IJC Heart & Vasculature 27 (2020) 100476

Contents lists available at ScienceDirect

IJC Heart & Vasculature

journal homepage: www.journals.elsevier.com/ijc-heart-and-vasculature

Cardiovascular risk assessment in the resource limited setting of Western Honduras: An epidemiological perspective

Eleazar Enrique Montalvan Sanchez [a,1,*], Samuel Alejandro Urrutia [b,1], Aida Argentina Rodriguez [a,1], Gabriela Duarte [a,1], Axel Murillo [a,1], Ricardo Rivera [a,1], Andrea Alejandra Paredes Henriquez [a], Daniela Maria Montalvan Sanchez [c,1], Eva Ordoñez [a,1], Dalton Argean Norwood [a,1], Lucia Belem Dominguez [a,1], Ricardo Leonel Dominguez [a,1], Karla Torres [d,1], Esmelia Michell Reyes Fajardo [a], Carlos Amilcar Godoy [e,1]

[a] Western Honduras Gastric Cancer Prevention Initiative, Hospital de Occidente, Santa Rosa de Copan 41101, Honduras
[b] Indianapolis Health University, Indianapolis, IN 46202, USA
[c] Universidad Nacional Autonoma de Honduras, Tegucigalpa, Honduras
[d] Universidad Nacional Autonoma de Honduras, Santa Rosa de Copan 41101, Honduras
[e] Hartford Hospital, CT 06102, USA

ARTICLE INFO

Article history:
Received 6 November 2019
Received in revised form 8 January 2020
Accepted 21 January 2020
Available online 4 February 2020

Keywords:
Risk factors
Body mass index
Cardiovascular diseases
Cholesterol

ABSTRACT

Cardiovascular Disease (CVD) epidemiology varies significantly among Low and Middle-Income Countries. Honduras is the Central American country with the highest Ischemic Heart Disease and CVD mortality rates. The aim of this study was to assess the individual CVD risk factors and calculate Cardiovascular Risk Assessment Scores (CVRAS) from the population. **Methods:** A cross-sectional study in western Honduras. Estimation of CV risk was performed using Framingham, MESA, ACC/AHA-PCEs and ESC SCORE calculators. **Results:** 38% were male. For men and women respectively; 49% and 48% had self-reported hypertension (HTN), on measured blood pressure only 18% and 30% had normal readings. Diabetes Mellitus was reported in 19% and 22%. Tobacco use was 14% and 3%. Self-reported regular exercise was 39.9% and 25%. Obesity was diagnosed in 24% and 24%. Lipid profile; total cholesterol was ≥200 mg/dl in 63% of subjects. LDL-C was elevated (>100 mg/dl) in 74% of participants, 9% had LDL-C levels higher than 190 mg/dl. Triglycerides were high (>160 mg/dl) in 60%, of these subjects 22% were taking lipid-lowering medications. 52% reported family-history of CVD. The risk calculation for men and women respectively for each CVRAS were; AHA/ACC-PCEs high risk (score ≥ 7.5%) in 62% and 30%, FRS high risk (score ≥ 20%) 46% and 15%, MESA high risk (Score ≥ 7.5%) in 70.6% and 17.7%, ESC SCORE high risk (score ≥ 5% in 32.4% and 11.8%). **Conclusions:** CV risk calculations revealed higher than rates than expected with consequently reflected on higher than estimated CVRAS. This represents the first report of its kind in Honduras.

1. Introduction

The incidence and prevalence of Non-communicable Diseases (NCDs) including Cardiovascular Diseases (CVDs), diabetes, cancer and chronic respiratory diseases in many Low-and Middle-Income Countries (LMICs) has risen in recent years [1]. In fact, approximately 80% of global NCDs mortality occurs in LMICs [2–4]. The implementation of strategies to decrease the prevalence and incidence of CVD is a major public health concern [5,6]. For this reason, it is not only fundamental to understand the epidemiologic characteristics of the population, but most importantly, to develop tools and strategies to cost-efficiently decrease CVD morbidity and mortality rates considering the economic limitations of LMICs [7].

