Original research article

The relationship of Physical activity with prediabetes: A Cross-Sectional Study in Guanajuato, Mexico

ABSTRACT

Aims: The objective of this study is to analyze the association between low physical activity levels and the development of prediabetes in a population of adults aged 18-65, belonging to CAISES Pardo in Guanajuato, Mexico.

Study design: It was designed a cross-sectional study in adults from CAISES El Pardo of Guanajuato, México without Type II Diabetes.

Methodology. It was included 196 patients who signed the informed consent; in them, it was measured fasting glucose levels and capillary glucose; Body mass index was measured as a nutritional status. Physical activity was measured with international physical activity questionnaire. The sample size calculation was assuming that 73.9% of individuals with mild physical activity develop prediabetes, and those with moderate to vigorous physical activity develop it in 53%, the minimum sample size required is 92 for those with mild physical activity and 92 for those with moderate to vigorous physical activity, with 95% precision and 80% power. The statistical analyses were with Chi-squared test and *P*-value, and then OR (CI95%).

Results: It was a relationship between physical activity mild and prediabetes X^2= 54.43, df 1, *P*=.0001, and strong effect with OR= 16.56, CI95% 6.98 a 39.26. Age shown a confounding effect in the relationship between physical activity level and prediabetes.

The results showed a strong association between low physical activity levels and prediabetes, as well as a significant correlation between plasma glucose levels and capillary glucose levels. It was observed that most of the population is overweight or obese, with a predominantly female demographic.

Conclusion: Diabetes is known to be a significant health problem with high morbidity and mortality rates, underscoring the importance of implementing measures for its prevention, screening, and early detection. This study provides relevant information on the subject and emphasizes the need for implementing programs, training, and measures to reduce new cases of non-communicable chronic diseases and effectively manage existing ones.

Keywords: Body Mass Index (BMI), Diabetes, Obesity, Overweight, Physical Activity, Prediabetes.

1. INTRODUCTION

According to the National Health and Nutrition Survey (ENSANUT 2022), in Mexico, 75.2% of adults aged 20 and older are overweight or obese (1); we can infer that this is the result of a combination of factors predisposing individuals to this condition, including a calorie-rich diet, low fiber intake, and physical inactivity.

Engaging in physical activity improves quality of life and contributes to people's well-being by enhancing their health (2). Therefore, the absence of physical activity predisposes us to various diseases, primarily metabolic ones, among which this study focuses on type 2 diabetes.

Diabetes represents one of the most significant health problems in Mexico and is considered an epidemic with an exponential increase. According to the National Institute of Statistics, Geography, and Informatics (NISGI), diabetes ranked second among the top 5 causes of death in 2022.

In pursuit of early detection to prevent the disease, the latest ADA recommendations recognize individuals with elevated glucose levels who have not been diagnosed with diabetes but are at high risk of developing it—this is known as prediabetes. Prediabetes is identified by a Fasting Plasma Glucose (FPG) level ranging from 101 to 125 mg/dL (5.6-6.9 mmol/mol/L) (3).

Timely detection of prediabetes cases allows for diabetes prevention or, in other cases, delaying its onset.

This research aims to detect prediabetes cases among individuals who exhibit the following risk factors: aged 18-65 years, reported low levels of physical activity according to the International Physical Activity Questionnaire (IPAQ) short form, and indicative plasma glucose levels of prediabetes. The goal is to demonstrate the association between these variables.

2. METHODOLOGY

The study design was a cross-sectional, quantitative, and analytical, with the universe of 200 patients with age between 18-65 years old, who attend to CAISES Pardo de Guanajuato, Gto., from Institute of Public Health from Guanajuato State (IPHGS); the time of the study was between February and March 2024.

A simple random sampling was conducted among adults attending CAISES, and they were invited to participate.

The selection criteria were:

Inclusion criteria, participants with age between 18 and 65 years old, who signed the informed consent. The non-inclusion criteria participants with age less than 18 years old or adults over 65 years old. Participants with diagnosis of Type II diabetes. Elimination criteria were that participants did not complete all procedures in the study.

2.1 Variables

2.1.1 Sociodemographics

Age, sex, weight (kg), stature (cm), Body Mass Index (kg/m2), civil status, occupation

2.1.2 Independent

Physical activity is a quantitative variable; it is the movement of the body; it is measured in METS/min/week, by the International Physical Activity Questionnaire

Level of Physical activity is a categorical variable; it is the physical activity classified in levels; it is measured as low (0-599 METS/min/week), moderate (600-2999 METS/min/week), and vigorous (3000 or higher METS/min/week).

