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Prevalence of Risk Factors for Cardiovascular Disease and Type II Diabetes in Females within the Slum Nuevo Jerusalen, Peru

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Abstract

Background: Cardiovascular disease (CVD) and type II diabetes (T2D) are the leading causes of death worldwide, including those within developing countries. Few studies have measured the prevalence of risk factors for CVD and T2D within Latin America and even fewer have focused on socioeconomically depressed populations within Peru. To our knowledge, no previous study has measured the prevalence of obesity, elevated blood pressure, and elevated blood glucose within Nuevo Jerusalen, a slum community on the outskirts of Trujillo, Peru. This paper reports the results of two studies, a pilot study and an observational study, within the Nuevo Jerusalen community. The objective of these studies was to determine the prevalence of risk factors for CVD and T2D and to characterize the prevalence in terms of low-socioeconomic status.

Materials and methods: The observational study of 103 subjects (91 females and 12 males) was performed on residents of Nuevo Jerusalen, Peru in 2013. Three of the risk factors for CVD and T2D (obesity, elevated blood pressure, and elevated blood glucose levels) were evaluated on all subjects according to World Health Organization (WHO) criteria. Within the observational study, only the data on non-pregnant females (n=90) were evaluated and presented. The pilot study, which was conducted in 2011, collected more detailed information regarding socioeconomic status and dietary habits of Nuevo Jerusalen residents, which was useful in suggesting a context for the prevalence of risk factors for CVD and T2D.

Results: The prevalence of obesity, elevated blood pressure, and elevated blood glucose levels was found to be significant when compared to the 2008 Peruvian national averages. Specifically, the prevalence of obesity based on body mass index (BMI) was 30%. The prevalence of elevated blood pressure was 13.3%. Finally, the prevalence of elevated blood glucose levels was 17.9% based on the criteria used for the data collected.

Conclusion: These studies show a significant prevalence of three risk factors for CVD and T2D within females of the slum Nuevo Jerusalen, Peru. Further observational studies are needed to confirm these findings and to further investigate the prevalence rates in both sexes. Additional studies may also help develop preventive and interventional strategies to treat underserved people within the region.

Keywords

Cardiovascular Disease, Diabetes, Obesity, Blood Pressure, Blood Glucose, Peru, Nuevo Jerusalen

Abbreviations

NCD: Non-communicable Diseases, CVD: Cardiovascular Disease, T2D: Type II Diabetes, BMI: Body Mass Index, WHO: World Health Organization, NIH: National Institutes of Health

Introduction and Objective

Non-communicable diseases (NCDs) account for more than 36 million deaths worldwide [1]. The main categories of NCDs are cardiovascular disease (CVD), cancer, respiratory disease, and diabetes [2]. NCDs disproportionally affect low and middle-income countries, which account for nearly 80% of all NCD related deaths [3]. NCDs also disproportionally affect older age groups (above the age of 60) [3]. Within "premature" deaths (below the age of 60), 90% occur in low and middle-income countries [3]. Hence, people of all age groups, and especially low-income individuals, are vulnerable to NCDs, many of which are due to unhealthy diets, tobacco use, alcohol consumption, or lack of physical activity [4].

NCDs are positively correlated with increasing age, rapid urbanization, and unhealthy lifestyle choices [5]. For instance, populations that consume unhealthy diets rich in fats and carbohydrates or use excess tobacco and alcohol are more likely to have physiological changes associated with increased mortality [5]. Such physiological changes include obesity, elevated blood pressure, and elevated blood glucose levels that account for 5%, 16.5%, and 6% of global deaths, respectively [5].

A rise in NCDs and NCD-related deaths in low and middle-income countries has been linked to the number of low-income individuals in a population [6]. It has been postulated that these mortality rates are primarily a result of the lack of healthcare access for these low-income individuals in treating their health issues, which often arise from lifestyle decisions such as tobacco use, alcohol ingestion, and unhealthy food consumption [6]. In such regions, impoverished individuals have few resources for the lengthy and expensive treatments for NCDs such as CVD and T2D [6].

Peru is considered a low to middle-income country [7]. Across Peru, there is a wide disparity in income levels especially when comparing city residents to rural and slum residents [8]. This paper

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focuses on people within the slum Nuevo Jerusalen, which is located on the outskirts of Trujillo, the capital city of the coastal northwestern La Libertad Region of Peru. The total population of Nuevo Jerusalen is undocumented, but is estimated by locals to be 500 to 1000 people. Each household consists of nuclear families with 3-5 children. The families live in small, single-story thatched houses, with sand floors and plastic ceilings.