Latin America is a region with varying epidemiologic data in CVD, differing significantly among its sub regions [8–10]. Some countries, including Argentina, Brazil, Chile and Cuba have experienced sustained decreases in CVD mortality rates in the past several decades. Conversely, countries like Mexico and some Central American countries have increasing trends in CVD mortality [6]. Therefore, developing generalizable approaches to tackle CVD in

* Corresponding author at: Sala de Endoscopia, Hospital de Occidente, Avenida Solidaridad, Santa Rosa de Copan, Copan 41101, Honduras.
E-mail addresses: montalvan214@gmail.com, montalvan214@outlook.com (E.E. Montalvan Sanchez).
[1] This author takes responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

https://doi.org/10.1016/j.ijcha.2020.100476
2352-9067/

LMICs is a challenging task. CVD epidemics vary significantly among different LMICs due in part to genetic, racial, social and cultural diversity [11]. Accordingly, it is imperative that concerted efforts are made to better understand the needs and risk of each population separately.

Central America is a sub-region with few epidemiologic studies in CVD. Honduras is the Central-American country with the highest Ischemic Heart Disease (IHD) and CVD mortality rates for both men and women, as well as disability-adjusted life years (DALYs) due to CVD burden [12–14]. Most of Honduras' recent epidemiologic studies on CVD have been obtained from few cross-sectional studies. However, there is no data from longitudinal studies. As in the rest of LMICs, coordinated inter-institutional efforts need to be made in Honduras to cost-efficiently direct the scarce resources to help decrease the burden of CVD [15]. Stratification of high-risk patients according to their cardiovascular (CV) risk is one of the fundamental strategies to decide which are the most beneficial cost-effective measures to decrease CVD morbidity and mortality [16].

In this study we aim to provide a current epidemiologic perspective of the CVD burden in Copan, which is the most populated department in Western Honduras with a population of nearly four hundred thousand inhabitants, predominantly Hispanic/mestizo and indigenous population living mainly in rural areas. The main long-term objective of this study is to follow this cohort to further analyze their epidemiologic characteristics and gain a deeper understanding of CVD burden in Honduras. Our second objective is to estimate CVD risk in this population using various risk scores to determine which are most suitable for risk estimation in this population.

2. Methods

2.1. Population sample

A cross-sectional descriptive study of the resource limited setting of Western Honduras of random volunteers between 45 and 75 years, of both genders, who were seen by medical doctors in both public and private medical institutions in the Department (state) of Copán, Honduras, between November 2016 and January 2017. The study was promoted through the area to ensure catchment from the whole department. The physicians who participated were all educated about the study design

The Honduran National Institute of Statistics has a registered census of the adult population of the department of Copán ranging from 45 to 75 years old (N = 57,299 inhabitants), which represents the universe of the study. We hypothesized a difference between proportions of males and females with effect size (d = 0.1). In order to achieve a power of 0.8, the sample calculated for a 95% CI with a maximum error of 0.05, corresponded to 382 patients which were recruited randomly within the area.

The protocol, informed consent and study procedures and measurements were approved by the Western Hospital Ethics Committee (FWA: 00000669/IRB 00001470). The criteria for patients to be included in the study were: age between 45 and 75 years, both genders, living in the Department of Copan, with prior consent to be included in the study. The exclusion criteria were past medical history of cardiovascular disease; Myocardial Infarction (MI), Angina, Cerebrovascular Accident/Transient Ischemic Attack (CVA/TIA), Congestive Heart Failure (CHF), Atrial Fibrillation (AF), cardiac catheterization, ongoing cancer treatment, pregnancy, weight more than 300 lb ***or cognitive disability to participate in the study.

An instrument was developed to obtain information prior informed consent from each patient which included: patient general information, past medical history, past family history, use of tobacco, medications (lipid-lowering, anti-diabetic and antihypertensive), physical activity, blood pressure (BP), Body Mass Index (BMI), hip-waist ratio, glucose, triglycerides, total cholesterol, HDL-cholesterol (HDL-C), and LDL-cholesterol (LDL-C).