2.1.3 Dependent

Fasting capillary glucose (mg/dl) is a quantitative variable. It is the glucose in capillary fasting; it is measured in mg/dl.

Fasting plasma glucose (mg/dl) is a quantitative variable. It is the glucose in plasma in fasting; it is measured in mg/dl.

Prediabetes is a categorical dichotomic variable. It is the plasmatic glucose between 101-124 mg/dl; it is measured as yes or not.

2.2 Instruments

The IPAQ in its short version consists of 3 questions about the number of days per week spent doing vigorous, moderate, and mild physical activities, and 3 questions about the minutes per day spent on these activities. Vigorous activities are multiplied by the constant 8, days per week, and minutes per day; for moderate activities, the constant 4 is multiplied by days and minutes; and for mild activities, 3.3 is multiplied by days and minutes. The scores from these three categories are summed up, and classified as follows: 0-599 indicates low activity, 600-2999 indicates moderate activity, and 3000 or higher indicates high activity. Its reliability is 0.88 for Latin America (4).

2.3 Procedures

Adults who attended CAISES between February and March 2024 were informed about the research objectives and invited to participate, requesting their signature on the informed consent form. Data such as weight, height, and capillary blood glucose were collected, the IPAQ was administered, and they were offered fasting plasma glucose testing, which was processed by the GHG, and it was obtained a sample of capillary blood and processed in glucometer.

Following the blood sample collection from the participants, these were transported to the General Hospital of Guanajuato (GHG) for processing and subsequent reporting of results.

2.4 Calculation of Sample Size

Assuming that 73.9% of individuals with mild physical activity (5) develop prediabetes, and those with moderate to vigorous physical activity develop it in 53% (6), the minimum sample size required is 92 for those with mild physical activity and 92 for those with moderate to vigorous physical activity, with 95% precision and 80% power (Epi Info® 2021 version 7.2.50; CDC, Atlanta, GA, USA).

2.5 Statistical analysis

The statistical analyses proposed was descriptive statistics of the variables and inferential statistics between physical activity and fasting capillary and plasma glucose level were conducted using Chi-square and P-value; Odds Ratios and 95% Confidence Intervals were calculated.A multivariable logistic regression model including all variables was generated.The alpha level was set at 0.05 for all analyses.Statistical analysis was performed using Stata 13.0 (Stata Corp., College Station, TX, USA).

3. RESULTS AND DISCUSSION

From the sample of 200 participants, 4 were excluded because their fasting plasma glucose determination exceeded 125 mg/dL. Among the remaining 196 participants, the average age was 46.65 ± 15.77 years, the average weight was 72.78 ± 5.77 kg, BMI was 28.86 ± 5.82 kg/m², average physical activity was 927.99 ± 1276.00 METS/minute/week, capillary blood glucose was 96.42 ± 15.25 mg/dL, and plasma glucose was 97.61 ± 16.23 mg/dL (Table 1).

Table 1 Distribution of quantitative variables of the participants(n=196)

Variable	Range	Mean ± Standard Deviation
Age (years)	18 a 65	46.63 ± 15.09
Weight (kg)	40.4 a 145.2	72.78 ± 15.77
Height (mts)	1.4 a 1.82	1.59 ± 0.08
BMI (kg/m^2)	16.57 a 51.44	28.86 ± 5.82
Physical Activity (METS/min/week)	0 a 8472	927.99 ± 1276.00
Capillaryglucose (mg/dl)	65 a 127	96.42 ± 15.25
FPG (mg/dl)	61 a 124	97.61 ± 16.23

BMI: Body Mass Index, **FPG:** fasting plasma glucose
Source: Own design

Among the participants, women predominated with 79.08%, with the marital status of "married" at 37.24%, and "housewife" as the occupation for 46.43%. 65.82% had low physical activity levels (less than 600 METS/minute/week), and 92 individuals had plasma glucose levels corresponding to prediabetes (Table 2).

