 1 - 0.9 2 - 0.8 3 - 0.7 4 - 0.6 5 - 0.5 6 - 0.4 7 - 0.3 8 - 0.2 9 - 0.1 10 - 0 (not private)	Since the answers to these questions are expressed on an ordinal scale, we have considered a deprivation scale with gradients (decimals) between 0 and 1, where 1 and the closest numbers would be deprived. The questions refer to a level of satisfaction with their life, work, income, etc., allowing psychosocial risk to be measured
Household Composition	The following questions are about the satisfaction that you feel, on a scale from 0 to 10. Where 0 means that you feel "totally dissatisfied" and 10 means that you feel "totally satisfied". 27. In general, how satisfied are you... with your current job/activity? 10 Completely satisfied 9 8 7 6 5 4 3 2 1 0 Completely dissatisfied	0 - 1 (private) 1 - 0.9 2 - 0.8 3 - 0.7 4 - 0.6 5 - 0.5 6 - 0.4 7 - 0.3 8 - 0.2 9 - 0.1 10 - 0 (not private)	Since the answers to these questions are expressed on an ordinal scale, we have considered a deprivation scale with gradients (decimals) between 0 and 1, where 1 and the closest numbers would be deprived. The questions refer to a level of satisfaction with their life, work, income, etc., allowing psychosocial risk to be measured

Household Composition	Imagine a ladder with steps numbered from 0 to 10, where 0 is the lowest step and 10 is the highest step. The highest represents the best life you could have and the lowest represents the worst. 32. On which step would you say you are standing right now? 10 Best life 9 8 7 6 5 4 3 2 1 0 Worst life	0 - 1 (private) 1 - 0.9 2 - 0.8 3 - 0.7 4 - 0.65 5 - 0.5 6 - 0.4 7 - 0.3 8 - 0.2 9 - 0.1 10 - 0 (not private)	Since the answers to these questions are expressed on an ordinal scale, we have considered a deprivation scale with gradients (decimals) between 0 and 1, where 1 and the closest numbers would be deprived. The questions refer to a level of satisfaction with their life, work, income, etc., allowing psychosocial risk to be measured
Living Place	Class 1 Capital 2 Populated centers, police inspection or corregimientos - Dispersed rural area	1 = 0 (not private) 2 = 1 (private)	If the older adult lives in a rural area, they are considered to be at risk of social vulnerability.
Living Place	1. Type of housing 1 House 2 Apartment 3 Room(s) 4 Traditional indigenous housing 5 Other (tent, container, wagon, boat, cave, natural refuge, etc.)	1,2,3,4 = 0 (not private) 5 = 1 (private)	If the adult does not have a closed place with four walls, it is considered at risk.
Living Place	2. Predominant material of the exterior walls 1 Block, brick, stone, polished wood 2 Tapia trodden, adobe 3 Revoked Bahareque 4 Unrevoked Bahareque 5 Rough wood, board, plank 6 Prefabricated material 7 Guadua, cane, mat, other vegetable 8 Zinc , cloth, coal, cans, waste, plastic 9 No walls	1, 6 = 0 (not private) 2:5 and 7:9 = 1 (private)	If the construction material of the walls of the house is not block, brick or prefabricated material, it is considered to be at risk of vulnerability due to the low quality of the material
Living Place	3. Predominant flooring material 1. Wall-to-wall carpet or rug 2. Polished and lacquered wood, parquet 3. Marble 4. Tile, vinyl, tablet, brick, laminate 5. Rough wood, board, plank, other vegetable 6 .Cement, gravel 7. Earth, sand	1-4 = 0 (not private) 5-7 = 1 (private)	If the predominant material of the floors is not of quality, it is considered at risk of vulnerability
Living Place	4. What is the predominant material of the roof or cover? 1 Concrete, cement or concrete sheet 2 Clay tiles 3 Asbestos-cement tile 4 Metal tile or zinc sheet 5 Plastic tile 6 Straw, palm or other vegetables 7 Waste material (fabric, cardboard, cans, plastic, others)	1-2 = 0 (not private) 3-7 = 1 (private)	If the predominant material of the roof is not of quality, it is considered at risk of vulnerability

Living Place	5. Which of the following public, private or communal services does the dwelling have? 1. Electric power 1 Yes 2 No	1 = 0 (not private) 2 = 1 (private)	If you do not have access to public services, you are considered at risk of vulnerability
Living Place	5. Which of the following public, private or communal services does the dwelling have? 2. Aqueduct 1 Yes 2 No	1 = 0 (not private) 2 = 1 (private)	If you do not have access to public services, you are considered at risk of vulnerability
Living Place	if the dwelling was affected by at least 1 of the disasters in questions P4065S1, PP4065S2, PP4065S3, PP4065S4	private 1= if there is at least one affectation	This is a compound question, if some of the questions considered qualify as private, then the entire question about exposure to disasters will be considered private, this in order to reduce its weight within the dimension
Living Place	6. In the last twelve months, has the dwelling been affected by? 1. Floods, overflows, rising waters, streams 1 Yes 2 No	1 = 1 (private) 2 = 0 (not private)	If the home has been affected by a natural disaster, it is considered to be at risk of vulnerability
Living Place	6. In the last twelve months, has the dwelling been affected by? 2. Avalanches, landslides, landslides 1 Yes 2 No	1 = 1 (private) 2 = 0 (not private)	If the home has been affected by a natural disaster, it is considered to be at risk of vulnerability
Living Place	6. In the last twelve months, has the dwelling been affected by? 3. Land subsidence 1 Yes 2 No	1 = 1 (private) 2 = 0 (not private)	If the home has been affected by a natural disaster, it is considered to be at risk of vulnerability
Living Place	6. In the last twelve months, has the dwelling been affected by? 4. Gales, storms, gales 1 Yes 2 No	1 = 1 (private) 2 = 0 (not private)	If the home has been affected by a natural disaster, it is considered to be at risk of vulnerability

Living Place	7. In the last 12 MONTHS, how often have the following problems occurred in the sector where your home is located: 2. Bad odors from outside 1. Never 2. Sometimes 3. Many times 4. Always	1 = 0 (not private) 2 = 0.25 3 = 0.75 4 = 1 (private)	If the dwelling has been exposed to problems in the sector, it is considered private, according to the level of frequency on a scale with gradients (decimals) between 0 and 1, where 1 is private (vulnerable)
Living Place	7. In the last 12 MONTHS, how often have the following problems occurred in the sector where your home is located: 3. Presence of garbage in the streets 1. Never 2. Sometimes 3. Many times 4. Always	1 = 0 (not private) 2 = 0.25 3 = 0.75 4 = 1 (private)	If the dwelling has been exposed to problems in the sector, it is considered private, according to the level of frequency on a scale with gradients (decimals) between 0 and 1, where 1 is private (vulnerable)
Living Place	7. In the last 12 MONTHS, how often have the following problems occurred in the sector where your home is located: 4. Air pollution 1. Never 2. Sometimes 3. Many times 4. Always	1 = 0 (not private) 2 = 0.25 3 = 0.75 4 = 1 (private)	If the dwelling has been exposed to problems in the sector, it is considered private, according to the level of frequency on a scale with gradients (decimals) between 0 and 1, where 1 is private (vulnerable)
Living Place	7. In the last 12 MONTHS, how often have the following problems occurred in the sector where your home is located: 5. Pollution in rivers, canals, lakes and reservoirs 1. Never 2. Sometimes 3. Many times 4 . Always	1 = 0 (not private) 2 = 0.25 3 = 0.75 4 = 1 (private)	If the dwelling has been exposed to problems in the sector, it is considered private, according to the level of frequency on a scale with gradients (decimals) between 0 and 1, where 1 is private (vulnerable)
Living Place	7. In the last 12 MONTHS, how often have the following problems occurred in the sector where your home is located: 7. Presence of insects, rodents, etc. 1. Never 2. Sometimes 3. Many times 4. Always	1 = 0 (not private) 2 = 0.25 3 = 0.75 4 = 1 (private)	If the dwelling has been exposed to problems in the sector, it is considered private, according to the level of frequency on a scale with gradients (decimals) between 0 and 1, where 1 is private (vulnerable)

Education	1. Can you read and write? 1 Yes 2 No	1 = 0 (not private) 2 = 1 (private)	If the older adult does not know how to read and write, then they are considered to be at risk of vulnerability, since they have less access to better job opportunities.
Education	4. What is the highest educational level attained by ... and the last year or grade passed at this level? 1 None 2 Preschool 3 Basic Primary (1st - 5th) 4 Basic Secondary (6th--9th) 5 Middle (10th--13th) 6 Technician without a degree 7 Technician with a degree 8 Technological without a degree 9 Technological with a degree 10 University without a degree 11 University with degree 12 Postgraduate without degree 13 Postgraduate with degree	1:4 = 1 (private) 5:13 = 0 (not private)	If they did not reach at least the middle educational level, they are considered to be at greater risk of vulnerability, since they would not be a bachelor's degree.
Work force	2. In what activity did you spend... Most of the time LAST WEEK? 1 Working 2 Looking for work 3 Studying 4 Housework 5 Permanently unable to work 6 Other activity, which one?	1,3,4,6 = 0 (not private) 2.5 =1 (private)	If you were inactive, looking for work or permanently disabled, you are considered deprived, that is, with a higher risk of vulnerability
Work force	5. ....worked LAST WEEK at a business for ONE HOUR OR MORE without being paid? 1 Yes 2 No	1 = 1 (private) 2 = 0 (not private)	If you worked without pay, you are considered to be at higher risk of vulnerability
Work force	16. Do you have any type of contract to carry out this work? 1 Yes 2 No	1 = 0 (not private) 2 = 1 (private)	If you worked without a contract, you are considered to be at higher risk of vulnerability
Work force	21. Does the company where you work provide you with personal protection elements to carry out your work? 1 Yes 2 No 3 No need	1.3 = 0 (not private) 2 = 1 (private)	If you are not provided with personal protection elements at work, the risk of social vulnerability is considered

Work force	22. Before discounts, how much did you earn LAST MONTH at this job? (include tips and commissions and exclude overtime, travel and in-kind payments).	<= Minimum vital ($800.) private =1 otherwise not private =0	Establishing a vital minimum of 800 thousand pesos per month, any lower income would be considered a greater risk of vulnerability
Work force	48. Last month, did _____ receive any income from a retirement pension, pension substitution, disability or old age? Value $_____	Variable to add with gross income	This variable was used to calculate a total value VTOTAL* of income per person.
Work force	49.Last month _____did you receive any money income to support children under 18 years of age? (include child support and contribution from absent parents). Value $_____	Variable to add with gross income	This variable was used to calculate a total value VTOTAL* of income per person.
Work force	50. Last month, did _____ receive any income from rentals of houses, apartments, recreational farms, lots, vehicles, machinery and equipment? Value $_____	Variable to add with gross income	This variable was used to calculate a total value VTOTAL* of income per person.
Work force	38. How many hours a week does ____ normally work at this job? Hours	<= 48 hours = 0 (not private) >48 hours = 1 (private)	If the number of hours worked is greater than the legal maximum allowed, then it is considered to be at greater risk of vulnerability.
Work force	46.Are you ..... currently contributing to a pension fund? 1 Yes 2 No 3 Already a pensioner	1.3 = 0 (not private) 2 = 1 (private)	If you are listed in a pension fund or are a pensioner, you have a lower risk of vulnerability
Health	1. Is _____ affiliated with, is he a contributor or is he a beneficiary of any health social security entity? (see note) (Health promotion entity [EPS] or subsidized health promotion entity EPS-S) 1 Yes 2 No 9 Does not know, does not report	1 = 0 (not private) 2 = 1 (private) 9 = NaN	If you do not have a health network, you are considered to be at greater risk of social vulnerability
Health	3. To which of the following social security health schemes are you affiliated? 1 Contributory (eps) 2 Special (armed forces, ecopetrol, public universities, teachers) 3 Subsidized (eps-s) 9 Does not know, does not report	1,2,9 = 0 (not private) 3 = 1 Private	If you are affiliated with the public (subsidized) health system, you are considered to be at greater risk of social vulnerability

Health	10. The general state of health of ___ is: 1 Very good 2 Good 3 Fair 4 Bad	1.2 = 0 (not private) 3.4 = 1 (private)	If your health status is fair or poor, you are considered to be at greater risk of social vulnerability
Health	11. Has _____ been diagnosed with any chronic disease? (long-term illness and prolonged treatments such as: cardiovascular diseases-hypertension, asthma, chronic bronchitis, gastritis, lupus, cancer, gout, leukemia, diabetes, etc.). 1 Yes 2 No	1 = 1 (private) 2 = 0 (not private)	If you suffer from a long-term illness, you are considered to be at greater risk of vulnerability
Health	Do you receive or did you receive treatment prescribed by the doctor? 1 Yes 2 No	1 = 0 (not private) 2 = 1 (private)	If you have not been able to receive medical treatment, you are considered to be at higher risk of vulnerability
Health	16. Given your physical and mental condition, and without any help, can ____: 1. Hear voice or sounds? 1 Cannot do it 2 Yes, with great difficulty 3 Yes, with some difficulty 4 Without difficulty	1 = 1 (private) 2 = 0.75 3 = 0.25 4 = 0 (not private)	If you cannot hear sounds, or do so with difficulty, you are considered to be at higher risk of vulnerability.
Health	16. Given your physical and mental condition, and without any help, can ____: 2. Talk or converse? 1 Cannot do it 2 Yes, with great difficulty 3 Yes, with some difficulty 4 Without difficulty	1 = 1 (private) 2 = 0.75 3 = 0.25 4 = 0 (not private)	If you cannot speak or converse, or do so with difficulty, you are considered to be at higher risk of vulnerability.
Health	16. Given your physical and mental condition, and without any help, can ____: 3. See near, far, or around 1 Unable to do so 2 Yes, with great difficulty 3 Yes, with some difficulty 4 No difficulty	1 = 1 (private) 2 = 0.75 3 = 0.25 4 = 0 (not private)	If you cannot see, or do so with difficulty, you are considered to be at higher risk of vulnerability.
Health	16. Given his physical and mental condition, and without any help, can ____: 4. Move his body, walk or go up and down stairs? 1 Cannot do it 2 Yes, with great difficulty 3 Yes, with some difficulty 4 Without difficulty	1 = 1 (private) 2 = 0.75 3 = 0.25 4 = 0 (not private)	If you cannot move freely, or do so with difficulty, you are considered to be at higher risk of vulnerability.
Health	16. Given his physical and mental condition, and without any help, can ____: 5. Grasp or move objects with his hands? 1 Cannot do it 2 Yes, with great difficulty 3 Yes, with some difficulty 4 Without difficulty	1 = 1 (private) 2 = 0.75 3 = 0.25 4 = 0 (not private)	If you cannot grasp objects with your hands, or do so with difficulty, you are considered to be at higher risk of vulnerability.