2.2. Risk factor assessment

The patients included in the study were either referred to a clinical laboratory or voluntarily attended the clinic/laboratory complex where they were examined, measured and tested by certified health professionals. After informed consent, blood pressure was taken by a medical doctor with a Welch Allyn sphygmomanometer, appropriately sized cuffsand a Littman classic II stethoscope. After 5 min, the instrument was filled and then a second BP measurement was taken. The average of 2 BP measurements was registered.

An analogous calibrated scale was used to determine weight and height following the clinical method according to the Frankfort plane (patient standing up with head in horizontal position), calculating the BMI. A soft tape measure (ADC Woven®) was used to measure the abdominal and hip circumferences to calculate the hip-waist ratio. Laboratory analysis was carried using HumaStar 200 (HUMAN® Germany) using enzymatic colorimetric assay for all tests.

2.3. Risk estimation

The cardiovascular risk for each participant in the study was estimated using 3 cardiovascular disease risk assessment scores; MESA risk score, Framingham risk score (FRS), the Pooled Cohort Equations (PCEs) of the AHA/ACC and ESC SCORE risk score [17–19]. These scores use CV risk factors to predict the probability of having hard CV outcomes in 10 years such as Coronary Heart Disease (CHD) and/or Stroke. For FRS and MESA the CV outcome is Coronary Heart Disease (CHD) while PCEs also includes stroke.

All of the CVRAS focus mainly on traditional CV risk factors, but each of them have unique features. MESA for instance, was based on a study which included approximately 1600 patients of multiple ethnicities with sufficiently pondered African-American and Hispanics populations. Optionally, it can incorporate the measurement of Coronary Artery Calcium (CAC) Score.

PCEs also adjusts for African-Americans or "Other" races and incorporates new factors such as being on antihypertensive medications. FRS has the known limitation of being designed from a highly predominant Caucasian study population. Patients will be followed up for 10 years to asses the development of CVD or stroke. By actively searching morbidity and death records at the national registry.

2.4. Statistical analysis

All data was captured via REDCap (Research Electronic Data Capture) which is a secure, web-based used for a variety of types of research and provides easy data manipulation with an automated export mechanism to common statistical packages (SPSS, SAS, Stata, R/S-Plus). REDCap servers are housed in a local data center at Vanderbilt, and all web-based information transmission is encrypted.

Data was analyzed using STATA 14. Continuous variables were reported as means and standard deviations (SD); categorical variables as frequencies with their respective percentage. Wilcoxon rank-sum was employed for continuous variables hypothesis testing and Pearson's chi-squared was used for categorical variables. The threshold selected for statistical significance was 0.05.

3. Results

Voluntary attendance and referrals ranged between five to ten patients each day. 384 patients were found eligible and went through examination and testing. Two of these patients were removed from the final analysis due to missing or conflicting data (BP, cholesterol and BMI). The final analysis sample was 382; 145 (38%) male and 237 (62%) female.

3.1. Subject characteristics

Mean age was similar between both genders (57 and 58 years for men and women, respectively, P = 0.31). Among the selected sample, all male subjects except one, and all women were from Hispanic/Latino descent. Approximately 80% of subjects resided in Santa Rosa de Copán, the capital city of the department (state), followed by nearby rural towns: San Juan de Opoa and Corquín, each with approximately 4%. Self-reported family history of cardiovascular disease (stroke, myocardial infarction, PAD) was 52.9%, while family history of myocardial infarction was 31.3%.

3.2. Prevalence of self-reported cardiovascular risk factors

Prevalence of hypertension was 49.7% and 47.7% among men and women respectively (see Table 1). 91.3% of diagnosed subjects were currently taking anti-hypertensive medication. Self-reported, previously diagnosed diabetes mellitus ranged from 19% in men to 22.1% in women; 95.7% of these were currently being treated. Tobacco consumption was significantly higher among men, 14% versus 3.4% in women. Self-reported regular physical activity (defined as moderate aerobic physical activity for at leas 150 min a week ‘‘30 min a day for 5 days a week or 75 min a week of vigorous aerobic physical activity) was 39.9% in men, while only 24.5% of women reported exercising regularly.