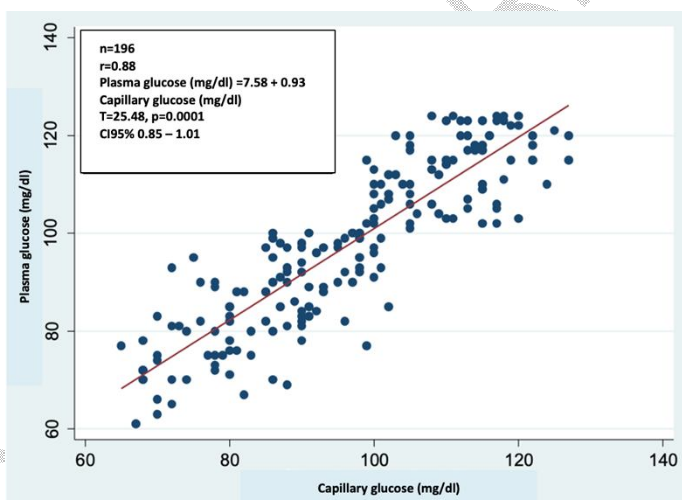
Table 2 Distribution of categorical variables of the participants(n=196)

Variable	n=196	%
Sex		
Man	41	20.92
Woman	155	79.08
Civil Status		
Single	54	27.55
Married	73.	37.24
Free Union	44	22.45
Divorced	13	6.63
Widowed	12	6.12
Occupation		
Housewife	91	46.43
Student	11	5.61
Full time worker	52	26.53
Half time worker	20	10.20

Unemployed	8	4.08
Retired	10	5.10
Other	4	2.04
Family history of diabetes		
Yes	115	58.67
No	81	41.33
Physical Activity		
High	29	14.80
Moderate	38	19.39
Low	129	65.82
Prediabetes		
Yes	92	46.94
No	104	53.06

Source: Own design

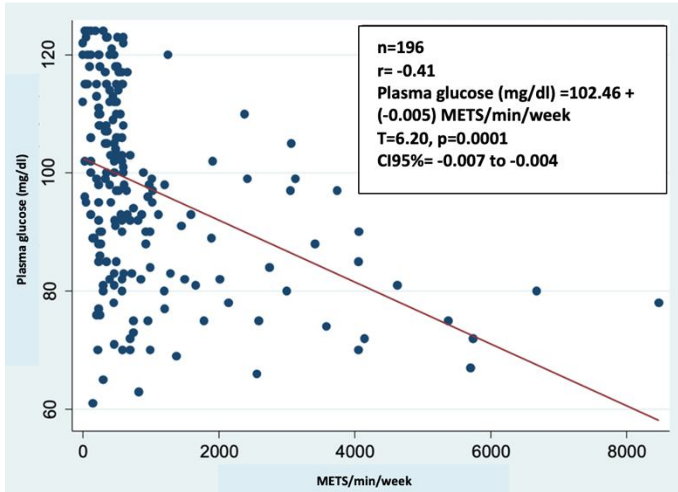
In Figure 1, a r Pearson correlation of 0.88 is shown, indicating a significant linear relationship (P = .0001) between capillary blood glucose (mg/dL) and plasma glucose (mg/dL).



Source: Own design

Figure 1 Correlation between plasma glucose and capillary blood glucose

In Figure 2, a moderate negative correlation is shown, with a Pearson's r of -0.41, indicating a significant negative linear relationship (P = .0001) between physical activity (METS/minutes/week) and plasma glucose level (mg/dL).



Source: Own design

Figure 2 Correlation between the physical activity level and plasma glucose (mg/dl)

When tabulating physical activity with prediabetes diagnosis, a significant association between both variables is found (P = .0001) (Table 3).

Table 3 Association of physical activity level with prediabetes by plasma glucose

	Prediabetes (>100 to125 mg/dl)		**Without prediabetes (<100 mg/dl)**		**X^2**	**DF**	***P*-Value**
	n	**%**	**n**	**%**			
Low Level of Physical Activity (<600 METS/min/week)	85	65.89	44	34.11	54.43	1	.0001
Moderate/High Level of Physical Activity (>600 METS/min/week)	7	10.45	60	89.55			

DF= Degree of freedom
Source: Own design

When evaluating the effect of physical activity on the diagnosis of prediabetes, a strong effect of physical activity was found with an Odds Ratio (OR) of 16.56, indicating that participants diagnosed with prediabetes had nearly 17 times higher odds of having a low level of physical activity (Table 4). The variables "Age" and "BMI" showed a confounding effect on the relationship between physical activity and prediabetes diagnosis, reducing the OR to 10.58, but still reflecting a strong effect.

Table 4 Logistic regression models with confounding variables

	PreD/PA	PreD/PA/Age	PreD/PA/BMI	PreD/PA/Age/BMI
OR	16.56	14.59	12.37	10.58
CI95%	6.98 a 39.26	6.08 a 35.02	5.00 a 30.58	4.21 a 26.61
LRT	60.54	6.79	21.90	29.18
P-Value	.00001	.009	.00001	.00001

PreDPrediabetes PA Physical activity BMI Body mass index OR Odds Ratio CI95% Confidence intervals 95% LRT Likelihood Ratio Test

Source: Own design

Table 1 highlights that the mean age in the studied population was 46.65 with a standard deviation (SD) of ±15.11, and a mean BMI of 28.86 with a SD of ±5.82, indicating overweight-obesity status. According to Campos Nonato et al., analyzing data from 8,563 participants aged 20 years and older, the prevalence of overweight in Mexico was 38.3% and obesity was 36.9% (with 41.0% of this in women); furthermore, comparing by age groups, the prevalence of obesity was highest in adults aged 40-59 years (44.4%) (7).

Table 2 shows that within the studied population, most participants were female (79.08%), married (37.24%), and homemakers (46.43%). Many had first-degree family history of diabetes and/or hypertension. Additionally, 65.82% of participants had low physical activity levels, consistent with data reported by INEGI in the Physical Activity and Sports Practice Module (MOPRADEF) 2023, which mentioned a decrease in the active population percentage from 42.1% in 2022 to 39.8% in 2023 (8).

Table 3 presents the association between low physical activity level and prediabetes development, showing that out of 129 participants with low physical activity, 65.89% had plasma glucose levels indicative of prediabetes (100-125 mg/dL), while among the 67 participants with moderate/vigorous physical activity, 89.55% reported plasma glucose levels below 100 mg/dL. A p-value of .0001 was obtained from the chi-square test, indicating a significant association between both variables. This coincides with the premise of results observed in the randomized trial conducted by the Diabetes Prevention Program (DPP), where 27 centers evaluated whether lifestyle intervention and pharmacological intervention would prevent or delay the onset of diabetes in patients with glucose intolerance; It was found that metformin reduced diabetes incidence by 31%, while lifestyle intervention reduced it by 58%, including measures such as achieving a 7% initial body weight loss and engaging in moderate physical activity for 150 minutes per week (9).

The Da Qing study may face challenges in comparability with our study due to its educational intervention being influenced by food scarcity (10). It was a 6-year intervention study involving diet and exercise (alone or in combination) designed to investigate the development of diabetes in an adult population of 577 subjects with impaired glucose tolerance. At the end of the follow-up, the lifestyle intervention group showed a 42% lower incidence of diabetes (11).

Figure 2 reinforces the previous paragraph by showing a negative linear correlation, Pearson's r of -0.41 (P = .0001), between physical activity level (METS/min/week) and plasma glucose (mg/dL).

This underscores the importance of physical inactivity as a risk factor for developing chronic non-communicable diseases, knowing that integrating physical exercise into lifestyle is a low-cost intervention that promotes and improves cardiovascular health.

Table 1 allows us to observe the similarity of data obtained from capillary and plasma glucose, showing an average plasma glucose of 97.61 ± 16.23 mg/dL and an average capillary glucose of 96.42 ± 15.25 mg/dL.

This is corroborated by Figure 1, which presents a r Pearson correlation coefficient of 0.88 and a significant linear relationship (P = .0001) between both variables. This aligns with Esquivel Molina et al., who found a Pearson correlation of 0.9797 between glucose data obtained through plasma and capillary glucose measurements using reflectometry (12).

In contrast, Arias Rivera et al., evaluated the reliability of capillary blood glucose compared to arterial blood glucose and plasma glucose (considered the "gold standard"), concluding a statistically significant difference with a systematic error of 11 mg/dL between capillary and plasma glucose values (13).

Understanding this information enables its beneficial use in primary care settings, where one of the main objectives is timely detection and prevention of diseases. This is achieved through the implementation of screening and early detection programs, dissemination of information, and training of personnel to address this issue appropriately.

4. CONCLUSION

Non-communicable chronic diseases constitute a significant health problem that impacts not only the population's quality of life but also exerts a strong economic burden on the country due to their detection mostly when complications arise.

In conclusion, this research provides evidence of the current situation regarding the quality of life of a specific population, highlighting the benefits that a lifestyle change can offer. It serves as a guideline for making relevant changes in local programs and intervention measures to improve the physical activity levels of the population and consequently reduce the incidence of non-communicable chronic diseases.

CONSENT

All participants signed the informed consent form, before to participate in the research.

ETHICAL APPROVAL

The protocol was reviewed and approved by the Ethics Committee for Research from Hospital General San Luis de la Paz.

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