In Nuevo Jerusalen, mothers typically remain at home to care for the children while fathers work as manual laborers and street vendors in the city of Trujillo. We have found that each household typically earns just enough income to purchase necessities such as food, water, shelter, and clothing. Many children can read Spanish and do basic mathematics; however, parents frequently complain that the local public school facilities are under-resourced and overcrowded. Taken together, it is evident that the people of the Nuevo Jerusalen slum have limited resources and earn a significantly lower income than the Peruvian national average [9].

Since a rise in NCDs has been a trend in impoverished communities, especially within low to middle-income countries, it is of epidemiological importance to determine whether the slum Nuevo Jerusalen would have a high prevalence for risk factors. Since there is a lack of observational studies within Peru, especially among people of lower socioeconomic status, the objective of these studies was to determine the prevalence of risk factors for CVD and T2D in Nuevo Jerusalen. In addition to characterizing risk, the results of these studies will also be useful in suggesting possible strategies for the prevention of NCDs within the community.

Methods and Guidelines

2013 observational study

All subjects of the 2013 observational study were men and women above the age of 16 from Nuevo Jerusalen, Peru who came to a clinic (August 2013) and agreed to be interviewed, measured, and tested. Before the medical services, each subject filled out a medical questionnaire for background information such as age, gender, and previous medical history. Upon completion, vitals and three risk factors for CVD and T2D were measured: obesity, elevated blood pressure, and elevated blood glucose. As the male population of this study was too small a sample size for statistical analysis, the female population was exclusively analyzed according to WHO standards. All subjects provided informed consent.

Obesity

Two methods of assessing obesity were used, namely general obesity by Body Mass Index (BMI) and central/abdominal obesity by waist-to-hip ratio. BMI is an accepted clinical standard by WHO by determining the ratio between height and weight. In this study, a digital weighing scale was used to measure the weight of each individual, and a standard stadiometer was used to determine the height. Subjects BMIs were then calculated and subjects were then classified into their respective weight statuses [10].

For central obesity, the waist-to-hip ratio was determined. A stretch-resistant tape was used for the body measurements as per the WHO STEPwise Approach to Surveillance (STEPS) [11]. The waist and hip measurements were taken twice and averaged. While WHO STEPS protocol advocates a standard "100 g of tension" at which to measure circumference to ensure uniformity, the specific apparatus to measure this tension was not used. This is expected to contribute a very minor source of error because the measuring tape was consistently laid directly over the skin without tightening. Waist-to-hip ratios were stratified according to the WHO standards [11].

Blood pressure

Blood pressure was determined by using a standard analog sphygmomanometer on the upper left arm of each individual. Patient blood pressures were stratified into groups based on standards of WHO [12].

Blood glucose levels

An OneTouch Mini® glucometer and the compatible glucose strips were used to test fasting and random blood glucose levels. Before drawing the blood sample, the time of last food/drink intake as well as the pregnancy status of the individual was recorded for each subject. Results were analyzed on non-pregnant patients according to WHO standards [13].

WHO standards

BMI-based obesity is classified with a BMI greater than or equal to 30 (kg/m^2) [10]. Central obesity for a Peruvian woman is classified as a waist-to-hip ratio greater than 0.85 [11]. Elevated blood pressure is defined as systolic blood pressure greater than or equal to 140 mm Hg diastolic blood pressure greater than or equal to 90 mm Hg or previously diagnosed hypertension with medication [12]. Elevated blood glucose levels are classified as greater than 100 mg/dL (fasting for 8 hours or more), greater than 140 mg/dL (fasting for 2-8 hours), and greater than 200 mg/dL (meal within 2 hours of test; post-prandial), which is indicative of impaired glucose homeostasis [13].

Analysis

Prevalence rates for BMI obesity, central obesity, elevated blood pressure, and elevated blood glucose levels were determined according to WHO standards. Within this paper, the WHO standards were used to compare the prevalence of risk factors in the Nuevo Jerusalen population to that of Peru. Statistical significance was calculated using a two-tailed binomial test in SAS software with national Peruvian prevalence statistics as the baseline for each risk factor.

2011 pilot study

In 2011, a pilot study was conducted with a cohort of 14 females from the Nuevo Jerusalen community. In contrast to the 2013 observational study, the primary objective of the pilot study was to obtain basic physical and lifestyle-related information about the women regarding their health status. This information consisted of age, height, weight, hip circumference, waist circumference, and blood glucose levels. Additional questions included daily diet, daily activities, daily water consumption, monthly income, average cost per meal, most concerning diseases, and most pressing problems within the community. Hence, the 2011 pilot study provided key information to characterize the social background for the risk factors of NCDs in the 2013 study, and it also provided context to evaluate possible intervention options.

Results

2013 Observational study: prevalence of each risk factor for CVD and T2D

In a cohort of 90 non-pregnant females of Nuevo Jerusalen, the prevalence of central obesity, BMI obesity, elevated blood pressure, and elevated blood glucose levels was 90%, 30%, 13.3%, and 17.9% respectively according to WHO guidelines for the 2013 observational study. Figure 1 compares the prevalence of each risk factor from Nuevo Jerusalen to that of Peruvian national average.

2013 Observational study: prevalence of risk factors by age group

It is well-documented that NCDs disproportionally affect older age groups [14]. The 2013 observational study also indicated that as the age group increased, the prevalence of obesity, elevated blood pressure, and elevated blood glucose levels increased as well (Figure 2). An increase in the prevalence of obesity and elevated blood glucose was noted in the 30-39 age range, while an increase in the prevalence of elevated blood pressure and blood glucose was noted in the 40-49 age range. All the three risk factors reached maximal prevalence in the 50+ age range.

Comparing 2013 Observational study and 2011 Pilot Study

Within the 2013 observational study, 103 members (90 females)

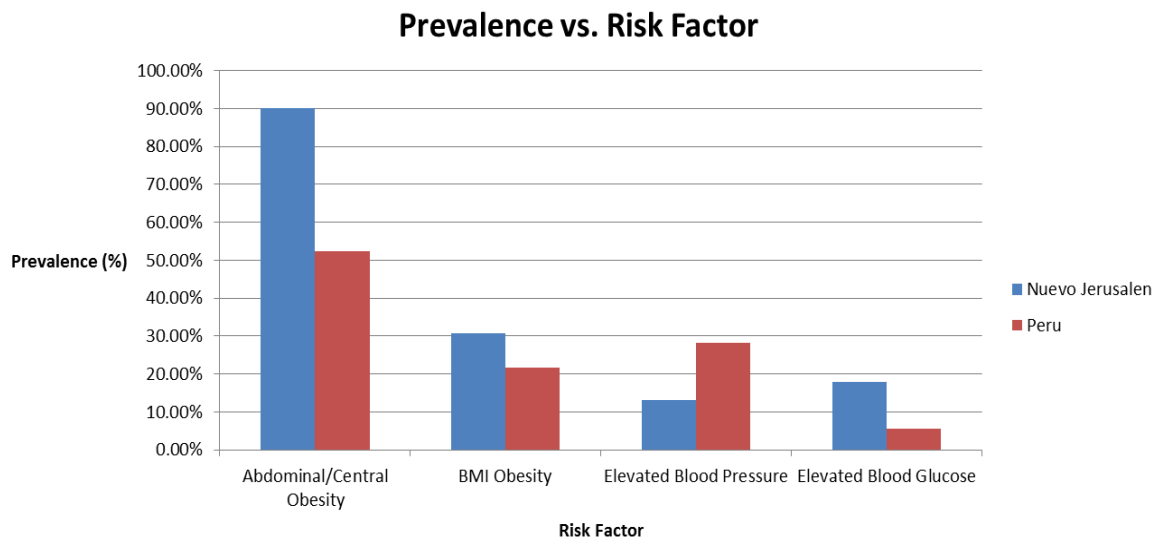

Figure 1: The prevalence of each risk factor for CVD and T2D for females within the 2013 observational study. Comparison rates for prevalence of BMI obesity, elevated blood pressure, and elevated blood glucose are based on females by WHO guidelines for entire country of Peru [16]. Comparison rates for prevalence of abdominal/central obesity are based on females by ATP III guidelines for Peru [22].

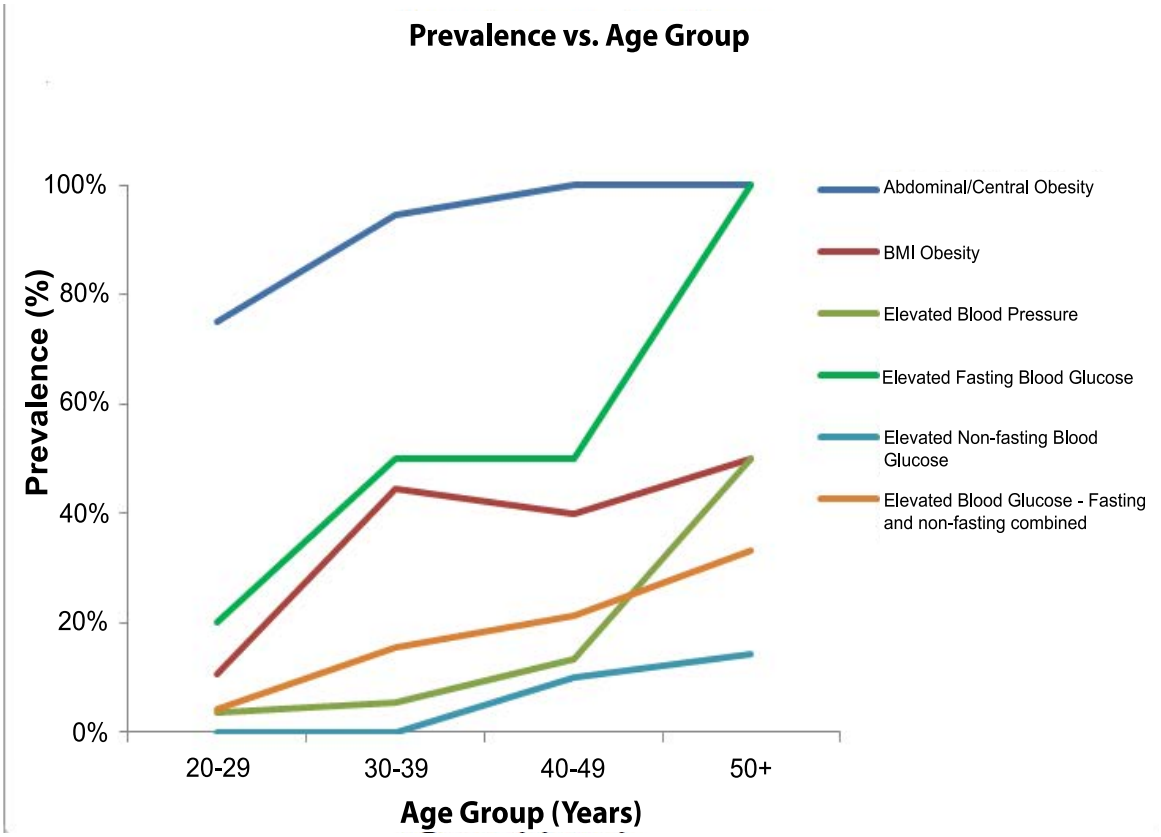

Figure 2: The prevalence of different risk factors for CVD and T2D for females vs. age group within the 2013 observational study

of the Nuevo Jerusalen population were tested for three risk factors for CVD and T2D. Within the 2011 pilot study, 14 female members of the Nuevo Jerusalen population were tested for biometric data (Table 1) and were given detailed questionnaires regarding income, food habits, and lifestyle (Table 2).

On average, the height, weight, BMI, and waist-to-hip ratio for females in the 2013 observational study and females in the 2011 pilot study were not considerably different. Notable differences between the two studies were the average age of females and the total sample size. The 2011 pilot study provided meaningful information regarding lifestyle and income within this community. The 2013 observational study obtained prevalence rates for three risk factors for CVD and T2D. Hence, the 2013 observational study and the 2011 pilot study

Table 1: Comparison between 2013 Observational Study and 2011 Pilot Study

	2013 Observational Study	2011 Pilot Study
Sample Size	103	14
Number of Females Analyzed	90	14
Average Age (years)	40	32.4
Average Height (cm)	150.6	149.7
Average Weight (kg)	62.8	60.2
Average BMI (kg/m^2)	27.7	26.4
Average Waist/Hip Ratio	0.948	0.933

Table 2: 2011 Pilot Study results showing a breakdown of the 14 females studied by biometric, financial, and nutritional data gathered from a standard questionnaire

Subject #	Age (yrs)	BMI	Waist/hip	Blood Glucose Level (mg/dL)	Monthly Income (soles)	Cost per Meal (soles)	Typical Breakfast	Typical Lunch	Typical Dinner	Recent diseases faced in community	What in their opinion is the greatest problems of the community?
1	48	26.6	0.96	253	450	6	O, Br, S	R, V, Beans	R, C, P	Diabetes, Malnutrition	Lack of water, Living in dirt, Travel to city
2	23	18.8	0.85	63	300	10	O, M	R, C	M	x	x
3	30	30.1	0.95	86	400	3	O, M, S	R, Sa, V, C	C, B, Soy	Anemia, Contamination	Lack of water
4	42	19	0.83	52	200	6	O, Br	R, V, Sa	R, S, E, Tea	Heart condition	Access to fruits
5	34	25.3	0.99	73	400	5	O, Br, Jelly	R, V, C, F	O, R, Sa	Bronchitis	Delinquency
6	48	34.1	1.00	94	600	6	O, Br, Butter, Avocado	R, C, Sa	Leftovers	High Cholesterol	Malnutrition, Access to medicine
7	28	31.5	0.95	69	400	10	O, Br, E	R, V, C, Potato	Leftovers	Diabetes, epilepsy	Lack of water, Sewage
8	42	27.5	0.63	x	400	6	O, Br	Sa	S, C	Kidney stones, UT infection	Lack of security, Access to medicine
9	23	23.3	0.97	87	1200	5	O, Br, E	R, C	O, B, S	x	Lack of water, Delinquency, Children's diarrhea
10	23	27.7	0.99	77	500	5	O, Soy, Grains	R, C, P	S	x	Lack of water, Sewage, Diarrhea
11	27	23.3	0.94	75	800	5	M, E, Br, Cheese	R, C, Sa	S	Anemia, Allergy	Malnutrition, Anemia, Pollution, Sewage
12	24	21.8	0.90	71	500	5	O, Br, Cereal	R, C, V	S	x	Lack of security, Delinquency
13	32	36	1.13	72	300	3.5	O, Br, S	R, V	S	Anemia	Lack of water, Sewage, Diarrhea
14	29	25	0.97	69	500	7	O, Br, Butter	R, C, V, P	S	Constant abdominal pain	Lack of water

Legend	
Obese/High Blood Sugar	
Overweight	
Normal	
O	Oatmeal
M	Milk
Br	Bread
R	Rice
C	Chicken
V	Vegetable Soup
S	Soup
E	Egg
Sa	Salad
F	Fish
P	Potato

Information that was not collected was marked by 'x.'

work together to provide valuable correlations among lifestyle, income, and prevalence of risk factors for CVD and T2D.

The dietary information presented in Table 2 is useful in identifying lifestyle characteristics of the members of Nuevo Jerusalen that may contribute to the state of their health. Of note, the average income of females in Nuevo Jerusalen was 496.4 soles per month, while the national average income is 1501 soles per month [15]. The low wages could play a role in the community's frequent consumption of cheap carbohydrate-rich meals that were described in the questionnaire. There was also a noticeable lack of fruits in the diet, which was also a self-described problem in the community, as noted in the survey. Overall, malnutrition was a self-reported problem among the community members, along with anemia, which could have been the result of a nutritional deficiency.

These data therefore lend support to the claim that low-socioeconomic status and diet composition could be contributing factors to the prevalence of risk factors for CVD and T2D.

Discussion

Deaths due to CVD and T2D remain the leading cause of mortality around the world, accounting for 134.5 deaths per 100,000 in Peru [16]. While NCDs such as CVD and T2D affect people globally, they also disproportionally affect impoverished populations in low to middle-income countries. Nuevo Jerusalen, the location of the 2013 observational and 2011 pilot studies, is an impoverished community within the developing nation of Peru. With these two studies combined, we have found the prevalence of obesity, elevated blood pressure, and elevated blood glucose (immediate risk factors) to be significant in comparison to prevalence rates for Peruvian national average. These findings provide the framework for important discussions and possible interventions in the community.

Prevalence of each risk factor for CVD and T2D

Within the 2013 observational study, the prevalence of BMI obesity was 30.0% in Nuevo Jerusalen females based on WHO guidelines. Within Peru, the prevalence of BMI obesity was 20.7% for females based on WHO guidelines [16]. This indicates a statistically significant greater prevalence of BMI obesity for Nuevo Jerusalen females than that of average Peruvian females (p=0.0475).

In addition, the prevalence of elevated blood pressure within females in Nuevo Jerusalen was 13.3% according to WHO guidelines, compared to the national prevalence of 28.3% [16]. Interestingly, the sample population had a statistically significant lower prevalence of elevated blood pressure than Peruvian females (p=0.0012).

Additionally, the prevalence of elevated blood glucose levels within sample females was 17.9%, which was calculated according to WHO guidelines that use both fasting and non-fasting conditions due to the difficulty in controlling meal timing of the test subjects. According to WHO statistics, the prevalence of elevated fasting blood glucose levels for Peruvian females was 5.7% [16]. While this shows a high prevalence for elevated blood glucose levels within the sample, statistical significance could not be calculated due to the slightly different WHO criteria used for assessing the impairment of blood glucose regulation.

Rise in prevalence of risk factors vs. age group

It is well documented that there is a correlation between NCDs such as CVD and T2D and age group [17]. The results of the 2013 observational study indicate that within the Nuevo Jerusalen community there is a correlation between age group and prevalence of immediate risk factors. Specifically, as age increased between 20 and 59 years, there was a dramatic increase in the prevalence of central obesity, BMI obesity, and elevated blood pressure. Additionally, between ages of 20 and 59 years there was a noted increase in prevalence of elevated blood glucose levels. These results are in line with clinical reasoning and they suggest that older age groups in Nuevo Jerusalen are at higher risk for developing NCDs such as CVD and T2D.

Relationship between Socioeconomic Status and prevalence of immediate risk factors

It is noted in literature that people of lower socioeconomic status often face an increased rate of mortality due to CVD and T2D, typically correlated to poor nutrition and physical activity [18]. Additionally, impoverished populations frequently lack access to proper healthcare and health guidance, making unhealthy habits such as tobacco use and alcohol consumption more dangerous to these populations than to wealthier populations [19]. By combining the 2013 observational study and the 2011 pilot study, this paper is able to suggest a correlation between lifestyle/low-socioeconomic status and the prevalence of certain immediate risk factors for CVD and T2D on a qualitative level.

Within the 2011 pilot study, the average female in Nuevo Jerusalen earns 496 soles/month while the average female in Peru

earns 1501 soles/month [15]. This difference in income could explain the unbalanced nutritional habits and lifestyles that contribute to statistically significant differences in regards to some of the immediate risk factors for CVD and T2D. For instance, due to financial restrictions, females in Nuevo Jerusalen may consume cheap unhealthy foods that predispose them to develop immediate risk factors for CVD and T2D. This is also compounded by the fact that a significant portion of females indicated that they do not complete physical exercise on a regular basis. The limited physical activity and meal quality of these females has likely contributed to their risk factors for the CVD and T2D, a trend that is supported by similar observations in a Swedish rural population [20].

While the unbalanced carbohydrate-rich food habits and poor physical activities in these females might have contributed largely to the risk factors of CVD and T2D, some genetic components also might have played a role in predisposing the population to these risk factors [21].

In addition, the raw data from the questionnaires of the 2011 pilot study indicate nutritional and resource deficiencies in the community. The interviewed individuals tended to eat carbohydrate-rich diets and they did not place nutritional health as a top concern within the community; rather, they specifically listed lack of clean water, security, and sewage as more pressing needs. Hence, future nutritional and lifestyle interventions within the community may need to be preceded by educational efforts and other infrastructural improvements in the area in order for the message to reach the level of cultural acceptance required for success.

Study Limitations

The 2013 observational and 2011 pilot studies have limitations that affect the results, discussion, and conclusion. There is the possibility of selection bias in the 2013 observational study because patients came in for a free medical service. Additionally, the observational study was conducted in 2013, and the Peruvian comparison rates were determined by WHO in 2008. Hence, it is possible that the national prevalence data could have changed in this time, thereby affecting statistical significance of the results. However, this was not expected to contribute a major source of error due to the relatively short time difference. Additionally, this paper exclusively uses the WHO guidelines for calculation and comparison of prevalence rates for immediate risk factors of CVD and T2D due to the availability of national data.

Conclusion

Our findings indicate a high prevalence of two immediate risk factors of CVD and T2D in the females from Nuevo Jerusalen, Peru: BMI obesity and elevated blood glucose levels. The females in Nuevo Jerusalen had a statistically lower prevalence of elevated blood pressure compared to the national average. The high carbohydrate diet, limited exercise, and low socioeconomic status of members in Nuevo Jerusalen may have contributed to these findings. These three immediate risk factors are indications of metabolic and physiological changes in the body and they are correlated to the development of NCDs, which are increasingly common within impoverished communities in developing countries. Hence, these studies provide valuable information regarding the risk factors for specific NCDs as well as the socioeconomic/cultural context of the Nuevo Jerusalen community. Renewed emphasis needs to be placed on education and primary prevention to reduce the risk of NCDs in Nuevo Jerusalen and similarly impoverished communities.

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