Health	16. Given your physical and mental condition, and without any help, can ____: 6. Understand, learn, remember, or make decisions on your own? 1 Cannot do it 2 Yes, with great difficulty 3 Yes, with some difficulty 4 Without difficulty	1 = 1 (private) 2 = 0.75 3 = 0.25 4 = 0 (not private)	If you cannot understand, learn or remember, or do so with difficulty, you are considered to be at higher risk of vulnerability.
Health	16. Given his physical and mental condition, and without any help, can ____: 7. Eat, dress or bathe himself/herself? 1 Cannot do it 2 Yes, with great difficulty 3 Yes, with some difficulty 4 Without difficulty	1 = 1 (private) 2 = 0.75 3 = 0.25 4 = 0 (not private)	If you are unable to eat, bathe or dress yourself, or do so with difficulty, you are considered to be at increased risk of vulnerability.
Health	39. _____ consume sugary drinks (sodas, soft drinks, processed fruit juice drinks, sweetened tea, powdered soft drinks)? 1 Yes 2 No	1 = 1 (private) 2 = 0 (not private)	If you consume sugary drinks, you are considered to be at greater risk of vulnerability, given the high incidence of this habit with diabetic diseases and cancer.
Health	40. During the last 12 months, did _____ have to be hospitalized? 1 Yes 2 No	1 = 1 (private) 2 = 0 (not private)	If you had to be hospitalized, you are considered at higher risk of vulnerability
Home Services	4. Does this household have Natural Gas service connected to the public network? 1 Yes 2 No	1 = 0 (not private) 2 = 1 (private)	If you do not have access to natural gas, you are considered to be at higher risk of vulnerability
Home Services	6. The sanitary service is located: 1 Inside the dwelling 2 Outside the dwelling, but on the lot or land	1 = 0 (not private) 2 = 1 (private)	If the sanitary service is not located inside the home, it is considered to be at greater risk of vulnerability
Home Services	11. How is garbage mainly disposed of in this household? 1 They pick it up by sanitation services 2 They throw it into a river, stream, pipe or lagoon 3 They throw it into a patio, lot, ditch or vacant lot 4 They burn it 5 They bury it 6 It is picked up by an informal service (fox, cart, etc.)	1 = 0 (not private) 2-6 = 1 (private)	If the rubbish is not removed by the sanitation services, it is considered to be at higher risk of vulnerability.
Home Services	15. Does the water reach the home 24 hours a day, seven days a week? 1 Yes 2 No	1 = 0 (not private) 2 = 1 (private)	If there is a failure in the aqueduct network, it is considered to be at greater risk of vulnerability

|			
Home Services	16. Mainly drinking water: 1 They use it as they get it 2 They boil it 3 They add chlorine to it 4 They use filters 5 They decant it or use natural filters 6 They buy bottled or bagged water	1 = 0 (not private) 2-6 = 1 (private)	If they must do an additional treatment to the water they consume, they are considered to be at greater risk of vulnerability
Home Services	19. What energy or fuel do you mainly use for cooking? 1 Electricity 2 Natural gas connected to the public network 3 Oil, gasoline, kerosene, alcohol, cooking oil 4 Propane gas / LPG (in cylinder or pipette) 5 Mineral coal 6 Firewood, wood 7 Charcoal 8 Waste material	1-2 and 4= 0 (not private) 3 and 5:8 = 1 (private)	If you do not use electricity, natural gas or propane gas for cooking, you are considered to be at higher risk of vulnerability
Technology	1A. How often do you use... desktop computer (anywhere)? 1 Every day of the week 2 At least once a week, but not every day 3 At least once a month, but not every week 4 At least once a year, but not every month 5 Does not use a desktop computer	1 = 0 (not private) 2 = 0.25 3 = 0.50 4 = 0.75 5 = 1 (private)	If you do not use this technology or do not use it frequently, you are considered to be at greater risk of vulnerability, since many health services, work and legal procedures are being handled through these channels.
Technology	1 B. How often do you use ... laptop (anywhere)? 1 Every day of the week 2 At least once a week, but not every day 3 At least once a month, but not every week 4 At least once a year, but not every month 5 Does not use a laptop	1 = 0 (not private) 2 = 0.25 3 = 0.50 4 = 0.75 5 = 1 (private)	If you do not use this technology or do not use it frequently, you are considered to be at greater risk of vulnerability, since many health services, work and legal procedures are being handled through these channels.
Technology	1 C. How often do you use ... tablet (anywhere)? 1 Every day of the week 2 At least once a week, but not every day 3 At least once a month, but not every week 4 At least once a year, but not every month 5 Does not use a tablet	1 = 0 (not private) 2 = 0.25 3 = 0.50 4 = 0.75 5 = 1 (private)	If you do not use this technology or do not use it frequently, you are considered to be at greater risk of vulnerability, since many health services, work and legal procedures are being handled through these channels.

Technology	8. Does _____ have a cell phone? 1 Yes 2 No	1 = 0 (not private) 2 = 1 (private)	If you do not use this technology or do not use it frequently, you are considered to be at greater risk of vulnerability, since many health services, work and legal procedures are being handled through these channels.
Life Conditions	1. Is the dwelling occupied by this household? 1. Own, fully paid 2. Own, they are paying for it 3. Leased or subleased 4. With permission of the owner, without any payment (usufructuary) 5. Possession without title (de facto occupant) 6. Collective property	1,2,4,5,6 = 0 (not private) 3 = 1 (private)	If the home is rented, it is considered to have a higher risk of vulnerability, in all other cases, the person does not pay any additional money monthly.
Life Conditions	2. How do you feel in the neighborhood, town or village where you live? 1 Secure 2 Unsure	2= 1 (private) 1= 0 (not private)	If the town is considered insecure, it would have a higher risk of vulnerability
Life Conditions	1. Robbery or robbery 1 Yes 2 No	2= 1 (private) 1= 0 (not private)	If the town is considered insecure, it would have a higher risk of vulnerability
Life Conditions	2. Other violent act (homicide, murder, kidnapping, personal injury, rape, extortion, eviction) 1 Yes 2 No	1= 1 (private) 2= 0 (not private)	If the town is considered insecure, it would have a higher risk of vulnerability
Life Conditions	4. Do you consider yourself poor? 1 Yes 2 No	1= 1 (private) 2= 0 (not private)	If the person is considered poor, they would have a higher risk of vulnerability
Life Conditions	5. Your household income: 1 is not enough to cover the minimum expenses 2 is enough to cover the minimum expenses 3 covers more than the minimum expenses	1= 1 (private) 2.3= 0 (not private)	If the household income does not cover the expenses, it is considered poor, it would have a higher risk of vulnerability
Life Conditions	1. Families in action? 1 Yes 2 No	1= 1 (private) 2= 0 (not private)	If you belong to a state social program, you are considered to be at greater risk of vulnerability

Life Conditions	2. Programs for older adults (Colombia Mayor)? 1 Yes 2 No	1= 1 (private) 2= 0 (not private)	If you belong to a state social program, you are considered to be at greater risk of vulnerability
Life Conditions	10. Does the household have an internet connection? 1 Yes 2 No	2= 1 (private) 1= 0 (not private)	If you do not have an internet connection, you are considered at higher risk of vulnerability

Graphs to analyze the data and the Social Vulnerability Index:

Graph 1. Distribution by Activity per years

More than 3.5 million older adults are dedicated to housework. Doing routine tasks helps keep your brain from aging. While seniors maintain brain health by regularly finishing chores, they also feel a rewarding sense of purpose. In addition, they provide help to members of their household, for example, taking care of their grandchildren. Almost 2 million of them are working, while almost 1 million are looking for work or are permanently disabled. Analyzing by years, there are some changes in trends between 2020 and 2021 in almost every activity shown, most likely because of the COVID pandemic.
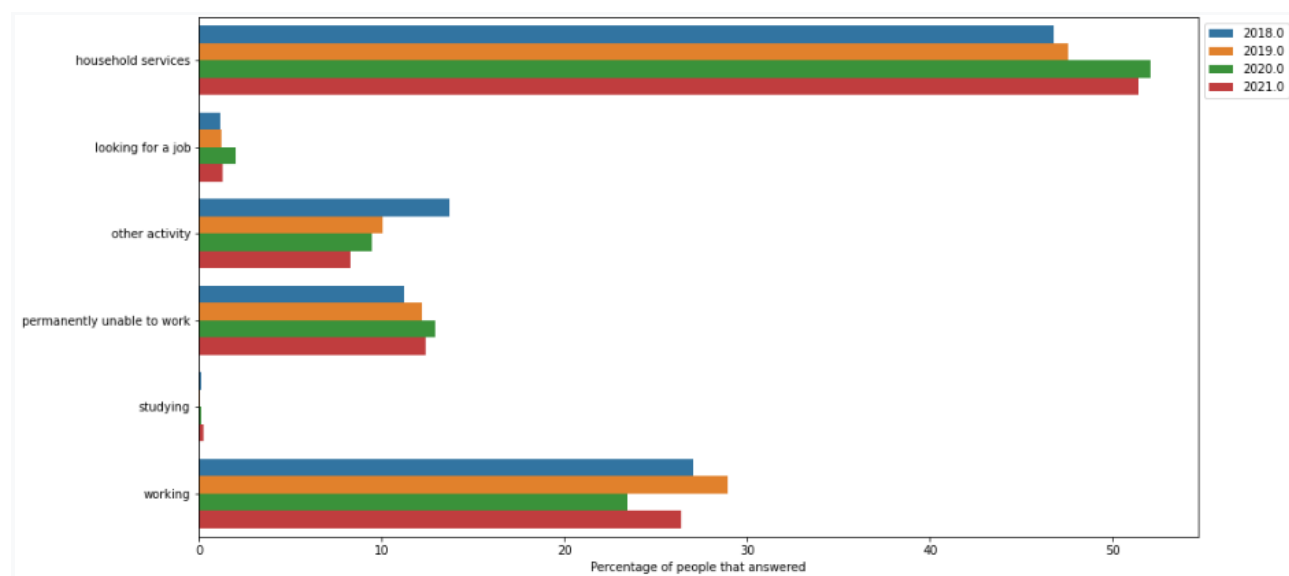
**Graph 2. Distribution by wellness perception per years**

The older population tends to rate their own wellness between 7 and 8, where 0 is the worst value and 10 is the topmost value. Taking in count the years, the levels from 4 to 6 show a decrease from 2020 to 2021, most likely caused by the COVID pandemic.
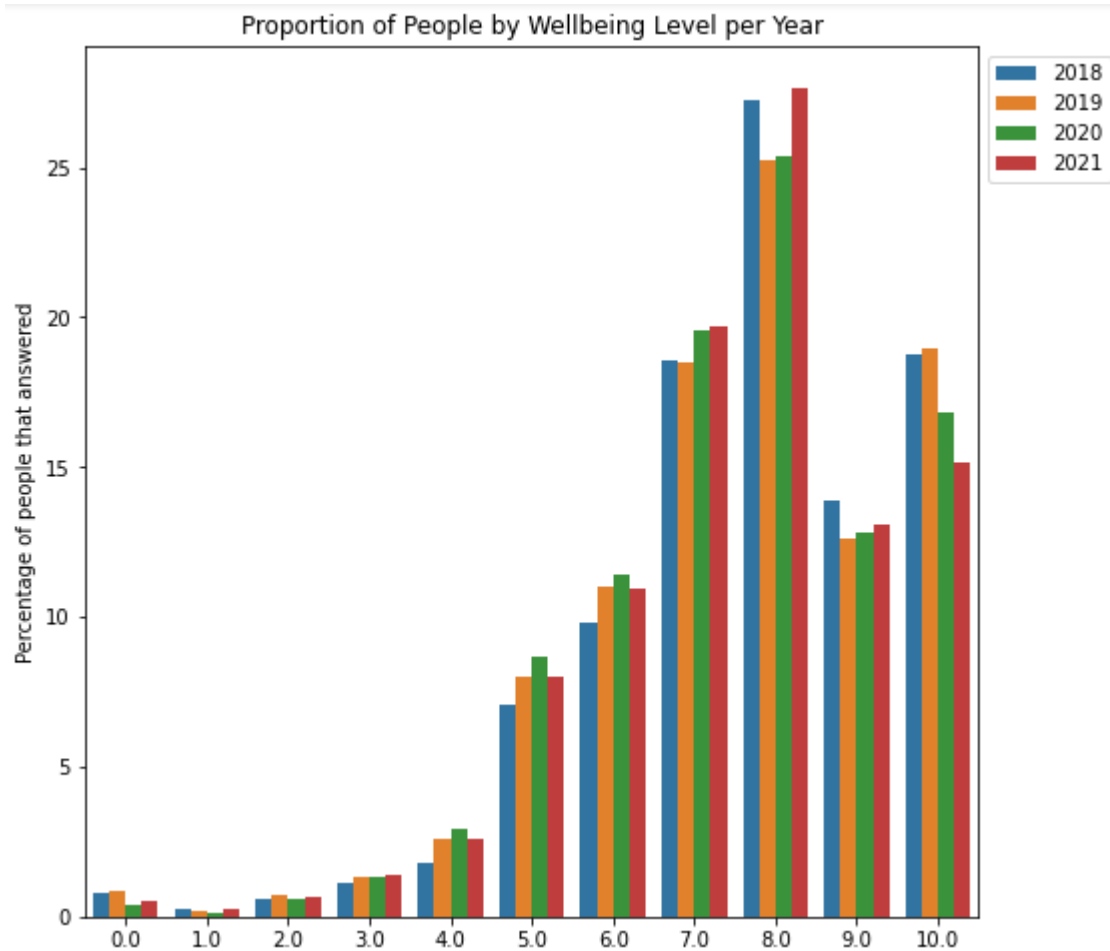
**Graph 3. Distribution by education level per years**

The most common educational level obtained by older adults was primary school, with almost 50% of older adults. But many of them, almost 15%, have no studies or only have Media School studies. A very low percentage reached professional levels. Analyzing for years, there is no clear trend.

Later, the impact of education on the levels of social vulnerability of our population will be studied through ANOVA tests.


Proportion of People by Education Level per Year
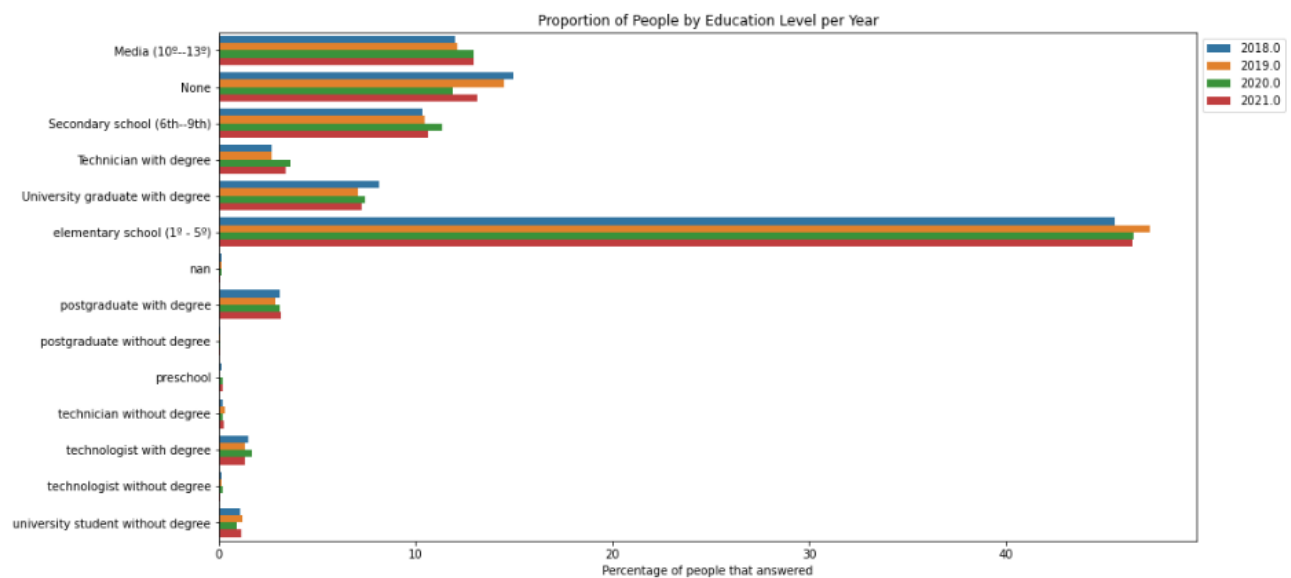
Graph 4. Total income by Gender per Year

In general, no important changes are observed in the distribution of income by gender during the last 4 years. It is possible to observe that at lower incomes, the vulnerability index tends to be much higher. While as income grows, the social vulnerability index is reduced, although the population that reaches said high income is also reduced.
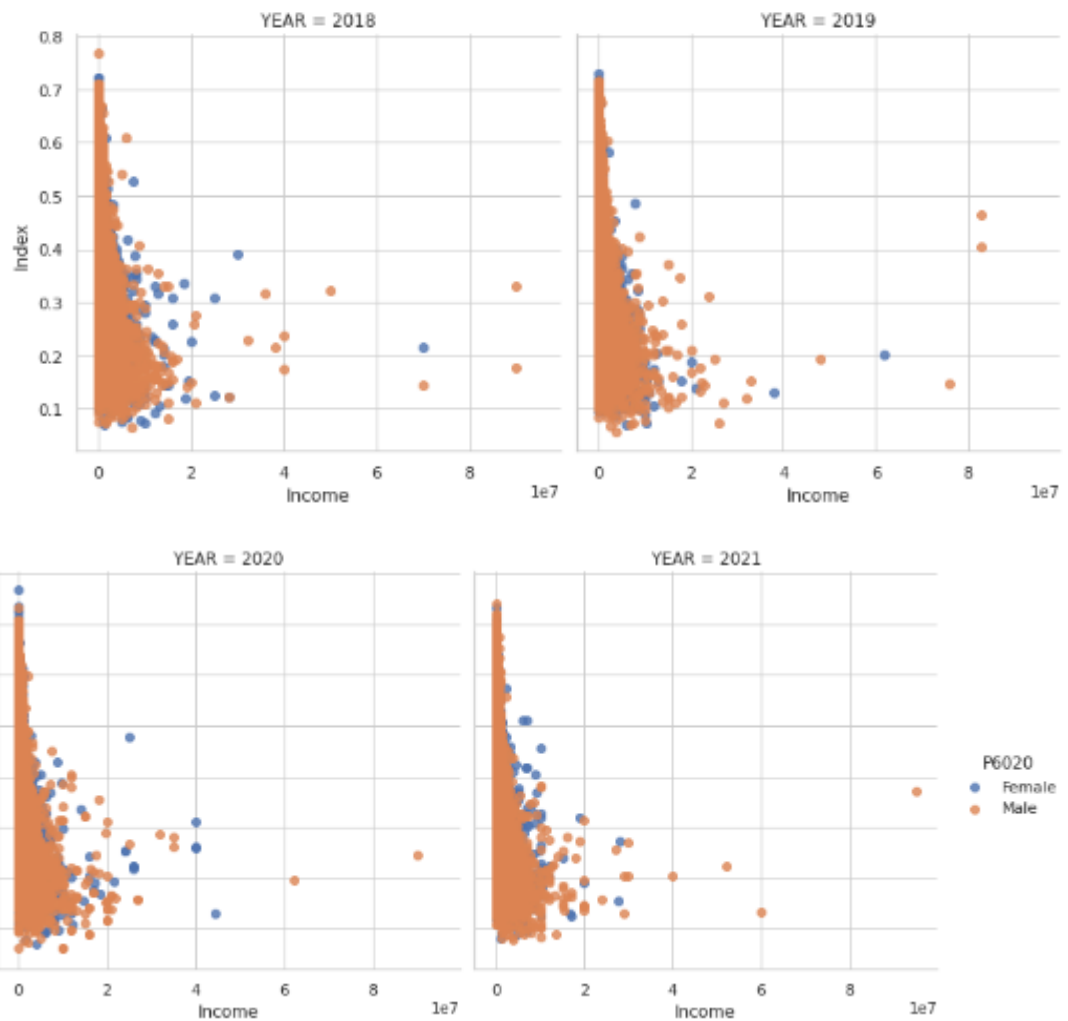
**Graph 5. Distribution of earnings by gender in the last month**

In this case, and for all of the data, we prefer to not erase the nan data or atypical data that can be seen in the Index or in the boxplots since they are considered part of the normal variability of individuals. In this sense, eliminating a single record of these would correspond to eliminating all the variables of an individual that represents approximately 500 people or more (expansion factor). In this case, we have considered it normal to have atypical data that would be very vulnerable people or very non-vulnerable people.
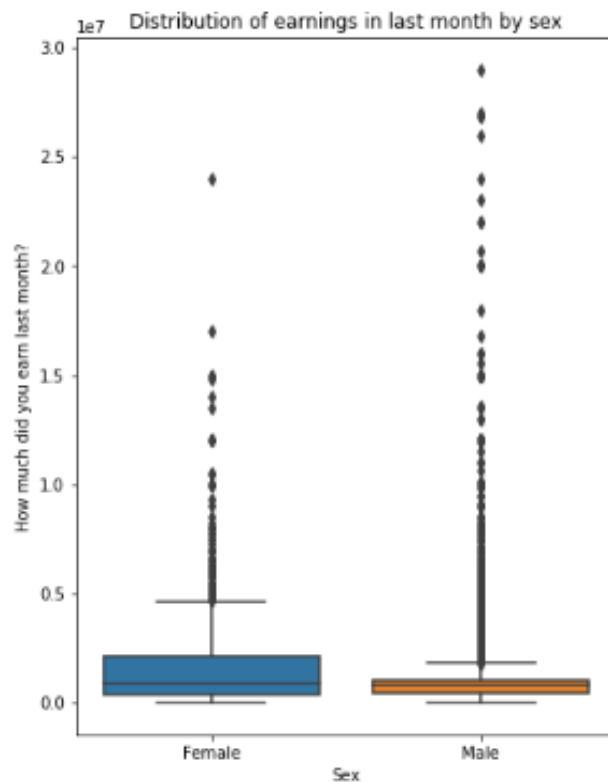
Older men have higher median incomes than older women (1.5 million vs. 1.2 million), but they also have a greater dispersion in their income. This could be due to the fact that there are more older men in the workforce compared to women. This result is interesting for the construction of our index, since it could be a sign of greater economic dependence of older adult women compared to their male counterparts. It is appreciated that women have a lower average salary than men, 50% of women earn more than 1.1 million while 50% of men earn more than 2 million, this measure of central tendency may be more appropriate than the average , due to the skewed distribution of the variables

Graph 6. Problems in the sector in the last twelve months by year

Problems in the sector are very important since they can be a very important health factor and in the older generation, since they have a more delicate immune system, it is riskier. It can be seen that the majority have not experienced any of these problems, but we have a group between 17% and 40% who have experienced any of these events at least once in the last 12 months, and between 6% and 11% who during this same period have experienced several times these inconveniences, and between 6% and 8% who are always in constant danger of experiencing these health hazards.

Problems in the housing sector
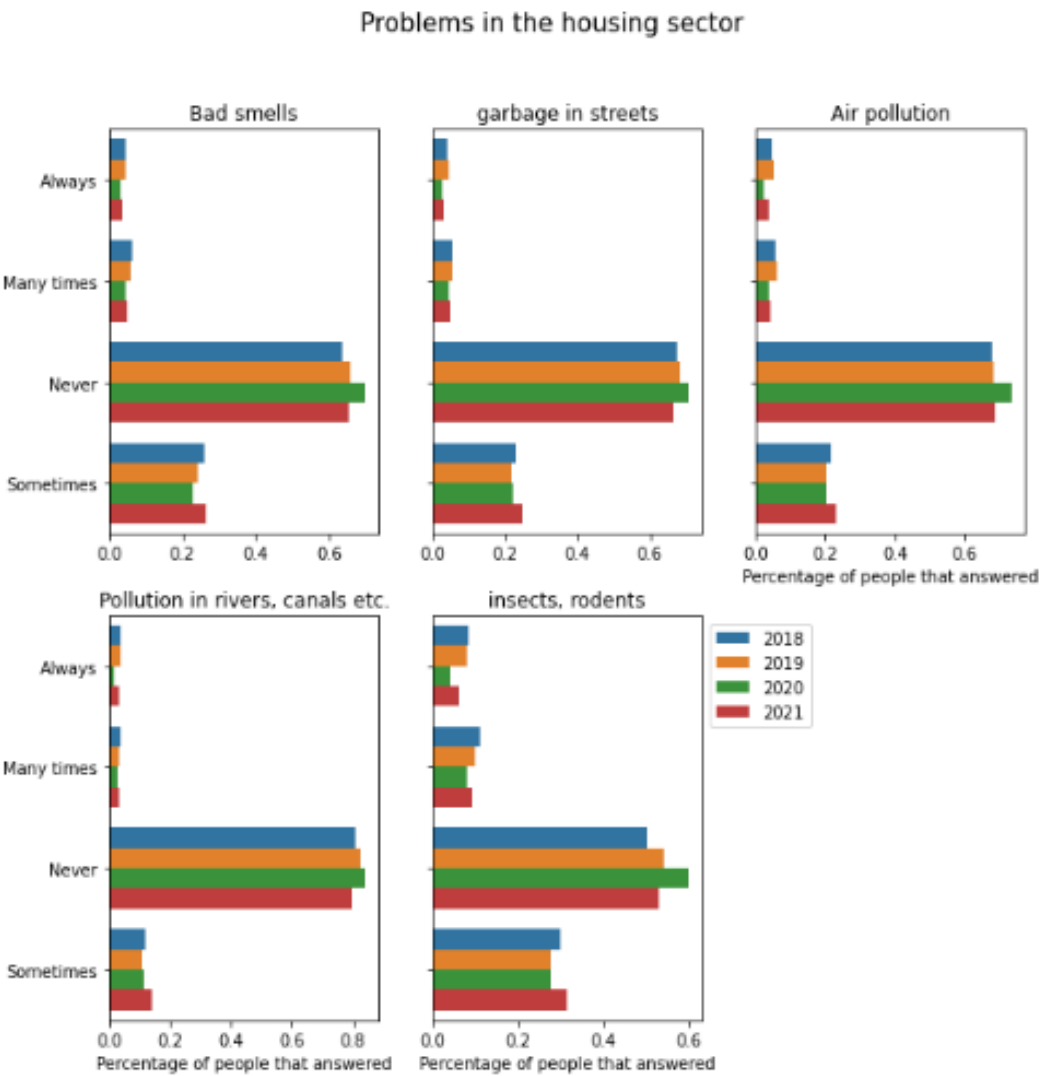
Graph 7. Home affectations in the last twelve months by year

In general, there is no high incidence of this type of natural disaster in our population. However, it should be noted that a smaller percentage claims to have been a victim of one or more of these disasters or damage to their home, such as floods, subsidence, among others, which shows a great vulnerability in this population due to the location and state of the type of home they own, the above, added to a slight increase in these incidents during the last year (2021)..

Affectation in the house
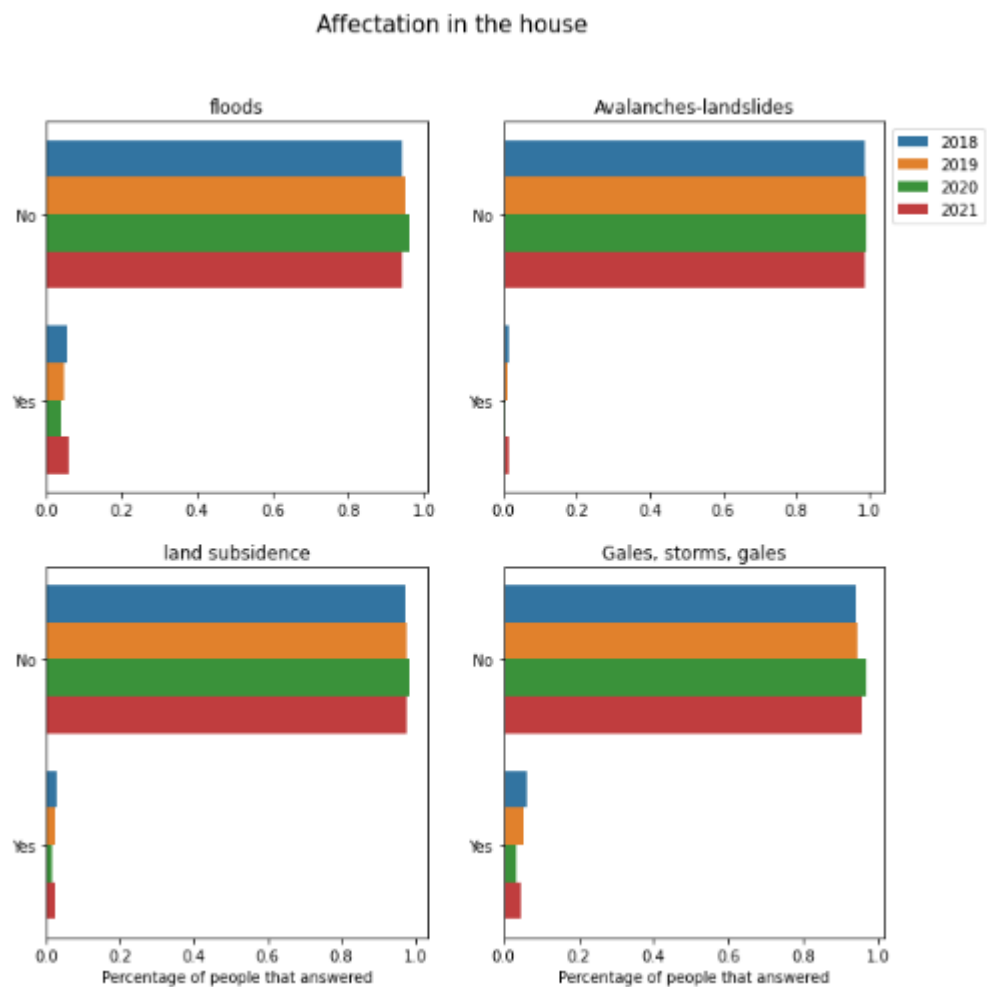
Graph 8. Access to public services per year

Public services are a fundamental right in society to guarantee a decent quality of life, which is why it is a variable that is considered important to diagnose the level of vulnerability of a person, especially if he is an older adult, since not having these services hinder daily activities and hygiene, which can become a public health problem. It can be seen that approximately 14% of the elderly population does not have access to garbage collection, in the same way, 23% of the said population does not have a sewer system and finally, approximately 10% of this population does not have an aqueduct, it is important to mention that nearly 829,000 people in third world countries die from lack of water sanitation and poor hygiene.
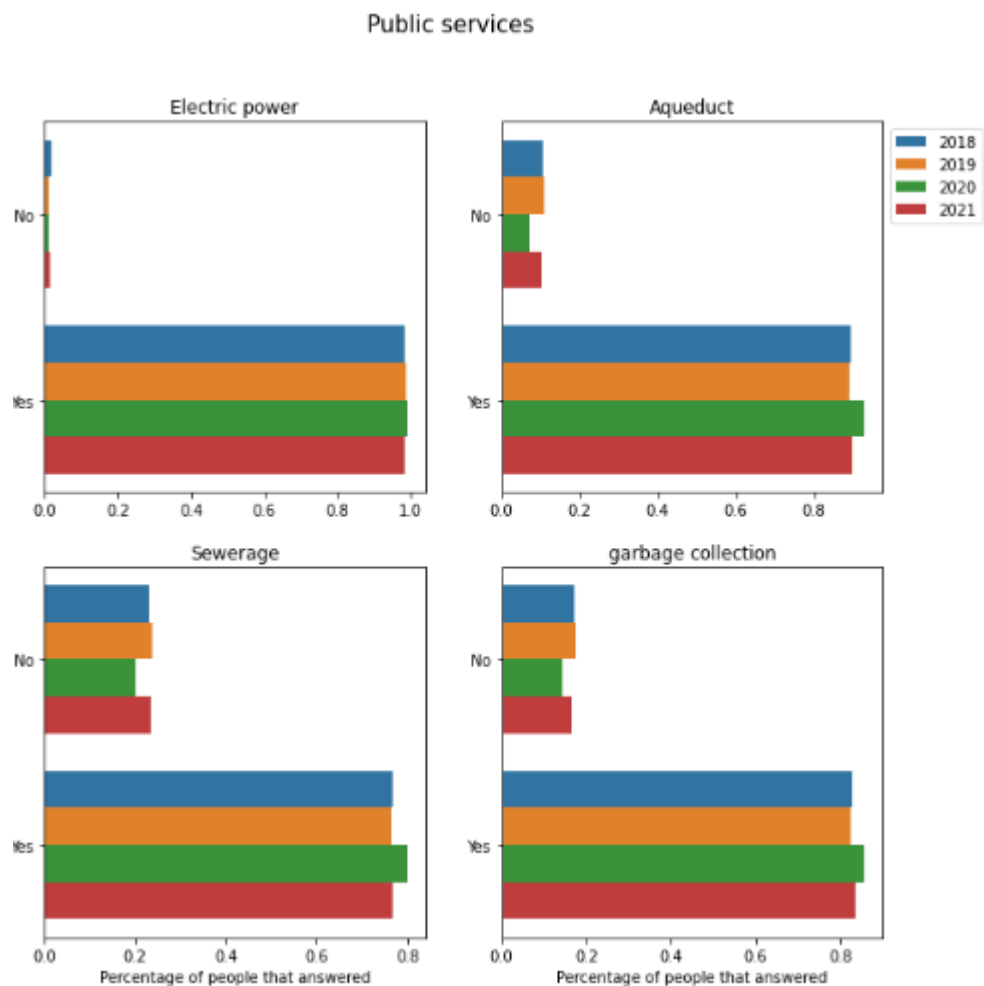
**Graph 9. Distribution of the use of technology per year**

The use of technology in a global and interconnected world is an essential skill for access to different services, in our population, we show that the majority of older adults state that they do not use a desktop, laptop, or tablet, which makes them vulnerable since they do not have access to information and/or digital medical services.
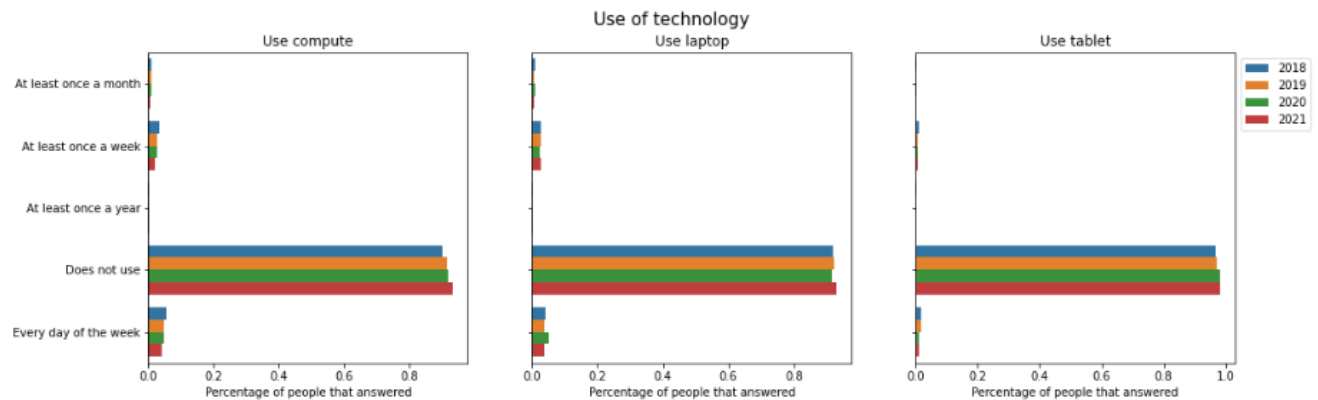
Graph 10. Correlation Plot between Dimensions

In the graph, a visible relationship between home services and living places is evident, which would lead us to think that the best living places also have the best services included. There is also a possible correlation between technology and education, leading us to think that the highest level of education also includes the use and access to technological means. Almost the same level of correlation is shown between life conditions and education, which also seems logical that higher levels of education should increase the chances of a better quality of life conditions.

It can be seen that the life conditions variable is moderately correlated (between 0.30 and 0.43), with the rest of the variables, which could lead us to think that living conditions are somehow improved by the rest of the other variables. Anyway, the low correlation between dimensions as shown is desirable to diminish the possible dependence of one dimension on others and reduce multicollinearity.

Correlation Between Dimension
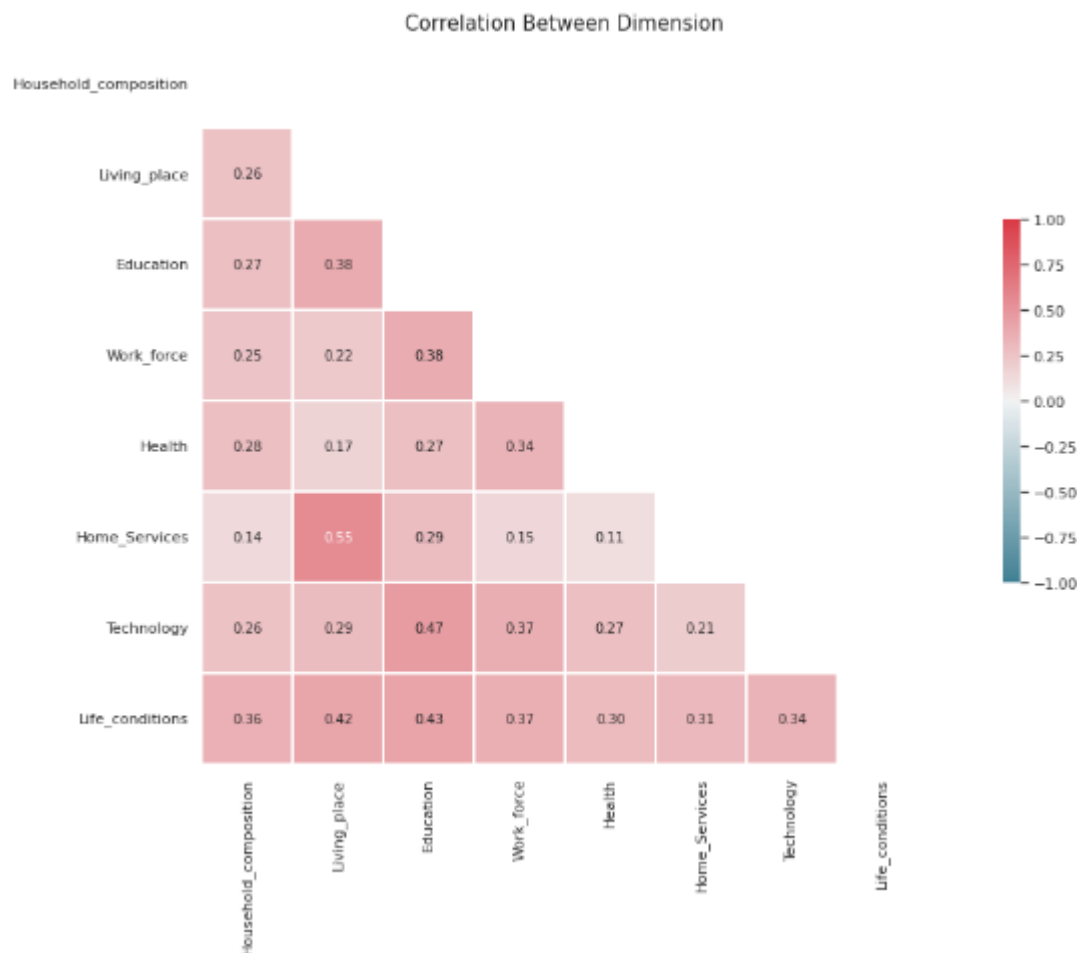
Graph 11. Index by Year

When plotting the social vulnerability index in a bar graph, it is not possible to observe any significant difference from year to year, therefore, it is not possible to draw conclusions about the effect of the Covid 19 pandemic. Apparently, the impact of the pandemic on this age group remained really stable, even decreasing slightly during 2020, perhaps as a result of the success of the emergency social programs of the Colombian state.
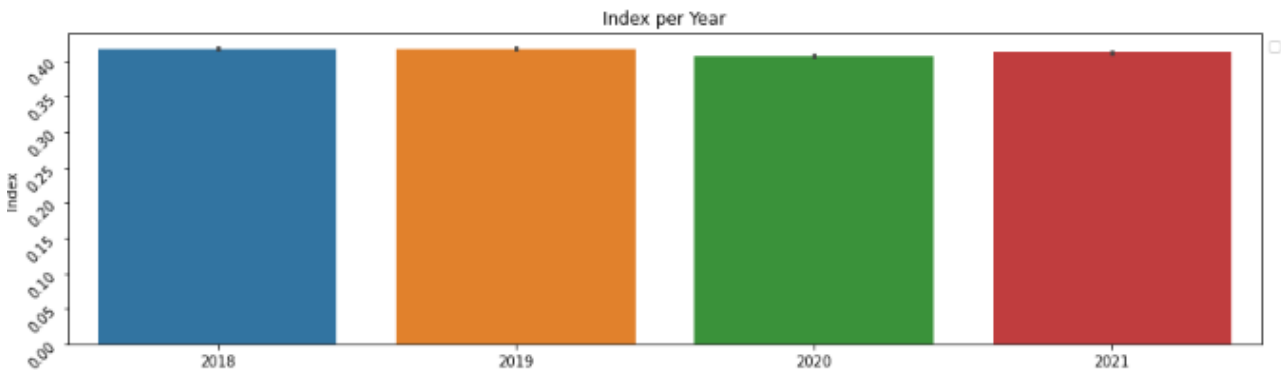
Graph 12. Index by Gender per Year

Our data present a very similar gender distribution, even from year to year. The results of our Index establish a small difference between the mean of the multidimensional index of social vulnerability in men and women, which will be studied later with hypothesis tests and ordinary least squares regression. Additionally, it is possible to observe a change in the average of the index in each gender, which decreases during 2019 and 2020 and increases again in 2021. This initial decrease, although little, may be due to state social programs implemented during the pandemic. of Covid-19, however, by 2021, the economic crisis generated by Covid-19 and the social outbreak may have affected the conditions of this age group.
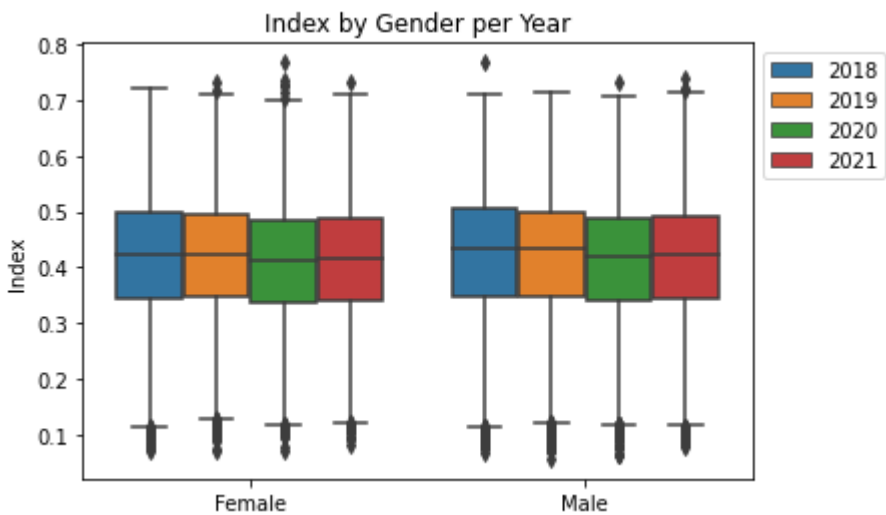
Graph 13. Index by Municipal type per years

The index shows that people living in Municipal heads are less vulnerable than the ones living in rural areas or similar. Analyzing each year, this exposition was declining from 2018 to 2020 but rose back in 2021. This initial decrease, although little, may be due to the success of state social programs implemented during the pandemic of Covid-19. However, in 2021, the economic crisis generated by Covid-19 and by the social outbreak has affected the conditions of this age group.
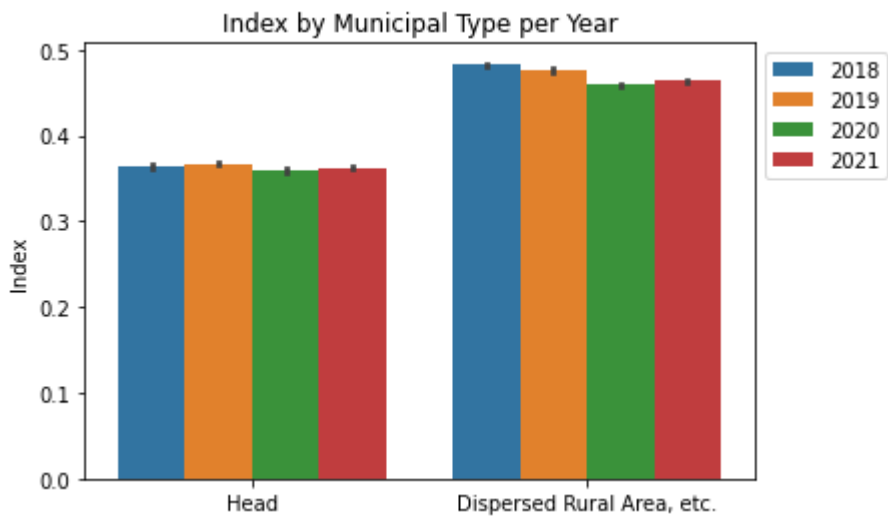
Graph 14. Index by Region per years

The index shows the great disparity in the exposition by region. The least socially vulnerable population is the one living in Bogotá (Capital City), and the most vulnerable are the people living in Orinoquia-Amazonia (wild areas) and pacific (not valley), which are one of the needed regions of the country. Looking at the last 4 years, some indexes by regions tend to slightly decline as caribe and Valle del Cauca, but others trend to oscillate like Central, and only one, oriental, shows clearly some affectation by the 2020 COVID pandemic effect.
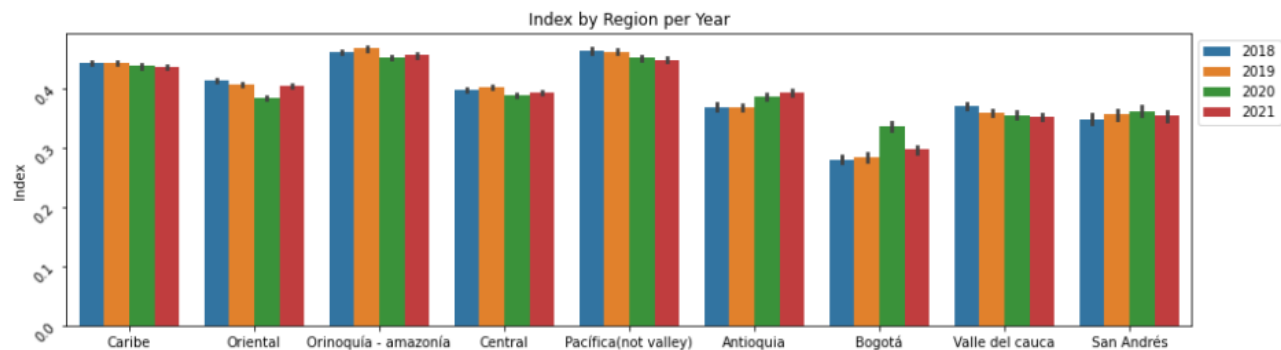
Graph 15. Index by Ethnic Group per Year

Ethnic groups are populations whose social, cultural, and economic conditions and practices distinguish them from the rest of Colombian society. Traditionally, these ethnic groups represent the most vulnerable social minorities. In our data, almost 9% of our population identifies with some ethnic group, while 91% does not. The majority of older adults who consider themselves to be part of an Ethnic Group are considered of indigenous or of African descent. In this case, our multidimensional vulnerability index shows that the most vulnerable Ethnic groups are Afro-Colombian and Indigenous. In some of these Ethnic groups, this Index has increased yearly, like Indigenous (the most susceptible group), Palenquero, and Root from the Archipelago of San Andrés.
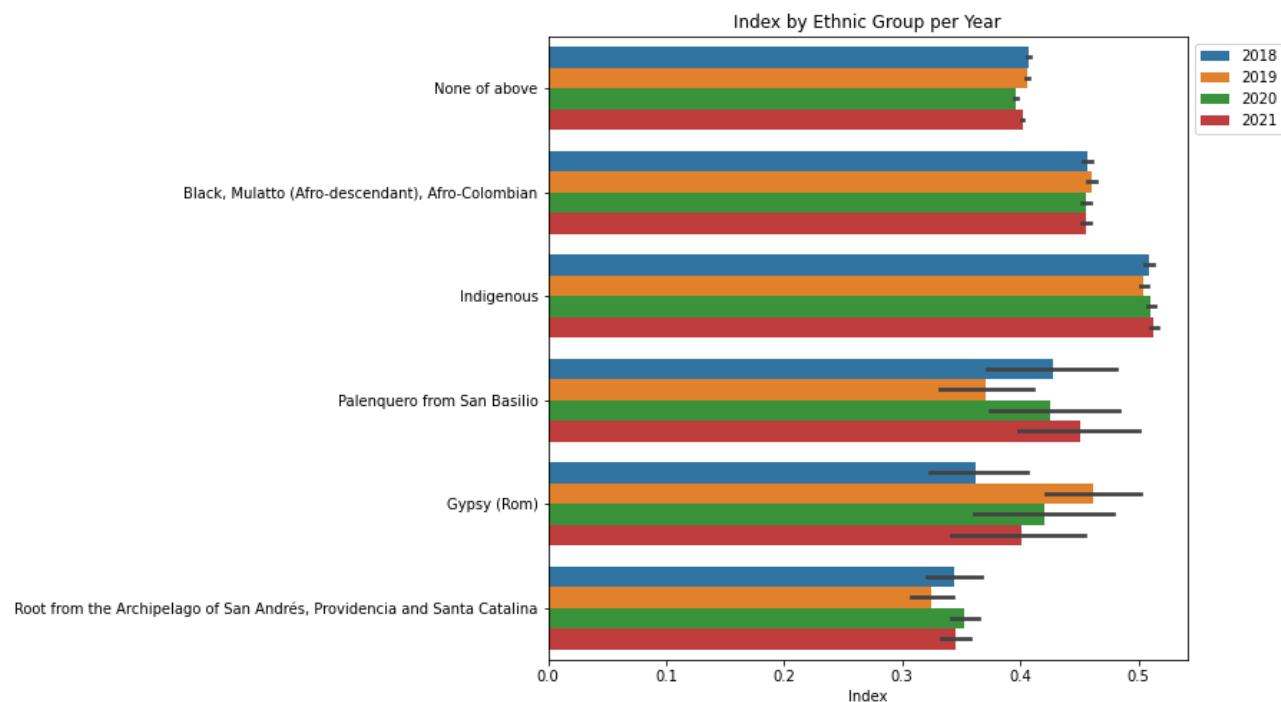
Graph 16. Index by literacy per years

The index shows that literacy has a clear influence on the level of vulnerability of people. Illiterate people tend to be more vulnerable than those who can read and write. There is no evidence of an important change in these levels in the last 4 years.
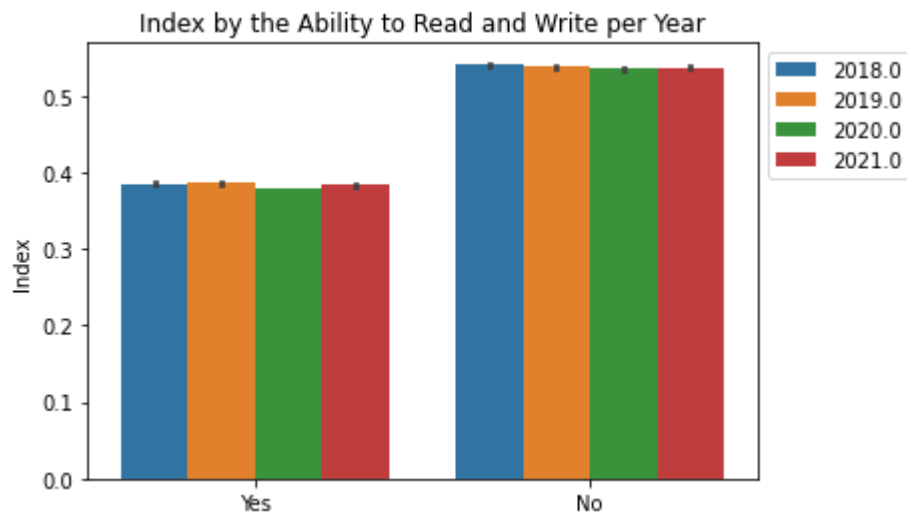
Graph 17. Index by Paid work per Year

In the graph, it is possible to observe a clear difference between people who work without pay and those who do not. On average, the vulnerability index is higher in those who work without pay, which is especially visible during the years 2018 and 2021.
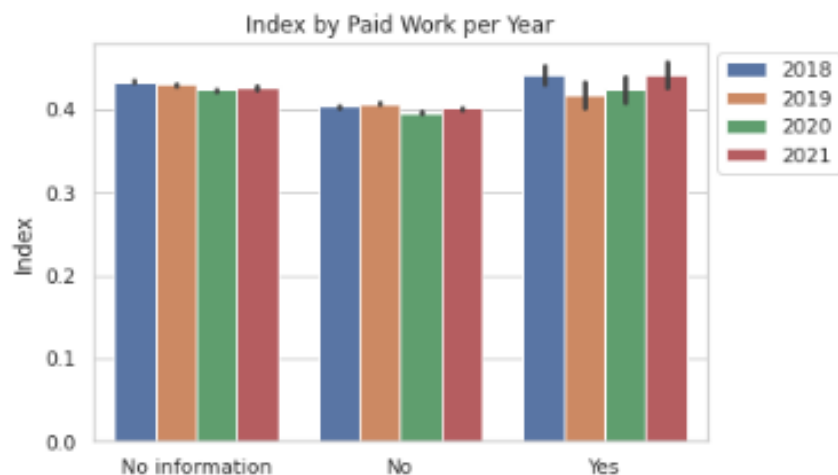
Graph 18. Index by Dimension per Year

In general, our index shows similar behavior in each dimension per year. In general, the population is more vulnerable in terms of technology, education, work force and household composition. These four dimensions measure different characteristics. Vulnerability in terms of technology is important to control because many services such as: health, payments, education, among others, have turned to virtuality. Vulnerability in terms of Education must be controlled because it allows access to better economic, mental and social conditions. Vulnerability in terms of the workforce seeks to establish the economic conditions (monetary income) and type of work activity available to the elderly to cover expenses. Vulnerability in terms of household composition makes it possible to understand the material conditions available to the person for personal protection.
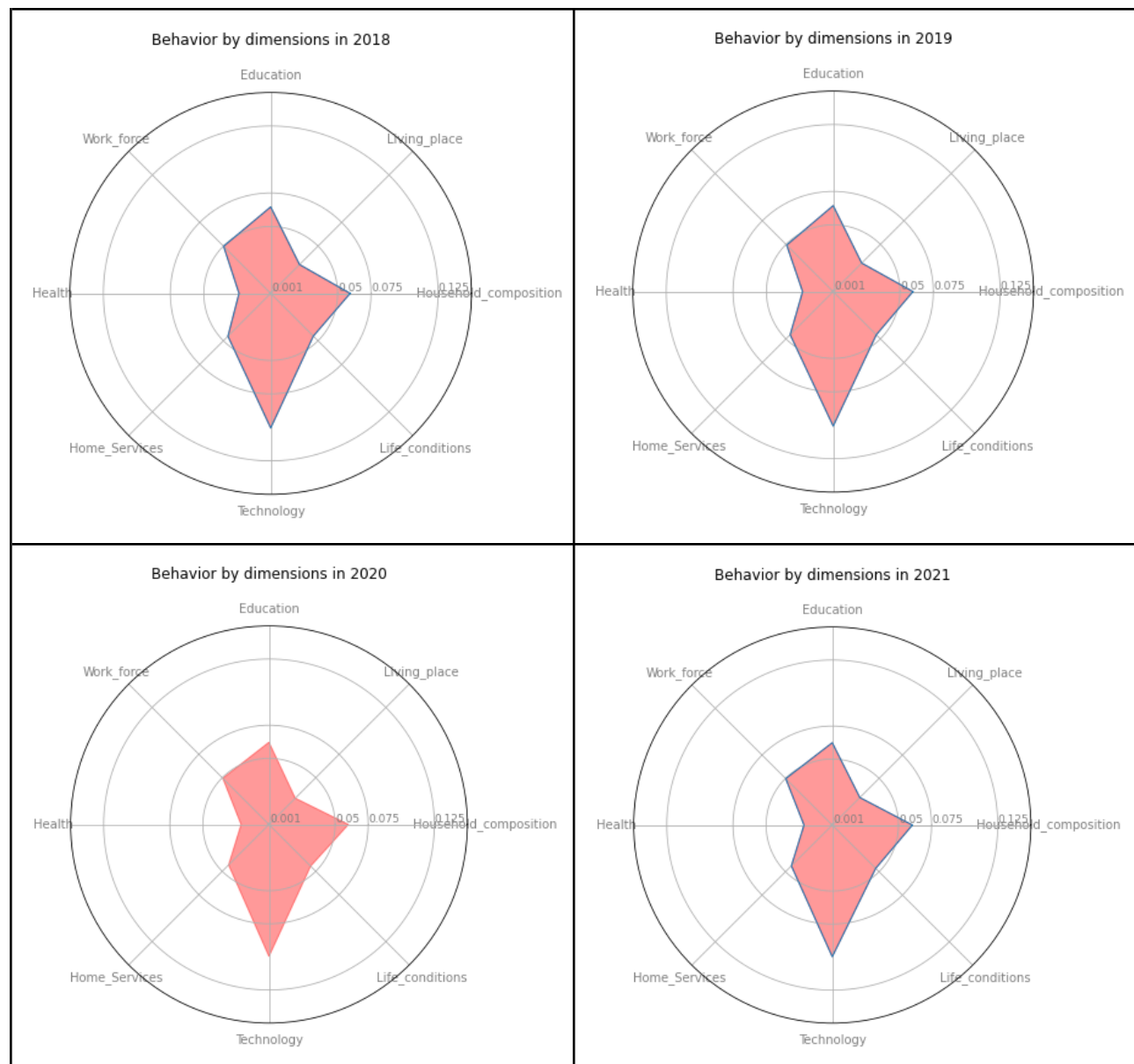
Graph 19. Index by Clusters
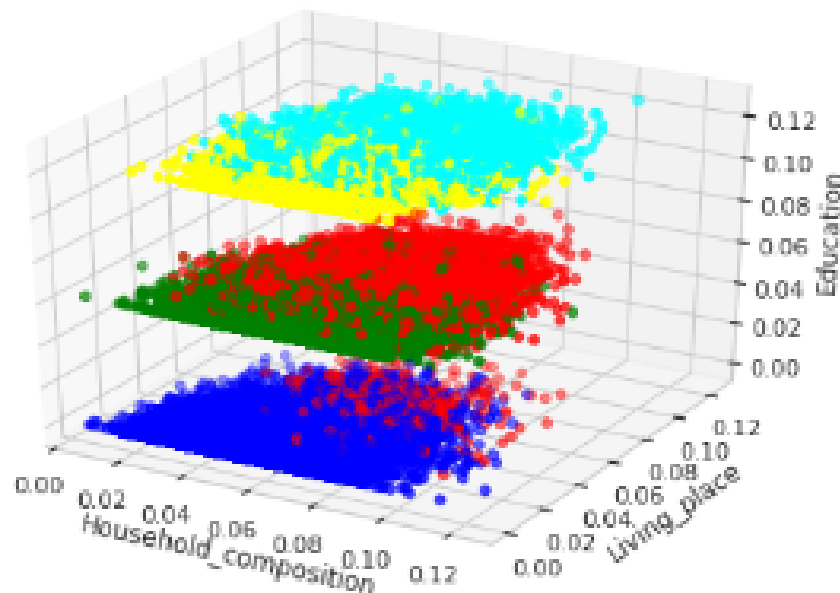
As shown in the graphic, the dimension Education (Z axis) allows to generate 3 clusters over the index, with the lower index cluster around 0, the second index cluster around 0.04 and the third cluster around 0.1.

The dimension Living Place (Y axis), also generates two sets of clusters, not as clear as the first dimension's cluster result, but still visible. The household composition does not generate visible clusters.

The analysis shows that the education dimension groups clearly three clusters and also defines a low exposed group, a medium exposed group and a high exposed group. It could indicate that education is generating clear separation and has a high impact in the possible exposure to the index.

Graph 20. Geographic Distribution of the Vulnerability Index per years:
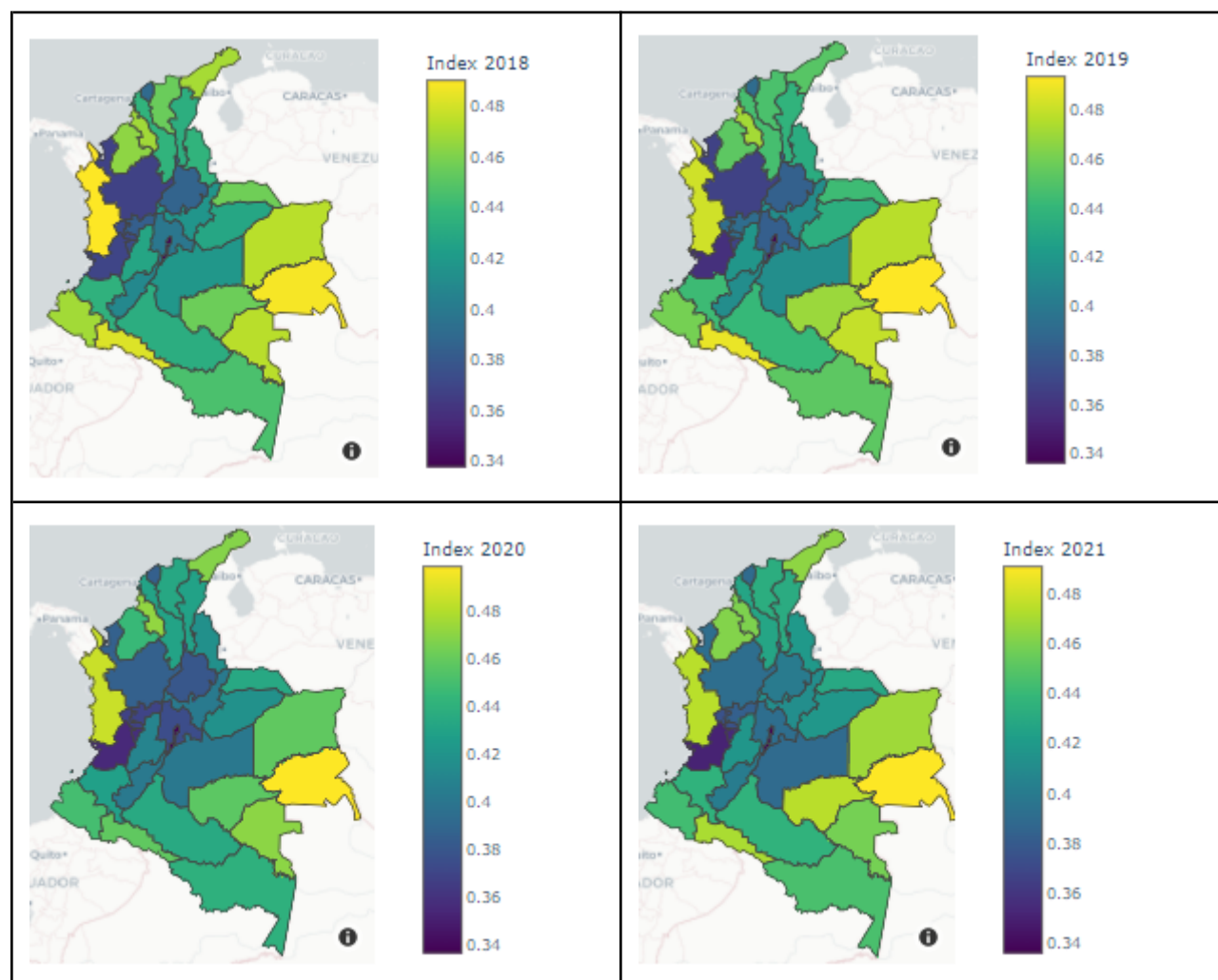
The index seems to increase in the departments that are far from the center of the country, that usually are the poorest of the country, for example Choco, Guania, Guaviare and Putumayo. It can be said that those departments usually have less economic resources to cover the population with programs and public services, especially for the elder people, which increases the exposure shown in the index.

As shown in the graphs, there is no sensible change between years, though some departments seem to increase the index value from 2020 to 2021 as example Cordoba, Guaviare and Putumayo, which lead us to infer that the poorest departments could be more exposed to index increments because of the COVID pandemic.

Graph 21. "Traffic light" of Vulnerability distribution of people in Colombia by Year

While our 11th bar chart didn't give us many clues about the year-to-year behavior of our index, the "traffic light" we built in Dash did show the behavior of this index. The Dash traffic light distributes the index according to 3 levels of vulnerability: high vulnerability (greater than 0.66), medium (between 0.66 and 0.33) and low (less than 0.33). The high level has been decreasing for the

Vulnerability	Years			
Level	2018	2019	2020	2021
Low	39,3%	38,0%	43,7%	39,8%
Medium	60,5%	61,8%	56,2%	60,1%
High	0,20%	0,18%	0,12%	0,13%

last 4 years, in fact, there is a difference of 7 percentage points between 2018 and 2021. Parallel to this decrease, there has been an increase in people in the lowest levels of the index, which is extremely favorable for the population in general. However, some of the post-pandemic effects can be seen in the index of our older adults during the year 2021, where low levels of vulnerability decreased and high levels of vulnerability increased slightly.
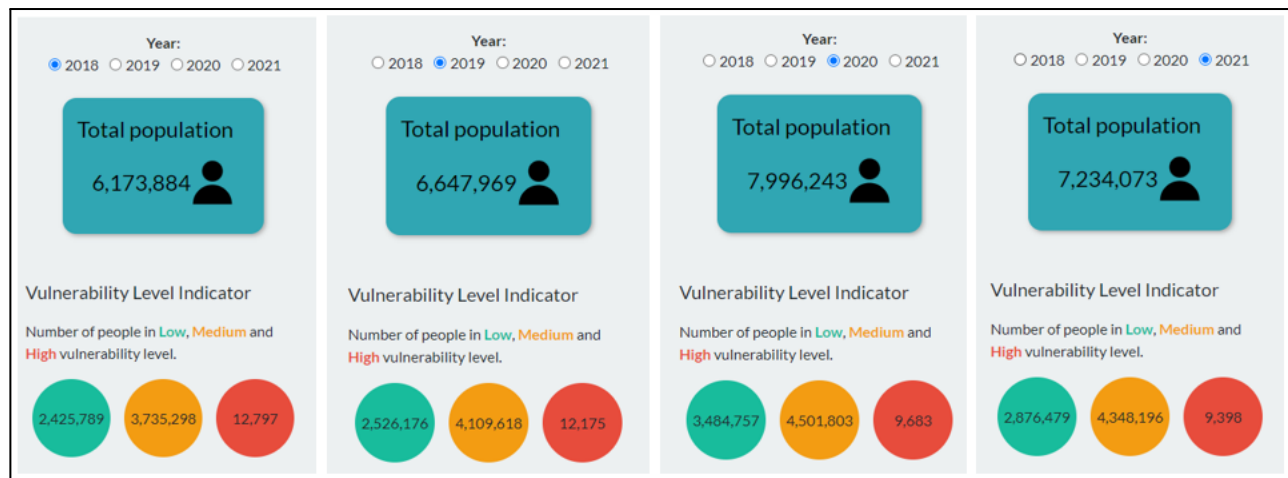
Models:

Hypothesis tests:

Since the weights of each variable were calculated using the methodology described above, it did not make much sense to do a simple linear regression, since the coefficients would give results very similar to the weights used in the construction of the index.

To understand the real behavior of our data and the significance differences between values of the variables, we did t-tests and ANOVAs taking into account the Expansion factor (How many people in the total population are represented by the respondent in the sample?), because some of the graphs used (such as boxplots) do not allow the use of expansion factors, therefore we only had the sample view, but not the representation of the total population.

1. **T-test: Vulnerability index mean between Men and Women:**

H0: Index for Male = Index for Female

H1: Index for Male != Index for Female

Our null hypothesis was rejected, so we have statistically significant evidence at $\alpha=0.05$ to show that there is a difference in mean vulnerability index in Men and Vulnerability index in Women.

```
(-66.35942000781282, 0.0, 28052167.076317392)
```

To weigh the impact of this difference between the vulnerability index means between men and women, we performed a WLS regression and found that the vulnerability index for men is 0.0146 units below the index for women. This means that if we compare two people in equal conditions in the other variables, but with different genders, the vulnerability index of women will grow at a rate of 0.0146 units faster than that of men.

```
                      WLS Regression Results
Dep. Variable:       indice              R-squared:        0.005
       Model:        WLS            Adj. R-squared:        0.005
      Method:        Least Squares      F-statistic:       802.8
        Date:        Fri, 01 Jul 2022 Prob (F-statistic): 3.86e-176
        Time:        04:03:40          Log-Likelihood:    -80054.
No. Observations: 153792                        AIC:      1.601e+05
  Df Residuals:   153790                        BIC:      1.601e+05
     Df Model:    1
Covariance Type: nonrobust
          coef   std err    t      P>|t|  [0.025 0.975]
const  0.3238   0.000   935.556 0.000 0.323  0.325
P6020 -0.0146   0.001   -28.333 0.000 -0.016 -0.014
    Omnibus:     78846.959 Durbin-Watson:  0.974
Prob(Omnibus): 0.000      Jarque-Bera (JB): 5939190.319
       Skew:     -1.620        Prob(JB):     0.00
   Kurtosis:     33.271        Cond. No.     2.52

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

2. **T-test: Vulnerability index mean between Dispersed Rural Areas and Municipal head:**

H0: Index for Dispersed Rural Areas = Index for Municipal Head

H1: Index for Dispersed Rural Areas != Index for Municipal Head

Our null hypothesis was rejected, and we have statistically significant evidence at $\alpha=0.05$ to show that there is a difference in mean between vulnerability index in Dispersed Rural Areas and Vulnerability index in Municipal head.

```
(3234.3046276428163, 0.0, 28052167.076317392)
```

To weigh the impact of this difference between vulnerability index in Dispersed Rural Areas and Vulnerability index in Municipal head, we performed a WLS regression and found that the vulnerability index for Dispersed Rural Areas is 0.164 units above the index for Municipal head. This means that if we compare two people under equal conditions in the other variables, but with a different type of municipality, the vulnerability index of people located in dispersed rural areas will grow at a rate of 0.164 units faster than that of people located in municipal heads.

```
                    WLS Regression Results
   Dep. Variable:   indice            R-squared:       0.145
        Model:      WLS               Adj. R-squared:  0.145
        Method:     Least Squares     F-statistic:     2.616e+04
        Date:       Fri, 01 Jul 2022 Prob (F-statistic): 0.00
        Time:       04:03:39          Log-Likelihood:  -68375.
   No. Observations: 153792           AIC:             1.368e+05
     Df Residuals:   153790           BIC:             1.368e+05
        Df Model:    1
   Covariance Type: nonrobust
            coef  std err    t      P>|t|  [0.025 0.975]
   const  0.3077 0.000   1253.311 0.000 0.307  0.308
   CLASE 0.1641 0.001    161.736  0.000 0.162  0.166
      Omnibus:      59463.498  Durbin-Watson:  1.139
   Prob(Omnibus): 0.000       Jarque-Bera (JB): 7664362.847
        Skew:      -0.841         Prob(JB):      0.00
      Kurtosis:    37.543         Cond. No.      4.28

   Notes:
   [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

3. T-test: Vulnerability index mean between literacy people and non literacy people:

H0: Index for literacy people = Index for non literacy people

H1: Index for literacy people != Index for non literacy people

Our null hypothesis was rejected, and we have statistically significant evidence at $\alpha=0.05$ to show that there is a difference in mean between vulnerability index in literacy people and Vulnerability index in non literacy people.

```
(-3400.0153026712305, 0.0, 28052167.07631739)
```

To weigh the impact of this difference between vulnerability index in literacy people and Vulnerability index in non literacy people, we performed a WLS regression and found that the vulnerability index for literacy people is 0.186 units below of the index for non literacy people. This means that if we compare two people under equal conditions in the other variables, but with a different type of literacy, the vulnerability index of non literacy people will grow at a rate of 0.186 units faster than the index for literacy people.

```
                          WLS Regression Results
    Dep. Variable:    indice                R-squared:      0.216
         Model:       WLS             Adj. R-squared:  0.216
         Method:      Least Squares        F-statistic:    4.239e+04
          Date:       Wed, 06 Jul 2022 Prob (F-statistic): 0.00
          Time:       23:56:40           Log-Likelihood: -61735.
No. Observations: 153792                        AIC:      1.235e+05
    Df Residuals:    153790                      BIC:      1.235e+05
       Df Model:     1
Covariance Type: nonrobust

          coef   std err     t      P>|t|  [0.025  0.975]
const   0.4906  0.001   562.528  0.000  0.489  0.492
P6160  -0.1860  0.001  -205.880  0.000 -0.188 -0.184

    Omnibus:      86328.619   Durbin-Watson:   1.103
Prob(Omnibus): 0.000      Jarque-Bera (JB): 8280729.611
        Skew:     -1.807          Prob(JB):     0.00
    Kurtosis:     38.766          Cond. No.     7.52

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

4. **ANOVA: Difference between the variances of the vulnerability indices of the main regions of Colombia:**

H_0: all the variances are equal and H_1: at least one of the variances is different

H_0: Antioquia Index = Bogotá Index = Caribe Index = Central Index = Oriental Index = Orinoquia-Amazonia Index = Pacifica Index = San Andrés Index = Valle del Cauca Index

H_1: Antioquia Index != Bogotá Index != Caribe Index != Central Index != Oriental Index != Orinoquia-Amazonia Index != Pacifica Index != San Andrés Index != Valle del Cauca Index

Our null hypothesis was rejected, and we have statistically significant evidence at $\alpha=0.05$ that there is a difference in variances of the index in the main regions of Colombia.

	Source	SS	DF	MS	F	p-unc	np2
0	REGION	182.385055	8	22.798132	2104.484916	0.0	0.098675
1	Within	1665.949270	153783	0.010833	NaN	NaN	NaN

To weigh the impact of this difference between vulnerability indexes in the main regions of Colombia, we performed a WLS regression and found that the vulnerability index for each region is significantly different. This means that if we compare two people under equal conditions in the other variables, but with a different region, the vulnerability index for regions like: Caribe, Oriental, Orinoquia and Pacific will grow faster than the index for regions like: Bogotá, San Andrés or Valle del Cauca.

```
                              WLS Regression Results
        Dep. Variable:    indice                R-squared:         0.099
              Model:    WLS              Adj. R-squared:      0.099
             Method:    Least Squares          F-statistic:     2104.
               Date:    Wed, 06 Jul 2022 Prob (F-statistic): 0.00
               Time:    23:56:41         Log-Likelihood:  1.2975e+05
    No. Observations: 153792                      AIC:       -2.595e+05
       Df Residuals:   153783                      BIC:       -2.594e+05
           Df Model:   8
     Covariance Type: nonrobust
```

	coef	std err	t	P>|t|	[0.025	0.975]
Antioquia	0.3791	0.001	307.005	0.000	0.377	0.382
Bogotá	0.3036	0.002	177.480	0.000	0.300	0.307
Caribe	0.4398	0.001	779.494	0.000	0.439	0.441
Central	0.3952	0.001	728.993	0.000	0.394	0.396
Oriental	0.4015	0.001	675.105	0.000	0.400	0.403
Orinoquía - amazonía	0.4583	0.001	607.731	0.000	0.457	0.460
Pacífica(not valley)	0.4558	0.001	518.069	0.000	0.454	0.457
San Andrés	0.3547	0.002	143.939	0.000	0.350	0.360
Valle del cauca	0.3588	0.001	280.740	0.000	0.356	0.361

```
       Omnibus:    3336.246  Durbin-Watson:   0.974
 Prob(Omnibus): 0.000    Jarque-Bera (JB): 3498.323
          Skew:    -0.360        Prob(JB):       0.00
      Kurtosis:     2.835       Cond. No.       4.55
```

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

In fact, when establishing the differences between the coefficients of each region (Table 3), it is evident that the vulnerability index of Orinoquía-Amazonía and Pacífico grows at a rate of 0.15 units faster than the vulnerability index of Bogotá. The indices for the Caribbean, Central and Eastern regions, meanwhile, grow at a rate of 0.14 - 0.09 and 0.10 units faster than the Bogotá Vulnerability Index. On the other hand, the vulnerability indices of Valle del Cauca and San Andrés (0.36 and 0.35) are the closest to the lowest index of Bogotá (0.30), that is, these two regions grow at a rate of 0.05 and 0.06 units faster than that of the capital of Colombia.

Table 3. Differences between Vulnerability Index coefficients by region. Own elaboration

Region		Antioquia	Bogotá	Caribe	Central	Oriental	Orinoquía - amazonía	Pacífica (not valley)	San Andrés	Valle del cauca
		0,38	0,30	0,44	0,40	0,40	0,46	0,46	0,35	0,36
Antioquia	0,38	0,00								
Bogotá	0,30	-0,08	0,00							
Caribe	0,44	0,06	0,14	0,00						
Central	0,40	0,02	0,09	-0,04	0,00					
Oriental	0,40	0,02	0,10	-0,04	0,01	0,00				
Orinoquía - amazonía	0,46	0,08	0,15	0,02	0,06	0,06	0,00			
Pacífica (not valley)	0,46	0,08	0,15	0,02	0,06	0,05	0,00	0,00		
San Andrés	0,35	-0,02	0,05	-0,09	-0,04	-0,05	-0,10	-0,10	0,00	
Valle del cauca	0,36	-0,02	0,06	-0,08	-0,04	-0,04	-0,10	-0,10	0,00	0,00

Legend:
- Difference < 0
- Difference = 0
- Difference > 0

5. ANOVA: Difference between the variances of the vulnerability indexes of the Ethnic Groups of Colombia:

H_0: all the variances are equal and H_1: at least one of the variances is different

H_0: Afro-Colombian Index = Gypsy Index = Indigenous Index = None Index = Palenquero Index = Root from San Andres Index

H_1: Afro-Colombian Index != Gypsy Index != Indigenous Index != None Index != Palenquero Index != Root from San Andres Index

Our null hypothesis was rejected, and we have statistically significant evidence at $\alpha=0.05$ that there is a difference in variances of the Index in the Ethnic groups of Colombia.

	Source	SS	DF	MS	F	p-unc	np2
0	P6080	140.835447	5	28.167089	2536.870779	0.0	0.076196
1	Within	1707.498878	153786	0.011103	NaN	NaN	NaN

To weigh the impact of this difference between the vulnerability indexes of the main ethnic groups in Colombia, we performed a WLS regression and found that the vulnerability index of each ethnic group is significantly different. This means that if we compare two people in equal conditions in the other variables, but with different ethnic groups, the vulnerability index of ethnic groups such as Indigenous, Afro-Colombian and Gypsies will grow faster than the index of people who do not identify themselves. with any ethnic group.

```
                        WLS Regression Results
Dep. Variable:      indice                R-squared:      0.076
      Model:        WLS              Adj. R-squared:     0.076
     Method:        Least Squares       F-statistic:     2537.
       Date:        Wed, 06 Jul 2022 Prob (F-statistic): 0.00
       Time:        23:56:41        Log-Likelihood:  1.2785e+05
No. Observations: 153792                    AIC:       -2.557e+05
 Df Residuals:    153786                    BIC:       -2.556e+05
    Df Model:        5
Covariance Type: nonrobust

                                                          coef  std err     t      P>|t|  [0.025 0.975]
Black, Mulatto (Afro-descendant), Afro-Colombian        0.4575 0.001  476.357  0.000 0.456 0.459
                              Gypsy (Rom)               0.4318 0.015   28.092  0.000 0.402 0.462
                               Indigenous               0.5092 0.001  506.985  0.000 0.507 0.511
                              None of above             0.4030 0.000 1379.534 0.000 0.402 0.404
                    Palenquero from San Basilio         0.4076 0.013   32.129  0.000 0.383 0.432
Root from the Archipelago of San Andrés, Providencia and Santa Catalina 0.3431 0.005  73.739  0.000 0.334 0.352
    Omnibus:      2786.110  Durbin-Watson:   0.946
Prob(Omnibus): 0.000      Jarque-Bera (JB): 2775.064
       Skew:     -0.306        Prob(JB):       0.00
   Kurtosis:      2.757        Cond. No.       52.6


Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

In fact, when establishing the differences between the coefficients of each ethnic group (table 4), it is evident that the vulnerability index of groups such as indigenous and Afro-Colombian grows at a rate of 1.06 and 0.55 units faster than the index vulnerability of people who do not identify with any ethnic group. On the other hand, it should be noted that the vulnerability index of people with roots in San Andres, Providencia and Santa Catalina is the lowest, even lower than the index of those who say they do not belong to any ethnic group and grows 0.6 units below those who do not belong to any ethnic group, 0.65 units below palenqueros, 0.89 units below gypsies, 1.14 units below Afro-Colombians and 1.66 units below indigenous (the most vulnerable ethnic group).

Table 4. Differences between Vulnerability Index coefficients by ethnic group. Own elaboration

Ethnic Group		Afro-Colombian	Gypsy (Rom)	Indigenous	None of above	Palenquero from San Basilio	Root from San Andrés
		4,58	4,32	5,09	4,03	4,08	3,43
Afro-Colombian	4,58	0,00				Difference < 0	
Gypsy (Rom)	4,32	-0,26	0,00			Difference = 0	
Indigenous	5,09	0,52	0,77	0,00		Difference > 0	
None of above	4,03	-0,55	-0,29	-1,06	0,00		
Palenquero from San Basilio	4,08	-0,50	-0,24	-1,02	0,05	0,00	
Root from San Andrés	3,43	-1,14	-0,89	-1,66	-0,60	-0,65	0,00

6. ANOVA: Difference between the variances of the vulnerability indexes of the Education levels of Colombia:

H_0: all the variances are equal and H_1: at least one of the variances is different

H_0: Media (10º--13º) Index = None Index = Secondary school (6th--9th) Index = Technician with degree Index = University graduate with degree Index = elementary school (1º - 5º) Index = postgraduate with degree Index = postgraduate without degree Index = preschool Index = technician without degree Index = technologist with degree Index = technologist without degree Index = university student without degree Index

H_1: Media (10º--13º) Index != None Index != Secondary school (6th--9th) Index != Technician with degree Index != University graduate with degree Index != elementary school (1º - 5º) Index != postgraduate with degree Index != postgraduate without degree Index != preschool Index != technician without degree Index != technologist with degree Index != technologist without degree Index != university student without degree Index

Our null hypothesis was rejected, and we have statistically significant evidence at $\alpha=0.05$ that there is a difference in variances of the index in the Education levels of Colombia.

	Source	SS	DF	MS	F	p-unc	np2
0	P8587	1138.414656	13	87.570358	18968.899037	0.0	0.615914
1	Within	709.919669	153778	0.004617	NaN	NaN	NaN

To weigh the impact of this difference between the vulnerability indexes of the different educational levels in Colombia, we perform a WLS regression and find that the vulnerability index of each educational level is significantly different. This means that if we compare two people in equal conditions in the other variables, but with different educational levels, the vulnerability index of people who did not receive any education, those who only attended pre-school and those who only attended elementary school , will grow considerably faster than the rate of people who received higher technical or professional education.

```
                        WLS Regression Results
Dep. Variable:    indice                R-squared:        0.616
     Model:       WLS              Adj. R-squared:  0.616
    Method:       Least Squares        F-statistic:     1.897e+04
     Date:        Wed, 06 Jul 2022 Prob (F-statistic): 0.00
     Time:        23:56:42          Log-Likelihood:  1.9534e+05
No. Observations: 153792                    AIC:          -3.907e+05
 Df Residuals:    153778                     BIC:          -3.905e+05
  Df Model:       13
Covariance Type:  nonrobust

                                     coef  std err     t     P>|t|  [0.025 0.975]
              Media (10º--13º)      0.2894 0.001  492.878  0.000 0.288 0.291
                      None         0.5280 0.000 1379.086 0.000 0.527 0.529
      Secondary school (6th--9th)  0.3807 0.001  629.933  0.000 0.379 0.382
         Technician with degree    0.2636 0.001  207.032  0.000 0.261 0.266
University graduate with degree    0.2282 0.001  274.795  0.000 0.227 0.230
      elementary school (1º - 5º)  0.4297 0.000 1798.566 0.000 0.429 0.430
                      nan          0.2920 0.006   52.643  0.000 0.281 0.303
        postgraduate with degree   0.2055 0.001  160.561  0.000 0.203 0.208
     postgraduate without degree   0.2164 0.008   27.770  0.000 0.201 0.232
                   preschool       0.4756 0.004  124.424  0.000 0.468 0.483
       technician without degree   0.2856 0.005   62.620  0.000 0.277 0.294
        technologist with degree   0.2467 0.002  127.474  0.000 0.243 0.250
     technologist without degree   0.2544 0.007   37.252  0.000 0.241 0.268
university student without degree  0.2587 0.002  115.822  0.000 0.254 0.263

  Omnibus:        70.001 Durbin-Watson:   1.115
Prob(Omnibus): 0.000   Jarque-Bera (JB): 63.457
    Skew:        0.007       Prob(JB):     1.66e-14
  Kurtosis:      2.901       Cond. No.     32.6


Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

When establishing the differences between the coefficients of each level of education (table 5), it is evident that the vulnerability index of educational levels such as no educational level, pre-school and elementary school grows at a rate of 3.23, 2.70 and 2.24 units respectively faster than the vulnerability index of people who finished a professional postgraduate degree. On the other hand, it should be noted that the vulnerability index of people with professional technical, university and postgraduate studies is the lowest, on average, 2 units lower than those who do not have any educational level.

Table 5. Differences between Vulnerability Index coefficients by Education level. Own elaboration

Education Level		Media (10°--13°)	None	Secondary school (6th--9th)	Technician with degree	University graduate with degree	elementary school (1° - 5°)	postgraduate with degree	postgraduate without degree	preschool	technician without degree	technologist with degree	technologist without degree	university student without degree
		2,89	5,28	3,81	2,64	2,28	4,30	2,06	2,16	4,76	2,86	2,47	2,54	2,59
Media (10°--13°)	2,89	0,00												
None	5,28	2,39	0,00											
Secondary school (6th--9th)	3,81	0,91	-1,47	0,00										
Technician with degree	2,64	-0,26	-2,64	-1,17	0,00									
University graduate with degree	2,28	-0,61	-3,00	-1,53	-0,35	0,00								
elementary school (1° - 5°)	4,30	1,40	-0,98	0,49	1,66	2,02	0,00							
postgraduate with degree	2,06	-0,84	-3,23	-1,75	-0,58	-0,23	-2,24	0,00						
postgraduate without degree	2,16	-0,73	-3,12	-1,64	-0,47	-0,12	-2,13	0,11	0,00					
preschool	4,76	1,86	-0,52	0,95	2,12	2,47	0,46	2,70	2,59	0,00				
technician without degree	2,86	-0,04	-2,42	-0,95	0,22	0,57	-1,44	0,80	0,69	-1,90	0,00			
technologist with degree	2,47	-0,43	-2,81	-1,34	-0,17	0,19	-1,83	0,41	0,30	-2,29	-0,39	0,00		
technologist without degree	2,54	-0,35	-2,74	-1,26	-0,09	0,26	-1,75	0,49	0,38	-2,21	-0,31	0,08	0,00	
university student without degree	2,59	-0,31	-2,69	-1,22	-0,05	0,31	-1,71	0,53	0,42	-2,17	-0,27	0,12	0,04	0,00

Legend: Difference < 0 | Difference = 0 | Difference > 0

7. ANOVA: Difference between the variances of the vulnerability indexes of the type of living place of Colombia:

H_0: all the variances are equal and H_1: at least one of the variances is different

H_0: Apartment index = House index = Indigenous Traditional House index = Other (tent, container, wagon, etc.) Index = Room index

H_1: Apartment index != House index != Indigenous Traditional House index != Other (tent, container, wagon, etc.) Index != Room index

Our null hypothesis was rejected, and we have statistically significant evidence at $\alpha=0.05$ that there is a difference in variances of the index in the different types of living place of Colombia.

	Source	SS	DF	MS	F	p-unc	np2
0	P1070	244.610724	4	61.152681	5864.157225	0.0	0.132341
1	Within	1603.723601	153787	0.010428	NaN	NaN	NaN

To weigh the impact of this difference between the vulnerability indexes of the different types of places to live, we run a WLS regression and find that the vulnerability index of each type of dwelling is significantly different. This means that if we compare two people in equal conditions in the other variables, but with different types of housing, the vulnerability index of people who live in a traditional indigenous house, those who live in structures such as tents, containers, wagons, boat, cave, nature shelter and rooms, will grow considerably faster than that of people who live in apartments or houses.

```
                              WLS Regression Results
Dep. Variable:     indice              R-squared:        0.132
     Model:        WLS             Adj. R-squared:   0.132
    Method:        Least Squares       F-statistic:      5864.
     Date:         Wed, 06 Jul 2022  Prob (F-statistic): 0.00
     Time:         23:56:43          Log-Likelihood:   1.3268e+05
No. Observations: 153792                AIC:            -2.653e+05
 Df Residuals:    153787                BIC:            -2.653e+05
   Df Model:      4
Covariance Type: nonrobust
                                                          coef  std err     t      P>|t|  [0.025 0.975]
                               Apartment                0.3283 0.001   497.155  0.000 0.327 0.330
                                 House                  0.4281 0.000  1486.231  0.000 0.427 0.429
                       Indigenous Traditional House     0.5519 0.002   240.977  0.000 0.547 0.556
Other (tent, container, wagon, ship, cave, natural shelter, etc.) 0.5189 0.008   68.923   0.000 0.504 0.534
                                 Room                   0.4601 0.002   200.899  0.000 0.456 0.465
  Omnibus:       2214.330  Durbin-Watson:   1.053
Prob(Omnibus): 0.000       Jarque-Bera (JB): 2261.456
    Skew:       -0.285         Prob(JB):      0.00
  Kurtosis:      2.836        Cond. No.      26.1

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

When establishing the differences between the coefficients of each type of place to live (table 6), it is evident that the vulnerability index of the types of places to live such as the traditional indigenous house or in structures such as tents, containers, wagons, boat , cave, nature shelter, grows at a rate of 2.24 units and 1.91 units respectively, faster than the vulnerability index of people who live in an apartment. On the other hand, it should be noted that the vulnerability index of people who live in an apartment or a house is considerably much lower than that of other types of places to live.

Table 6. Differences between Vulnerability Index coefficients by type of living place. Own elaboration

Type of Living Place		Apartment	House	Indigenous Traditional House	Other (tent, container, wagon, etc.)	Room
		3,28	4,28	5,52	5,19	4,60
Apartment	3,28	0,00				
House	4,28	1,00	0,00			
Indigenous Traditional House	5,52	2,24	1,24	0,00		
Other (tent, container, wagon, etc.)	5,19	1,91	0,91	-0,33	0,00	
Room	4,60	1,32	0,32	-0,92	-0,59	0,00

Difference < 0
Difference = 0
Difference > 0

8. ANOVA: Difference between the variances of the vulnerability indexes of the type of external material of living place in Colombia:

H_0: all the variances are equal and H_1: at least one of the variances is different

H_0: Bahareque not plastered index = Bahareque plastered index = Blocks, bricks, stone, polished wood index = Guadua, cane, mat, other plants index = No walls index = Prefabricated material index = Rough wood, planks, board index = Stepped wall, adobe index = Zinc, fabric, coal, canister, disposals, plastic index

H_1: Bahareque not plastered index != Bahareque plastered index != Blocks, bricks, stone, polished wood index != Guadua, cane, mat, other plants index != No walls index != Prefabricated material index != Rough wood, planks, board index != Stepped wall, adobe index != Zinc, fabric, coal, canister, disposals, plastic index

Our null hypothesis was rejected, and we have statistically significant evidence at $\alpha=0.05$ that there is a difference in variances of the index in the different types of external material of living place in Colombia.

	Source	SS	DF	MS	F	p-unc	np2
0	P4005	369.450153	9	41.050017	4268.592379	0.0	0.199883
1	Within	1478.884173	153782	0.009617	NaN	NaN	NaN

To weigh the impact of this difference between the vulnerability indexes of the different types of external materials of the places to live, we perform a WLS regression and find that the vulnerability index of each type of material of the dwellings is significantly different. This means that if we compare two people in equal conditions in the other variables, but with a type of external material in their home such as Bahareque not plastered, Guadua, cane, mat, other plants, No walls, Rough wood, planks, board or Zinc, fabric, coal, canister, disposals, plastic, will have a vulnerability index that will grow much faster, on average, 2 additional units, than that of people who live in a house whose construction material is Blocks, bricks , stone, polished wood or Prefabricated material.

```
                         WLS Regression Results
  Dep. Variable:    indice              R-squared:        0.200
       Model:       WLS            Adj. R-squared:        0.200
      Method:       Least Squares      F-statistic:       4269.
        Date:       Wed, 06 Jul 2022 Prob (F-statistic): 0.00
        Time:       23:56:44        Log-Likelihood:       1.3891e+05
No. Observations:   153792                 AIC:           -2.778e+05
  Df Residuals:     153782                 BIC:           -2.777e+05
     Df Model:      9
Covariance Type:    nonrobust

                                            coef  std err      t      P>|t|  [0.025 0.975]
          Bahareque not plastered          0.5213 0.002   346.046   0.000 0.518 0.524
             Bahareque plastered           0.4813 0.001   409.803   0.000 0.479 0.484
  Blocks, bricks, stone, polished wood     0.3881 0.000  1358.745   0.000 0.388 0.389
    Guadua, cane, mat, other plants        0.5158 0.004   140.046   0.000 0.509 0.523
              No information                0.5379 0.013    41.412   0.000 0.512 0.563
                No walls                    0.5140 0.004   135.561   0.000 0.507 0.521
           Prefabricated material          0.4189 0.003   125.781   0.000 0.412 0.425
        Rough wood, planks, board          0.5116 0.001   676.155   0.000 0.510 0.513
          Stepped wall, adobe              0.4863 0.001   339.026   0.000 0.483 0.489
Zinc, fabric, coal, canister, disposals, plastic 0.5203 0.003 163.174 0.000 0.514 0.527
     Omnibus:       1424.237  Durbin-Watson:   1.073
 Prob(Omnibus):    0.000      Jarque-Bera (JB): 1449.942
        Skew:      -0.231          Prob(JB):    0.00
    Kurtosis:       2.889         Cond. No.     45.5


Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

By establishing the differences between the coefficients of each type of external material of the place to live (Table 7), it is evident that the vulnerability index of the different external materials of the places to live as 1) Bahareque not plastered, Guadua, cane, mat, other plants, 2) No walls, 3) Rough wood, planks, board or 4) Zinc, fabric, coal, canister, disposals, plastic, grow at a rate of about 1.33, 1.28, 1, 26, 1.24 and 1.32 units faster than the vulnerability index of people who live in a house whose external materials are Blocks, bricks, stone, polished wood. On the other hand, it should be noted that the vulnerability index of people who live in houses whose external material is Blocks, bricks, stone, polished wood or prefabricated material is considerably much lower than that of other types of external materials.

Table 7. Differences between Vulnerability Index coefficients by type of external material of living place. Own elaboration

Type of External Material in the Living Place		Bahareque not plastered	Bahareque plastered	Blocks, bricks, stone, polished wood	Guadua, cane, mat, other plants	No walls	Prefabricated material	Rough wood, planks, board	Stepped wall, adobe	Zinc, fabric, coal, canister, disposals, plastic
		5,21	4,81	3,88	5,16	5,14	4,19	5,12	4,86	5,20
Bahareque not plastered	5,21	0,00								Difference < 0
Bahareque plastered	4,81	-0,40	0,00							Difference = 0
Blocks, bricks, stone, polished wood	3,88	-1,33	-0,93	0,00						Difference > 0
Guadua, cane, mat, other plants	5,16	-0,05	0,35	1,28	0,00					
No walls	5,14	-0,07	0,33	1,26	-0,02	0,00				
Prefabricated material	4,19	-1,02	-0,62	0,31	-0,97	-0,95	0,00			
Rough wood, planks, board	5,12	-0,10	0,30	1,24	-0,04	-0,02	0,93	0,00		
Stepped wall, adobe	4,86	-0,35	0,05	0,98	-0,30	-0,28	0,67	-0,25	0,00	
Zinc, fabric, coal, canister, disposals, plastic	5,20	-0,01	0,39	1,32	0,04	0,06	1,01	0,09	0,34	0,00

9. **ANOVA: Difference between the variances of the vulnerability indexes of the type of floor material of living place in Colombia:**

H_0: all the variances are equal and H_1: at least one of the variances is different

H_0: Cement, gravel index = Dirt, sand index = Marble index = Polished and lacquered wood, parquetry index = Rough wood, plank, board, other plants index = Rug or carpet from wall to wall index = Tile, vinyl, tablet, brick, laminate index

H_1: Cement, gravel index != Dirt, sand index != Marble index != Polished and lacquered wood, parquetry index != Rough wood, plank, board, other plants index != Rug or carpet from wall to wall index != Tile, vinyl, tablet, brick, laminate index

Our null hypothesis was rejected, and we have statistically significant evidence at $\alpha=0.05$ that there is a difference in variances of the index in the different types of floor material of living place in Colombia.

	Source	SS	DF	MS	F	p-unc	np2
0	P4015	716.484856	6	119.414143	16224.864209	0.0	0.387638
1	Within	1131.849469	153785	0.007360	NaN	NaN	NaN

To weigh the impact of this difference between the vulnerability indexes of the different types of residential flooring materials, we performed a WLS regression and found that the vulnerability index of each type of residential flooring material is significantly different. This means that if we compare two people in equal conditions in the other variables, but with a type of material such as 1) Cement, gravel, 2) Earth, sand, or 3) Rough wood, plank, table or other plants, They will have a

higher vulnerability index than that of people who live in a house whose material is Marble or Carpet or wall-to-wall carpet.

```
                            WLS Regression Results
    Dep. Variable:    indice              R-squared:       0.388
         Model:       WLS             Adj. R-squared:      0.388
        Method:       Least Squares      F-statistic:      1.622e+04
          Date:       Wed, 06 Jul 2022 Prob (F-statistic): 0.00
          Time:       23:56:45        Log-Likelihood:      1.5947e+05
No. Observations:     153792                  AIC:         -3.189e+05
  Df Residuals:       153785                  BIC:         -3.189e+05
     Df Model:        6
Covariance Type:      nonrobust
                                              coef  std err      t      P>|t|  [0.025 0.975]
                   Cement, gravel            0.4606 0.000  1298.905  0.000 0.460  0.461
                      Dirt, sand             0.5263 0.001   744.167  0.000 0.525  0.528
                        Marble               0.2713 0.004    69.871  0.000 0.264  0.279
Polished and lacquered wood, parketry        0.3443 0.002   145.860  0.000 0.340  0.349
Rough wood, plank, board, other plants       0.4884 0.001   553.125  0.000 0.487  0.490
           Rug or carpet from wall to wall   0.3353 0.005    68.261  0.000 0.326  0.345
           Tile, vinyl, tablet, brick, laminate 0.3445 0.000 1054.771 0.000 0.344  0.345
    Omnibus:       425.610  Durbin-Watson:   1.312
Prob(Omnibus): 0.000    Jarque-Bera (JB): 431.561
        Skew:        -0.123      Prob(JB):      1.94e-94
    Kurtosis:       3.081        Cond. No.      15.0

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

When establishing the differences between the coefficients of each type of material of the floors of the dwellings (Table 8), it is evident that the vulnerability index of the different materials changes considerably. Materials such as 1) Cement, gravel, 2) Earth, sand, or 3) Rough wood, plank, board or other plants, grow at a rate of 1.89, 2.55 and 2.17 additional units than the vulnerability index of people who live in a house whose floor material is Marble or wall-to-wall carpet. On the other hand, it should be noted that the vulnerability index of people who live in homes whose flooring material is marble or wall-to-wall carpet is, on average, 2 units lower than that of other types of flooring materials.

Table 8. Differences between Vulnerability Index coefficients by type of floor material of living place. Own elaboration

Type of floor material of the living place		Cement, gravel	Dirt, sand	Marble	Polished and lacquered wood, parketry	Rough wood, plank, board, other plants	Rug or carpet from wall to wall	Tile, vinyl, tablet, brick, laminate
		4,61	5,26	2,71	3,44	4,88	3,35	3,45
Cement, gravel	4,61	0,00						Difference < 0
Dirt, sand	5,26	0,66	0,00					Difference = 0
Marble	2,71	-1,89	-2,55	0,00				Difference > 0
Polished and lacquered wood, parketry	3,44	-1,16	-1,82	0,73	0,00			
Rough wood, plank, board, other plants	4,88	0,28	-0,38	2,17	1,44	0,00		
Rug or carpet from wall to wall	3,35	-1,25	-1,91	0,64	-0,09	-1,53	0,00	
Tile, vinyl, tablet, brick, laminate	3,45	-1,16	-1,82	0,73	0,00	-1,44	0,09	0,00

10. ANOVA: Difference between the variances of the vulnerability indexes for the type of ceiling material of the living place in Colombia:

H_0: all the variances are equal and H_1: at least one of the variances is different

H_0: Asbestos - cement tile index = Clay roof tiles index = Concrete, cement or concrete plate index = Metal tile or zinc sheet index = Plastic tile index = Straw, palm or other plants index = Waste material (fabric, cardboard, others) index

H_1: Asbestos - cement tile index != Clay roof tiles index != Concrete, cement or concrete plate index != Metal tile or zinc sheet index != Plastic tile index != Straw, palm or other plants index != Waste material (fabric, cardboard, others) index

Our null hypothesis was rejected, and we have statistically significant evidence at α=0.05 that there is a difference in variances of the index in the different types of ceiling material of the living place in Colombia.

	Source	SS	DF	MS	F	p-unc	np2
0	P4567	506.602069	6	84.433678	9677.514368	0.0	0.274086
1	Within	1341.732256	153785	0.008725	NaN	NaN	NaN

To weigh the impact of this difference between the vulnerability indexes of the different types of roofing materials in houses, we performed a WLS regression and found that the vulnerability index of each type of material in houses is significantly different. This means that if we compare two people under equal conditions in the other variables, but with a type of external material in their home such as 1) Straw, palm or other plants, 2) Waste material (fabric, cardboard, cans, plastic, others) and 3) Metal tile or zinc sheet, will have a higher vulnerability index than people living in a house whose roof material is Concrete, cement or concrete plate

```
                              WLS Regression Results
        Dep. Variable:    indice              R-squared:        0.274
            Model:        WLS             Adj. R-squared:   0.274
           Method:        Least Squares       F-statistic:      9678.
            Date:         Wed, 06 Jul 2022 Prob (F-statistic): 0.00
            Time:         23:56:46        Log-Likelihood:   1.4639e+05
    No. Observations: 153792                  AIC:          -2.928e+05
       Df Residuals:     153785               BIC:          -2.927e+05
         Df Model:       6
    Covariance Type: nonrobust

                                                      coef  std err     t      P>|t| [0.025 0.975]
                    Asbestos-cement tile            0.3994 0.000  916.486  0.000 0.399  0.400
                        Clay roof tiles             0.4026 0.001  505.051  0.000 0.401  0.404
            Concrete, cement or concrete plate      0.3121 0.001  546.350  0.000 0.311  0.313
                  Metal tile or zinc sheet          0.4649 0.000  1245.362 0.000 0.464  0.466
                        Plastic tile                0.4006 0.004  109.089  0.000 0.393  0.408
                  Straw, palm or other plants       0.5309 0.002  351.941  0.000 0.528  0.534
Waste material (fabric, cardboard, cans, plastic, others) 0.5071 0.005  93.407   0.000 0.496  0.518

       Omnibus:      1133.917  Durbin-Watson:    1.182
    Prob(Omnibus): 0.000       Jarque-Bera (JB): 1159.059
          Skew:     -0.213         Prob(JB):      2.06e-252
        Kurtosis:    3.011         Cond. No.      14.5

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

When establishing the differences between the coefficients of each type of material in the roofs of the houses (Table 7), it is evident that the vulnerability index of the roofing materials is significantly different. Materials like 1) Straw, palm or other plants, 2) Waste material (fabric, cardboard, cans, plastic, others) and 3) Metal tile or zinc sheet, grow at a rate of about 2.19, 1.95 and 1.53 units respectively faster than the vulnerability index of people living in a house whose roof material is Concrete, cement or concrete plate. On the other hand, it should be noted that the vulnerability index of people who live in homes whose exterior material is Concrete, cement or concrete plate is considerably much lower than that of other types of exterior materials.

Table 9. Differences between Vulnerability Index coefficients by type of external material of living place. Own elaboration

Type of Ceiling material of the living place		Asbestos - cement tile	Clay roof tiles	Concrete, cement or concrete plate	Metal tile or zinc sheet	Plastic tile	Straw, palm or other plants	Waste material (fabric, cardboard, others)
		3,99	4,03	3,12	4,65	4,01	5,31	5,07
Asbestos - cement tile	3,99	0,00						Difference < 0
Clay roof tiles	4,03	0,03	0,00					Difference = 0
Concrete, cement or concrete plate	3,12	-0,87	-0,91	0,00				Difference > 0
Metal tile or zinc sheet	4,65	0,66	0,62	1,53	0,00			
Plastic tile	4,01	0,01	-0,02	0,89	-0,64	0,00		
Straw, palm or other plants	5,31	1,32	1,28	2,19	0,66	1,30	0,00	
Waste material (fabric, cardboard, others)	5,07	1,08	1,05	1,95	0,42	1,07	-0,24	0,00

Conclusions:

In conclusion, the construction of this social vulnerability index has allowed us to understand that vulnerability is multidimensional, it is not limited only to economic conditions but is accompanied by social, emotional, physical, and technological implications, among others.

Additionally, the analysis of the data allowed us to show that there is greater vulnerability in women than in men. This vulnerability increases if the person identifies themself with an ethnic minority, especially as indigenous or Afro-Colombian. Likewise, people located in rural areas tend to be much more vulnerable than those located in municipal heads, due to the limited access to public services and other public infrastructures (health, education quality, etc.).

Similarly, people geographically located in regions such as the Pacific, Orinoco and Caribbean, have the highest vulnerability rates, contrary to what happens in the capital, where the lowest rates in the country are found. This can be explained by the centralist model of resources that Colombia has, in which all the country's resources arrive in Bogotá and are then redistributed throughout the country.

With regard to education, it is evident that the highest levels of education have the lowest social vulnerability indices and vice versa, people who did not have access to any education or acquired very low levels of education, have the highest vulnerability indices. Additionally, three very clear clusters are observed according to the level of education, which supports the previous point.

The workforce is one of the dimensions where greater vulnerability is observed in this age group. This is due to the fact that they lose appeal in the market as they age, they must accept poorly paid jobs, and many do not manage to retire due to the high rate of labor informality in the country.

There is evidence of a significant change in the index during the last 4 years analyzed, due to the effect of the pandemic on it. In many cases, in fact, the index decreased, as a result of the success of the emergency social programs implemented by the Colombian national government.

Other of the dimensions proposed in which older adults are more vulnerable is the use of ICTs, which, after the pandemic, has become very relevant and has become the main source of access to medical appointments, legal procedures, of work and so on, leaving them at a great disadvantage.

Finally, we understand that the worst possible scenario for an older adult in Colombia would be: being a woman, indigenous, living in a house with low-quality materials, not receiving income from work or pension, not having access to information and communication technologies, have no or very low level of education, live in the Pacific or Orinoquía-Amazonía region and live in a rural area of these regions. These factors should be the main focus of government social programs to reduce the existing gap with respect to social vulnerability in our elderly people.

Interface

The final front-end product is located in this link: https://dash-project-ds4a.herokuapp.com/ and features the following landing pages:

1. The first tab is a contextualization page in which we explain what social vulnerability is, why we should measure it in adults over 60 years old, and what was the methodology used for building the social vulnerability index. Additionally, this page shows a small "traffic light" with the results of the index (in terms of people) according to each established level (low vulnerability, medium vulnerability and high vulnerability) per year.
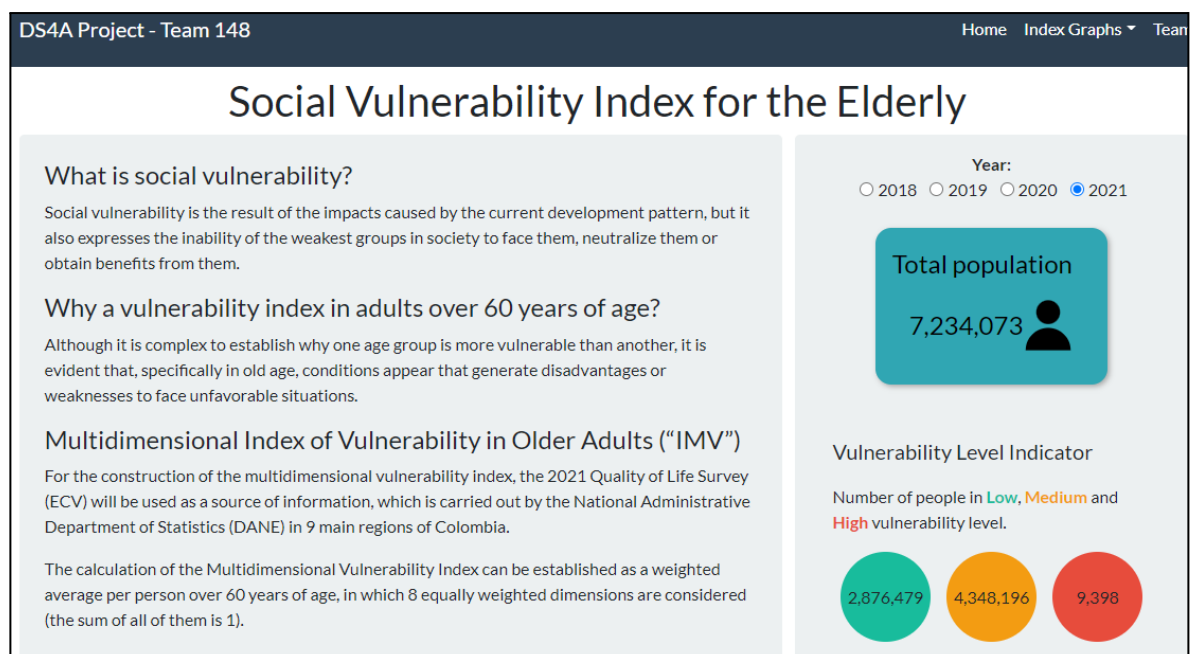
2. The second tab contains the most important graphs to describe the analysis of the data and to calculate the social vulnerability index. Some graphs correspond to a deeper multivariate analysis of the data, to understand what type of relationships exist between the chosen dimensions and variables. Additionally, this page contains the key metrics on social vulnerability in the elderly, correlation graphs to explain the impact of the most important variables on the index, and a geographic heat map with the most vulnerable regions in Colombia.
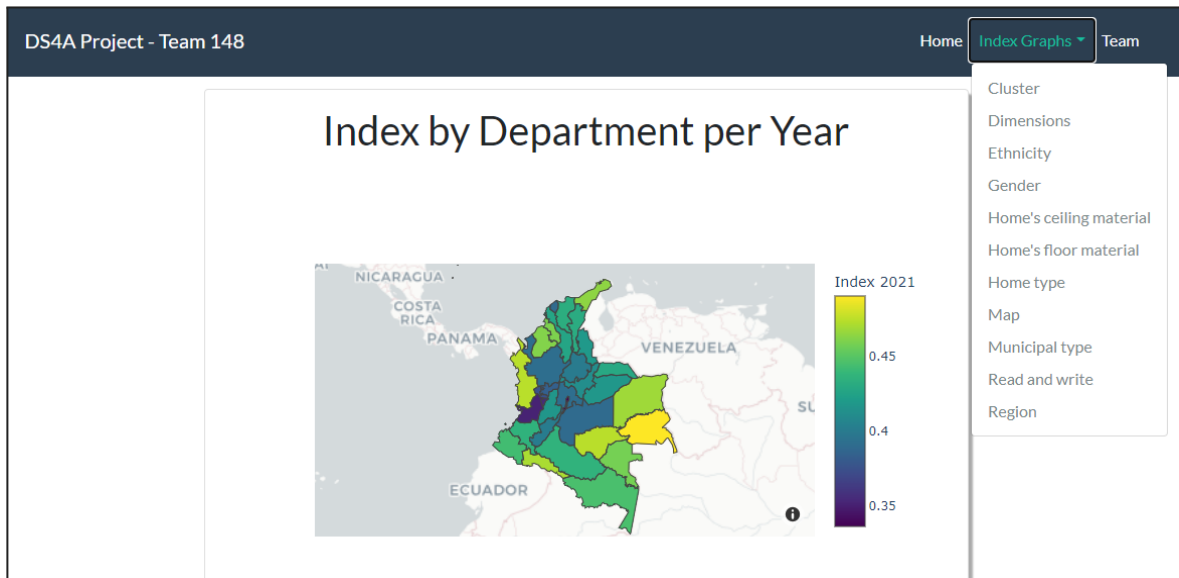
3. Finally, the third page contains a small presentation of each member of the team.