3.3. Prevalence of measured cardiovascular risk factors

Mean body mass index measurements were similar between both genders (27.4 kg/m^2 for males and 27.34 kg/m^2 for females). Obesity (BMI > 30 kg/m2) was 24.3% among males and 23.9% among females. However, only 31% of subjects were recorded to have a normal or underweight (BMI < 24.9 kg/m2). Abdominal obesity was more prevalent in women (65.4%) compared to men (34.9%) ($p < 0.001$) (see Table 1).

The average of two blood pressure measurements was used for analysis (Table 1). Only 18.2% of males and 29.5% of females had normal blood pressure measurements. More than a third of all participants had either stage 1 or stage 2 hypertension. Even though 44.5% of all participants admitted taking blood pressure lowering medication, 43.8% of patients in stage 1 and 25% of stage 2 were not taking any medication. ($p < 0.0001$). Furthermore, 42.5% of subjects in stages 1 or 2 did not have a previous diagnosis of hypertension. ($p < 0.0001$). From all patients on blood pressure lowering treatment n = 170 (44.5%), almost half (47.1) had blood pressures corresponding to Stage 1 or 2 (SBP $\geq$ 130 or DBP $\geq$ 80) (see Table 2).

Fasting blood glucose was abnormal (>125 mg/dl) in 11.6% of subjects; 5.5% were above 200 mg/dl. 6.7% of subjects had abnormal glucose measurements without a previous diagnosis of diabetes. 63.1% of subjects had cholesterol measurements above 200 mg/dl; there was a similar distribution between genders. Distribution of LDL-C categorization was similar between both genders (Table 3). 74.2% had LDL-C levels above 100 mg/dl. LDL-C was equal or higher than 190 mg/dl in 9.2% of patients, however only 22% of subjects in this subgroup were taking lipid-lowering treatment (Table 4). Triglyceride levels were high in 60% of the subjects studied. Levels higher than 500 mg/dl were more prevalent in men (7.7%) than women (2.1%).

Table 1
Basic Characteristics (n = 382).

Characteristic	*N (%)*
Age, mean ± SD	58 ± 7.9
Sex	
Male	145 (38)
Female	237 (62)
BMI	
<18.5 - Underweight	2 (0.5)
18.5–24.9 - Normal	116 (30.4)
25–29.9 - Pre-obese	172 (45.0)
30–34.9 - Obese Class I	73 (19.1)
35–39.9 - Obese Class II	12 (3.2)
>40 - Obese Class III	7 (1.8)
Abdominal circumference, mean ± SD	95.1 ± 11
Blood Pressure (mmHg)	
Normal	98 (25.7)
Pre-Hypertension	155 (40.6)
Stage 1 HTN	89 (23.3)
Stage 2 HTN	40 (10.4)
Self-reported Tobacco use	28 (7.3)
Self-reported Exercise	114 (29.8)
Blood Glucose (mg/dL)	
<126	316 (82.9)
126–199.9	43 (11.3)
≥200	22 (5.8)

Values are n, n (%), or mean ± SD, Normal = SBP < 120 mmHg & DBP < 80 mmHg, Pre-hypertension = SBP = 120–129 mmHg & DBP < 80 mmHg, Stage 1 HTN = SBP = 130–139 mmHg or DBP = 80–89 mmHg, Stage 2 HTN = SBP $\geq$ 140 mmHg or DBP $\geq$ 90 mmHg.
Abbreviations: BMI = Body Mass Index, HTN = Hypertension.

Table 2
Blood Preasure Lowering Treatment (n = 382).

Blood Pressure	*Not on Treatment (n = 212)*	*On Treatment (n = 170)*
Normal	73 (34.4)	25 (14.7)
Pre-Hypertension	90 (42.5)	65 (38.2)
Stage 1 HTN	39(18.4)	50 (29.4)
Stage 2 HTN	10 (4.7)	30 (17.7)

Values are n, n (%), Normal = SBP < 120 mmHg & DBP < 80 mmHg, Pre-hypertension = SBP = 120–129 mmHg & DBP < 80 mmHg, Stage 1 HTN = SBP = 130–139 mmHg or DBP = 80–89 mmHg, Stage 2 HTN = SBP $\geq$ 140 mmHg or DBP $\geq$ 90 mmHg.
Abbreviations: SBP = Systolic Blood Preasure, HTN = Hypertension, DBP = Diastolic Blood Preasure.

3.4. Risk stratification

Male sex, being a CV risk factor per se, significantly skewed male-female percentage risk of all cardiovascular risk scores tested. Mean of MESA risk score among men was 12.8 ± 8.4, women 4.5 ± 5.2. FRS calculation yielded 95% of men scored > 6% of risk, and 46.5% are classified as high risk (score > 20%), among females, only 15% were above the high risk cut point (score > 20%). ACC/AHA-PCEs was above 7.5% in 62% of men and 29.8% of women. ESC SCORE was calculated with 20% of participants had a high-risk score (>5%) 47% and 28% for males and females respectively (Table 5).

4. Discussion

To our knowledge, this is the first observational study of CVD risk factors in Western Honduras. We note several important

Table 3
Lipid Profile (n = 380*).

	Male (n = 143)	*Female (n = 237)*	*p-value*
Total Cholesterol (mg/dL)			
<200	56 (39.2)	84 (35.4)	0.76
200–239.9	45 (31.5)	80 (33.8)	
≥240	42 (29.4)	73 (30.8)	
LDL-c (mg/dL)			
<100 - Optimal	38 (26.6)	60 (25.3)	0.98
100–129.9 - Above optimal	36 (25.2)	66 (27.8)	
130–159.9 - Borderline high	40 (28.0)	62 (26.2)	
160–189.9 - High	16 (11.2)	27 (11.4)	
≥190 Very high	13 (9.1)	22 (9.3)	
HDL-c (mg/dL)			
<40 - Low	59 (41.3)	64 (27.0)	0.016
40–59.9 - Sub-optimal	70 (49.0)	144 (60.8)	
60 - Max-optimal	14 (9.8)	29 (12.2)	
Triglycerides (mg/dL)			
<150 - Normal	49 (34.3)	96 (40.5)	0.052
150–199.9 - Borderline high	33 (23.1)	50 (21.1)	
200–499.9 - High	50 (35.0)	86 (36.3)	
≥500 -Very high	11 (7.7)	5 (2.1)	

Values are n, n (%), or mean ± SD.
*Complete lipid profile for 2/382 patient were not adequately processed.
Abbreviations: LDL-c = Low-density Lipoprotein – Cholesterol, HDL-c = High-density Lipoprotein – Cholesterol.

Table 4
LDL-c and Lipid-Lowering Treatment (n = 380).

	Not on Treatment (n = 283)	*On Treatment (n = 95)*	*p-value*
Total LDL-c (mg/dL)			
<100 Optimal	68 (24.0%)	30 (31.6%)	0.20
100–129.9 Above optimal	73 (25.8%)	29 (30.5%)	
130–159.9 Borderline high	83 (29.3%)	17 (17.9%)	
160–189.9 High	32 (11.3%)	11 (11.6%)	
≥190 Very high	27 (9.5%)	8 (8.4%)	

Values are n, n (%), or mean ± SD.
Abbreviations: LDL-c = Low-density Lipoprotein – Cholesterol.

Table 5
Cardiovascular Risk Assessment Scores (n = 380).

	Male (n = 143)	*Female (n = 237)*	*p-value*
MESA risk score			
<7.5% risk	42 (29.4)	195 (82.3)	<0.001
≥7.5% risk	101 (70.6)	42 (17.7)	
Framingham risk score			
<6% risk	7 (5.0)	81 (34.6)	<0.001
6–19% risk	69 (48.9)	118 (50.4)	
>20% risk	65 (46.1)	35 (15.0)	
AHA/ACC-PCEs Score			
<7.5% risk	52 (38.0)	158 (70.2)	<0.001
≥7.5% risk	85 (62.0)	67 (29.8)	
ESC SCORE			
<5% risk	98 (67.6)	209 (88.2)	
≥5% risk	47 (32.4)	28 (11.8)	<0.001

Values are n, n (%), or mean ±
Abbreviations: MESA = Multi-Ethnic Study of Atherosclerosis AHA/ACC-PCEs = American Heart Association – Pooled Cohort.

findings in our study. (1) Baseline rates of hypertension and diabetes are markedly elevated (nearly 50% and 20% respectively) which is higher than the prevalence in developed as well as some other Latin American countries. (2) There were notable differences in health behaviors and risk factors among men and women including obesity rates (65% for women compared to 35% for men), and smoking (3% for women vs 14% for men). (3) Cholesterol is grossly undertreated for the highest risk patients. Only 95 out of 382 patients (24.9%) were taking lipid-lowering medications, out of the very high LDL-c group (n = 95) only 8% (n = 8) were on treatment) Hypertension is grossly undertreated with only one quarter of patients with diagnosed hypertension having a SBP < 120 and DBP < 80 mmHg. 5) ASCVD risk estimation varied between different risk scores but was alarmingly elevated in all cases.

This early study in western Copán provides several novel insights on CVD risk factor prevalence in the region. Santa Rosa de Copán is a small but partially urbanized city and the commercial center of Western Honduras due to its proximity to the Guatemala and El Salvador borders. Most of its population is comprised of Hispanic/Mestizo and indigenous descent, which is representative of the whole country [20]. Prevalence of family history of myocardial infarction, was found to be similar to what has been previously reported in the Latin American region [21]. However, family history of CVD (stroke, PAD, or MI) was 10–20% higher than previous Latin American studies [22,23].

Worldwide burden of hypertension is approximately 43.9% among the age groups hereby studied, however, in Latin America it can be as high as 61.7% in men and 39% in women [24]. Estimations account for >10% increase in the following 25 years in this region. Among the participants in this study, self-reported hypertension varied significantly from actual blood pressure measurements. While approximately half of participants reported being previously diagnosed with hypertension, only one quarter of patients had normal blood pressure, defined as <120/<80. >70% of males and>50% of females had abnormal blood pressure measurements. Decreased screening frequency, absence of symptoms, or negativity regarding regular healthcare may account for the underdiagnosed population.

It is estimated that by 2025, 8.1% of the Latin American population will be diabetic [25]. Cities in the region such as Mexico City and Bogota reach almost 10% [26]. The last reported nationwide estimation of Honduran diabetics was 7.6% [27]. Diet westernization may account for accelerated incidence of diabetes in Latin America [28]. 21% of our subjects had a previous diagnosis of diabetes, however 6.7% of subjects not previously diagnosed had abnormal glucose measurements, 1.8% of them with readings over 200 mg/dl.

Latin America comprises a heterogeneous mixture of smoking prevalence ranging from 2 to 3% in Costa Rica to 52% in Peruvian males [29]. Santa Rosa de Copan was the first trading post were the Spanish crown established a royal tobacco trading post in 1765 [30]. Since then, tobacco production has declined; less than 1% of agricultural land is devoted to tobacco growing. Honduras' nationwide smoking prevalence was previously estimated to be 36% in males and 11% in females [29]. However, our contemporary data sample demonstrated less than half of those prior estimates; which could be attributed to increased awareness of disease, medical recommendation or higher age in the sample studied.

Western high-fat/calorie diets at low prices have become increasingly popular in LMICs (Low and Middle-Income Countries). The additive effect of physical inactivity –less than 40% in men and less than 25% in women in our sample reported being physically active– feeds into other cardiovascular risk factors. In 1996, Honduras was the country with the smallest percentage of obese or overweight population in the region, but today more than half of the adult population is overweight [31]. Obesity, a CV risk factor itself, is associated with increased incidence of diabetes, stroke, dyslipidemia and increased overall mortality. Abdominal obesity correlated with previously reported data in Latin American populations (60% in females, 35% in males) [32]. However, some experts have suggested that visceral obesity and therefore increased cardiovascular risk, may present with lower abdominal circumference cutoffs in non-Caucasian populations [33,34].

Dyslipidemia was highly prevalent across the sample. Elevated LDL-C levels have been correlated with increased cardiovascular risk. Recent guidelines propose an aggressive treatment of elevated LDL-C levels. Compared to other Latin American cities, hypercholesterolemia prevalence was twice as high [35]. Similarly, LDL-C levels above 160 mg/dl ranged from 4% to 11% in the CARMELA dyslipidemia study [36]. Our sample presented with 20.5% prevalence above this threshold, with half of these subjects above 190 mg/dl. According to widely accepted predictive models, hypertension and dyslipidemia are fundamental in CHD development [37]. This might shed some light onto the mechanisms for CVD causality in this region.

CVRAS are important tools in current clinical practice for the management of cardiovascular diseases. They have an even more significant role in resource-limited countries due to their usefulness in risk-stratifying populations and identifying high-risk patients for more focused, cost-effective individual and population-based interventions [36]. For the past few decades, the Framingham Risk Score has been the most widely used score and it has been validated in many countries [38]. In 2013, the PCEs risk score of the AHA/ACC Assessment of Cardiovascular Risk guidelines became the most used CV risk assessment score in the United States [19]. The MESA risk score in particular, has been designed based on a racially-diverse population, therefore it takes into account Hispanics living in the USA [39].

These scores however, have been derived from studies based on populations in the United States, impeding their generalization and applicability to LMICs in Latin American with different races and ethnicities such as Honduras. Studies have been made to either recalibrate these scores to specific populations or to develop different scores such as INTERHEART or the WHO/ISH cardiovascular risk prediction model [40,41].

Our study revealed an alarming proportion of high-risk patients according to all three scores. For men and women respectively; ten-year ASCVD risk by the AHA/ACC-PCE was >7.5% in 62% and 29.8%. CHD riskby FRS was >20% in 46.1% and 15%, and ten-year CHD risk by the MESA Risk Score was >7.5% in 70.6% and 17.7%. According to this, there is a large high-CV-risk population in Honduras which is of significant public health concern. Most importantly, it points to a vast population of undiagnosed and untreated/inappropriately treated population for CV risk factors such as hypertension and hyperlipidemia.

However, multiple studies have shown an overestimation of predicted CV events of both FRS and PCEs in Hispanics living in USA as well as in Hispanics in some Latin American countries [42,43]. Being the first study of its type in Honduras, there are currently no studies to compare these results with. Efforts should be made to follow-up this study sample as a cohort in a longitudinal study to assess outcomes such as Major Adverse Cardiovascular Events (MACEs) and CV mortality which could be an opportunity to either recalibrate or validate these scores for the Honduran population, this done by continuously revising morbidity records and death records at the national registry for at least 10 years and adding the data to the already existing database.

5. Conclusions

This study has provided novel data about Western Honduras CV epidemiology and Honduras in general. Most importantly, it has revealed data which is unique to the Honduran population as compared to studies from other countries in the region and which adds to the concept of widely varying CV epidemiology within the different Latin American countries. Risk factors such as hypertension, diabetes and high cholesterol where markedly higher in our study population as compared to developed and some other Latin American countries. Many patients at high CVD risk were receiving inadequate treatment of their blood pressure and lipids. These findings translate to alarmingly elevated CVRAS, with an elevated proportion of high-risk patients in all 3 scores used (PCEs, FRS, MESA). This raises significant public health concern and underscores the importance of continued observational data and concerted public health efforts to aggressively reduce CVD risk in the region.

6. Limitations

The limitations of this kind of studies in LMIC settings are mainly due to the lack of some variables necessary for risk calculation in the population (lipid profile, renal function), lack of computerized risk calculators and the difficulty to follow-up volunteers in a setting with massive migration. At the moment of the study random sampling of volunteers were enrolled in which surprisingly accounted for a higher proportion of male participants >60% this may have been avoided by doing stratified sampling. This might result in selection bias, but we have to make the best use of the results acquired so we still interpret it for the population in study.

CRediT authorship contribution statement

Eleazar Enrique Montalvan Sanchez: Conceptualization, Methodology, Software, Data curation, Writing - original draft, Visualization, Investigation, Supervision, Validation, Writing - review & editing. **Samuel Alejandro Urrutia:** Conceptualization, Methodology, Software, Data curation, Writing - original draft, Visualization, Investigation, Supervision, Validation, Writing - review & editing. **Aida Argentina Rodriguez:** Conceptualization, Methodology, Writing - original draft, Visualization, Investigation, Writing - review & editing. **Gabriela Duarte:** Visualization, Investigation, Writing - review & editing. **Axel Murillo:** Visualization, Investigation, Writing - review & editing. **Ricardo Rivera:** Visualization, Investigation, Writing - review & editing. **Daniela Maria Montalvan Sanchez:** Visualization, Investigation, Writing - review & editing. **Eva Ordoñez:** Visualization, Investigation, Writing - review & editing. **Dalton Argean Norwood:** Conceptualization, Methodology, Software, Data curation, Writing - original draft, Visualization, Investigation, Supervision, Validation, Writing - review & editing. **Lucia Belem Dominguez:** Visualization, Investigation, Writing - review & editing. **Ricardo Leonel Dominguez:** Visualization, Investigation, Writing - review & editing, Supervision, Project administration. **Karla Torres:** Visualization, Investigation, Writing - review & editing, Supervision, Project administration, Funding acquisition. **Carlos Amilgar Godoy:** Conceptualization, Methodology, Software, Data curation, Writing - original draft, Visualization, Investigation, Supervision, Validation, Writing - review & editing.

Acknowledgment of grant support

We received no funding for this research.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcha.2020.100476.

References

[1] World Health Organization, World Health Organization. Chapter 1: Burden: mortality, morbidity and risk factors. Global status report on noncommunicable diseases. 2010, 2011.

[2] J.J. Miranda, S. Kinra, J.P. Casas, G. Davey Smith, S. Ebrahim, Non-communicable diseases in low-and middle-income countries: context, determinants and health policy, Trop. Med. Int. Health 13 (10) (2008) 1225–1234.
[3] S.M. Islam, T.D. Purnat, N.T. Phuong, U. Mwingira, K. Schacht, G. Fröschl, Non-Communicable Diseases (NCDs) in developing countries: a symposium report, Globaliz. Health 10 (1) (2014) 81.
[4] A. Boutayeb, S. Boutayeb, The burden of non-communicable diseases in developing countries, Int. J. Equity Health 4 (1) (2005) 2.
[5] V. Fuster, B.B. Kelly, R. Vedanthan, Promoting global cardiovascular health: moving forward, Circulation 123 (15) (2011) 1671–1678.
[6] B.B. Kelly, V. Fuster (Eds.), Promoting Cardiovascular Health in the Developing World: A Critical Challenge to Achieve Global Health, National Academies Press, 2010.
[7] D.E. Bloom, E. Cafiero, E. Jané-Llopis, S. Abrahams-Gessel, L.R. Bloom, S. Fathima, A.B. Feigl, T. Gaziano, A. Hamandi, M. Mowafi, D. O'Farrell, The global economic burden of noncommunicable diseases, Program on the Global Demography of Aging, 2012 Jan.
[8] G.A. Roth, M.H. Forouzanfar, A.E. Moran, R. Barber, G. Nguyen, V.L. Feigin, M. Naghavi, G.A. Mensah, C.J. Murray, Demographic and epidemiologic drivers of global cardiovascular mortality, N. Engl. J. Med. 372 (14) (2015) 1333–1341.
[9] S.M. Barreto, J.J. Miranda, J.P. Figueroa, M.I. Schmidt, S. Munoz, P.P. Kuri-Morales, J.B. Silva Jr, Epidemiology in Latin America and the Caribbean: current situation and challenges, Int. J. Epidemiol. 41 (2) (2012) 557–571.
[10] T.A. Gaziano, A. Bitton, S. Anand, S. Abrahams-Gessel, A. Murphy, Growing epidemic of coronary heart disease in low-and middle-income countries, