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# Glucose levels by age and body mass index in urban and rural areas of Venezuela

# Niveles de glicemia por edad e índices de masa corporal en zonas urbanas y rurales de Venezuela

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**Abstract**

**Introduction**: Urban and rural areas present differences in relation to lifestyle, which influences the presence of metabolic endocrine diseases and hyperglycemia. **Objective**: To compare blood glucose levels by age and Body Mass Indices in urban and rural areas. **Materials and methods**: A descriptive, cross-sectional and correlational study was carried out, from January to July of the year 2019, in urban and rural areas. A sample of 124 individuals from urban areas and 95 from rural areas were studied by intentional sampling; hyperglycemia screening was performed by capillary sample using a glucometer, in turn the following data were collected: weight, height, age and sex. The data were processed in the SPSS program (20), analyzed using frequencies, descriptive statistics, and inferential statistics at 95% confidence. **Results**: Higher glycemic values were observed in men (106.0 ± 29.2 mg / dL), without finding significant differences by sex; 63% had an age greater than or equal to 50 years; constituting the age group where higher blood glucose levels were observed (106.7 ± 30.3 mg /dL), showing differences between both groups. No glycemic differences were found according to the Body Mass Index. In urban areas, 26% of patients presented hyperglycemia (> = 101 mg / dL) vs 11.9% in rural areas. When comparing blood glucose levels according to the origin, they were higher in the urban area (106.9 ± 30.8 mg / dl). **Conclusion**: Blood glucose values were higher in the urban area, and the glycemia levels increased with older age.

**Keywords**: hyperglycemia, urban area, rural area, body mass index.

**Resumen**

**Introducción**: las zonas urbanas y rurales presentan diferencias en relación al estilo de vida lo cual influye en la presencia de enfermedades endocrinas metabólicas e hiperglicemia. **Objetivo**: comparar los niveles de glicemia por edad e índices de masa corporal en zonas urbanas y rurales. Materiales y métodos: Se realizó un estudio descriptivo, transversal de campo y correlacional, de enero a julio del año 2019, en zonas urbanas y rurales. Se incorporaron 124 individuos de zona urbana y 95 de zonas rurales, mediante un muestreo no probabilístico intencional; se realizó despistaje de glicemia, mediante muestra capilar con glucómetro, a su vez se recogieron los siguientes datos: peso, talla, edad y sexo. Los datos fueron procesados en el programa SPSS (20), analizado mediante frecuencias, estadísticos descriptivos, estadística inferencial al 95% de confianza. **Resultados**: se observó cifras mayores de glicemia en los hombres (106,0±29,2 mg/dL); sin encontrar diferencias significativas por sexo; el 63% tenían una edad mayor o igual a 50 años; constituyendo este último el grupo etario que presentó niveles mayores de glicemia (106,7± 30,3 mg/dL). No se encontraron diferencias de glicemia de acuerdo al índice de masa corporal. En las zonas urbanas un 26% de los pacientes presentó hiperglicemia (>=101 mg/dL) vs 11,9% en zonas rurales. Al comparar los niveles de glicemia de acuerdo a la procedencia, fueron mayores en la zona urbana (106,9±30,8 mg/dL). **Conclusión**: los valores de glicemia fueron más elevados en la zona urbana y a mayor edad aumentó los niveles de glicemia.

**Palabras clave**: hiperglicemia, medio urbana, medio rural, índice de masa corporal.

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## Introduction

The non-communicable chronic diseases (NCDs): diabetes, cardiovascular disease and cancer; they represent the leading cause of illness and premature death. There is a group of risk factors in the occurrence of these diseases, including an unhealthy diet, sedentary lifestyle, smoking, and alcohol consumption, which increase predisposition or directly cause most NCDs, being able to in turn, generate key metabolic / physiological changes for the development of: high blood pressure, overweight / obesity, hyperglycemia and hyperlipidemia, which are called risk factors and are themselves important causes of demand for health care (1).

The WHO points out that the obesity and overweight are considered public health problems, both in developed and developing countries, especially in urban areas (2). It is estimated that approximately 1.9 billion adults are overweight or obese worldwide. In this same context, in the last four decades the number of obesity in children and adolescents multiplied by 10, while the number of children under five years of age who were overweight rose to 38 million in 2017, representing an increase of eight million from the year 2000 to that period (3).

In this sense, the obesity is an increasingly prevalent disease and has rapidly become a nutritional problem worldwide, considering it as the global epidemic of the 21st century. The rapid increase in the figures for overweight and obesity are of great epidemiological importance, due to their chronic nature and their close

relationship with chronic non-communicable diseases (4).

In the last 30 years, cardiovascular diseases represent the causes of mortality, morbidity and disability, this product among other causes to the process of industrialization and changes in lifestyle, essentially due to less healthy habits, with more sedentary lifestyle and consumption of highly processed, which can lead to poor nutrition, among the problems of poor nutrition are overweight and obesity (5).

As for metabolic endocrine diseases related to hyperglycemic states, their prevalence has suddenly increased from 108 million individuals worldwide in 1980, to approximately 422 million by 2014, which represents a prevalence of 8.5%, and It is estimated that approximately 1.5 million deaths are directly caused by Type 2 Diabetes Mellitus and up to 2.2 million are attributable to some form of hyperglycemia (6).

In this particular, most chronic diseases are caused by unhealthy lifestyles, in fact, during the first years of adult life, there is a greater predisposition to acquire different habits in daily life that include, among others, the type diet, sedentary lifestyle, smoking, which later are difficult to modify (7).

The increase in industrialization, urbanization and mechanization that take place in most countries of the world is associated with changes in the diet and habits of its citizens; particularly, diets contain more and more foods rich in fats, energy and lifestyles are more sedentary. Changes in eating habits, as well as in physical activity, are the consequence of environmental and social changes associated with development and also of the lack of support policies in sectors such as: health, agriculture, transportation, urban planning, environment, food processing, distribution and marketing, and even education. (8)

Overweight and obesity have been shown to produce insulin resistance, which prevents glucose from entering the cell, causing an alteration of glycemia. Age is an important element to take into account when dosing blood glucose, although it depends in the first instance on the caloric intake of the diet and the metabolism of each individual. Aging has been shown to lead to decreased tolerance to glucose overload, and this is significantly related to postprandial glycemia (9).

The aging is the strongest known risk factor for diabetes mellitus and cardiovascular disease. Of the 30 million patients with diabetes mellitus, 12 million are over the age of 65 and represents> 25% of all people in this age group.5 If the current trend continues, it is projected that by 2050, 48 million people with diabetes mellitus, that is, more than half of all people with diabetes mellitus, will be in the age group> 65 years and similar trends are projected for the world population (10).

In a study whose objective was to determine the glycemic values and the risk of Diabetes in elderly patients of both sexes who attended the Multipharma Polyclinic of Hermelinda, by means of the biochemical examination of glycemia with the glucometer, revealed that there is a significant relationship between the age and body mass index. It was concluded that blood glucose levels are little influenced by sex, compared to age and body mass index, which are two important factors that are probably due to inadequate nutrition in patients, which would cause an increase in type 2 diabetes risk (11).

Similarly, a study carried out in Colombia, where risk factors associated with glycemic control and metabolic syndrome were studied in patients with Type 2 Diabetes Mellitus, concluded that there is no difference in glycemic control and the development of metabolic syndrome according to the geographical area studied (12), with the premise that the study was carried out in previously diagnosed hyperglycemic patients.

In a study carried out in Tinaquillo-Cojedes, Venezuela, on cardiovascular risk factors in urban and rural areas, it found the average glycemic levels close to the established standards, while 60% of individuals in the rural community were overweight and obese, similar values were found in the urban community, without finding statistically significant differences between the two populations (13).

In Venezuela, metabolic endocrine diseases rank first as a cause of mortality in the latest epidemiological records; It is relevant to compare blood glucose levels by sex, age and body mass index in urban and rural areas; to contribute to the knowledge about these chronic pathologies that affect the population. For all the aforementioned, the objective was set: to compare blood glucose levels by age and body mass indices in urban and rural

areas.

## Methods

The research was a descriptive, cross-sectional and correlational study, carried out from January to July of the year 2019, in urban and rural areas located in different states. The urban area corresponds to patients who come to the Casa de la Misericordia located in the city of Maracaibo municipality, Zulia-Venezuela state; and the participants of the rural area, are located in the Trujillo state in the Boconó and Trujillo-Venezuela municipalities, rural settlements whose main productive activity is agriculture.

The research carried out is achieved through inter-institutional, multidisciplinary collaboration, the Rotary Club of the state of Trujillo and the Dominican Sisters of La Presentation in Maracaibo, Maracaibo Municipality, Zulia State, entities involved in planning and logistics, to carry out screening and diagnosis. The activity is framed within the extension project called: Health intervention days: Medicine with the community, registered in the Extension Division of the Faculty of Medicine, LUZ, in 2017.

The sample was non-probabilistic with an intentional sampling and was made up of people who, of their own free will, agreed to join the investigation, for which they signed an informed consent. The call was made through the Catholic Church, community councils and the local media. A total of 219 individuals were incorporated, distributed as follows: 124 from the urban area and 95 from the rural areas; for the purpose of screening hyperglycemia in the population.

The inclusion criteria for participation were persons of legal age, of both sexes, without apparent pathology, who comply with the fast to perform the determination of blood glucose.

The interview was used as a data collection technique using a questionnaire that includes questions that sought to investigate through closed and multiple response options, epidemiological data and risk factors: geographic location, age, sex, weight, height, personal history of diabetes.

To determine fasting blood glucose levels, a capillary glucose sample was taken with a glucometer from the commercial company Suma Sensor.

In hyperglycemic screening, one of the diagnostic methods is the glucose tolerance test for 2 hours; however, for logistical reasons, capillary glucose determination with a glucometer was not performed and used. This ambulatory glycemic monitoring system is safe and without risk to health, presenting minor alterations in the number reported, being, from an epidemiological point of view, a rapid and low-cost screening test (14), whose Results altered or outside the normal parameters must be confirmed with other biochemical tests of greater sensitivity and specificity, together with the presence of the signs and symptoms of the patient and medical evaluation.

The procedure consists in that by means of a puncture in the previously aseptic thumb, a drop of blood was obtained to measure the capillary glycemia. Normal values between 80-99 mg / dL were considered, according to the equipment specifications. Any value outside the range was considered altered, either by decrease (hypoglycemia) or by increase (hyperglycemia).

In addition, the determination of weight was carried out, to identify the risk factor: obesity, using a portable scale and height was measured with a tape measure, attached to the wall under the same environmental conditions where the weight was taken (international standard procedures and with calibrated equipment). The body mass index (BMI) was calculated by dividing the weight by the squared height [BMI = weight (kg) / height (m) $^2$] and was classified according to the World Health Organization, (WHO, 2012) in: Low weight (<18.5 kg / m$^2$), normal (18.5 to 24.9 kg / m$^2$), overweight (25 to 29.9 kg / m$^2$) and obesity (> 30 kg / m$^2$).

The data obtained was processed with the SPSS version 20 program, analyzed using absolute and relative frequencies, as well as descriptive statistics and presented using tables. Inferential Statistics techniques were explored to identify any relationship. A $p < 0.05$ was considered statistically significant, taking into account the assumptions of normality in the parametric tests.

Among the ethical aspects considered, the participants were asked to sign the informed consent, the objectives, scope of the research

were explained, and the confidentiality of the data obtained was guaranteed. The research protocol and informed consent was approved and socialized with the community councils and the extension division of the Faculty of Medicine.

## Results

In the Table 1, higher glycemic values were observed in males (106.0 ± 29.2 mg / dL) compared to females (99.9 ± 27.1 mg / dL); however, when applying the statistical Student t test at 95% confidence, it was not possible to demonstrate statistically significant differences in blood glucose, yielding a value of p associated with the test> 0.05. When comparing the blood glucose variable according to the area geographic. It was observed that, in both sexes in urban areas, blood glucose values are higher (108.3 ± 34.6 mg / dL; in males and 106.5 ± 29.7 mg / dL in females); in relation to glycemia in rural areas.

**Table 1. Glycemia according to the sex. Urban and rural areas. Year 2019**

| Sex | n (%) | Glycemia * (mg/dL) Average ± SD | Glycemia (mg/dL) Urban area (n: 124) Average ± SD | Glycemia (mg/dL) Rural area (n: 95) Average ± SD |
|---|---|---|---|---|
| Male | 60 -23 | 106,0±29,2 | 108,3 ±34,6 | 104,6 ± 23,8 |
| Female | 159 -77 | 99,9±27,1 | 106,5 ± 29,7 | 90,0 ± 18,7 |

I.F: Questionnaire. * Blood glucose compared by the sex: Student T Test of: 1,44; p >0,05 (95% of confidence)

In the Table 2, 63% of the participants had an age greater than or equal to 50 years (63%); being the age group where higher blood glucose levels were observed (106.7 ± 30.3 mg / dL) than in those younger than 50 years (92.8 ± 19.8 mg / dL); When comparing the glycemic differences by age using the statistical t-student technique for independent samples, a p value of 95% confidence associated with the test <0.05 was obtained, demonstrating the glycemic differences according to the age group. On the other hand, when comparing the glycemia according to the area of origin, a predominance of higher glycemic levels was also observed in the urban area, in both age groups (98.8 ± 19.1mg / dL in ages younger than 50 years).

**Table 2. Glycemia according to the age. Urban and rural areas. Year 2019**

| Age (year) | n (%) | Glycemia * (mg/dL) Average ± SD | Glycemia (mg/dL) Urban area (n: 124) Average ± SD | Glycemia (mg/dL) Rural area (n: 95) Average ± SD |
|---|---|---|---|---|
| <50 | 80 -37 | 92,8±19,8 | 98,8 ± 19,1 | 85,9 ± 18,6 |
| >= 50 | 139 -63 | 106,7±30,3 | 111,2 ± 34,8 | 100,3 ± 21,4 |

I.F: Questionnaire * Blood glucose compared by the age: Student T Test of: -3,6; p <0,05 (95% of confidence)

In relation to the BMI (Table 3), people with normal weight predominated, in 51.5%; followed by overweight and obese patients, who together make up 42.8%. Regarding the mean glycemic values, the group of thin patients obtained higher figures in relation to this measurement (119 ± 49.1 mg / dL) compared to the other groups according to BMI. However, when comparing blood glucose levels according to the BMI classification categories, no differences were found by group, when applying the ANOVA statistical technique, at 95% confidence, obtaining a p value> 0.05.

In the same table 3, the mean and standard deviation of glycemia distributed according to the geographical area are presented. Higher blood glucose values were observed in urban areas in all BMI categories, except in the obese group, where blood glucose values were similar (104.2 ± 34.5 mg / dL, in urban areas vs 105.4 ± 17 , 9 mg / dL, in rural areas). When associating the BMI, with the geographical area applying Pearson's Chi2 (14.05), a p value of 95% was obtained: <0.05, demonstrating an association between the variables.

**Table 3. Glycemia according to the Body mass index.cUrban and rural areas. Year 2019**

| BMI (Kg/mts$^2$) | n (%) | Glycemia ** (mg/dL) Average ± SD | Glycemia (mg/dL) Urban area (n: 124) Average ± SD | Glycemia (mg/dL) Rural area (n: 95) Average ± SD |
|---|---|---|---|---|
| Thin (<=17) | 12 (5,5) | 119±49,1 | 125,8 ± 61,9 | 109,4 ± 26,3 |
| Normal (18-24) | 113 (51,5) | 99,0±25,1 | 105,8 ± 26,9 | 92,4 ± 21,4 |
| Overweight (25-29) | 63 (28,7) | 101,0±24,4 | 106,8 ± 25,7 | 94,0 ± 20,8 |
| Obese (>=30) | 31 (14,1) | 104,0±31,2 | 104,2 ± 34,5 | 105,4 ±17,9 |

I.F: Questionnaire. * Pearson's Chi2, BMI according to the geographical area: 14,05 p 95%:<0,05
** Blood glucose compared according to the BMI: ANOVA : 0,11; p >0,05 (95% of confidence)

Finally, the Table 4 shows the glycemic values grouped according to the reference values in: decreased, normal and hyperglycemia. In urban areas, 26% of patients with hyperglycemia (> = 100 mg / dL) were found vs. 11.9% in rural areas. When comparing the means of the glycemic values according to the origin, a higher figure was observed in the urban area (106.9 ± 30.8 mg / dL). When we tried to demonstrate the differences by means of the hypothesis tests by applying Student's t (test value: 3.2) to 95% confidence, a p value of <0.05 was obtained; demonstrating the difference in blood glucose values according to the geographical area. Similarly, by associating the glycemic variable according to the patient's area of origin, applying the Pearson's Chi2 test (test value: 14.05) to 95% confidence, a p value of <0.05 was obtained; demonstrating in the same way association between the glycemic values according to the geographical area of origin.

**Table 4. Glycemia by urban and rural areas. Year 2019**

| Categorized glycemic values ** | Urban area (n: 124) | | Rural area (n: 95) | |
|---|---|---|---|---|
| | n | % | n | % |
| Diminished (<80) | 8 | 3,7 | 20 | 9,1 |
| Normal (80-99) | 59 | 26,9 | 49 | 22,4 |
| High (>=100) | 57 | 26,0 | 26 | 11,9 |
| **Total** | 124 | 56,6 | 95 | 43,4 |
| **Average ± SD *Glycemia (mg/dL)** | 106,9±30,8 | | 94,7±21,5 | |

I.F: Questionnaire. * Blood glucose compared according to the geographical area: Student T Test of:3,2; p <0,05 (95% of confidence); * * Pearson's Chi2 of categorized glycemia according to the geographical area:14,05 p 95%:<0,05

## Discussion

The WHO Global Action Plan for the prevention and control of NCDs, has proposed for 2020 a relative reduction of 25% in premature mortality from cardiovascular diseases, and Diabetes mellitus 2; however, altered glycemia values are found in the sample studied in the apparently healthy general population, which constitutes an alarm sign that distances patients from the goal proposed by the WHO, which favors the appearance of future complications related to metabolic diseases, mainly in urban areas.

Regarding blood glucose values according to sex and age; higher glycemic values were observed in men (106.0 ± 29.2 mg / dL) from a descriptive point of view, but no differences were found by sex when applying hypothesis tests. These results are in contrast to those made by other researchers; (15) who describe that diabetes occurred mainly in the female sex, with the age group of 50-59 years being the most affected. In this last aspect, with reference to age, this work coincides with the present investigation, where glycemia with higher levels occurred at ages greater than or equal to 50 years (106.7 ± 30.3 mg / dL).

Regarding the BMI, it has been established by means of a logistic regression model that there is a relationship between blood glucose levels with the body mass index, where obesity contributes 4.5 times more to the risk of diabetes; On the other hand, in relation to age, this same study establishes that as age increases, the risk of diabetes mellitus also increases progressively (16). In this same order of ideas, another author found a correlation between fasting blood glucose level and body mass index, as it resulted in fasting blood glucose disorders (29%) occurring in 47, 5% of overweight people and 25% obese; however, although the difference was not demonstrated using statistical hypotheses, the blood glucose values were slightly above the reference values in the obese (17).

These results present conflicting positions to those of this study; Because the obtained values showed differences in blood glucose levels according to age (p <0.05 to 95% confidence), but not in relation to blood glucose levels according to BMI or sex (p> 0, 05 to 95%).

The fasting hyperglycemia constitutes a phase in the alteration of glucose metabolism, being a transitory condition and a risk factor for metabolic diseases; it is characterized by insulin resistance, which causes an increase in the synthesis and secretion of insulin and compensatory hyperinsulinism, capable of maintaining homeostasis for years. Globally, the prevalence of impaired fasting blood glucose is 15-25% (18), this finding is similar to that found in this research, with figures that are close to the prevalence range established by these researchers, finding that 26 % is hyperglycemic in urban areas vs. 11.9% in rural areas, always showing higher glycemic levels according to age, sex, and BMI, in urban areas over rural areas. A systemic review carried out in Peru indicates that the prevalence of diabetes in subjects in rural areas is 0.8%; 2.8% in rural to urban migrants, and 6.3% in urban areas. They refer cumulative incidence of 19.5 new cases per 1000 people per year, in the studied area (19).

The individuals in urban and rural populations have different lifestyles which vary according to their customs, culture and health education, eating habits and lack of physical activity, which may explain the increase in diseases metabolic disorders in urban populations, which can cause variations depending on the geographical area and the population group evaluated (20). These aspects were not directly investigated in this study; however, it was observed in relation to BMI, that patients in both urban and rural areas are 42.8% overweight and obese; however, this percentage is mainly at the expense of urban areas (28.2%).

The differences in blood glucose levels by area of origin were also demonstrated by different statistical techniques, favoring in all cases the glycemic figures in values closer to the reference values (80-99 mg / dL) in rural areas. This aspect differs from another study, which indicates that in rural areas due to socioeconomic patterns or access to health care, they may have inadequate management or control of diabetes, so it is recommended that research be carried out in these areas to obtain figures of the problem (21).

It should be noted that in this research, the main limitation is not to explore the relationship of other risk factors inherent in health behaviors and habits that may be associated with NCD, as well as fasting blood glucose levels. New lines of research are open to develop in this regard. Likewise, the screening carried out does not constitute a definitive diagnosis of diabetes, so it was recommended to those patients who were fasting and had high blood glucose levels, the need for a medical consultation to rule out the disease.

Despite the limitations found, relevant information was provided that may contribute to the development of preventive measures on the influence of age, sex and BMI on hyperglycemia; also allowing updating data on hyperglycemia in the urban and rural population.

## Conclusión

High fasting blood glucose levels were observed more frequently in urban than in rural areas; either by age, sex and BMI. Likewise, it was evidenced that age was associated with high glycemic values, however, no association was found between hyperglycemia and BMI, nor glycemic differences by sex.

## Conflict of interests

The authors have no conflict of interest.

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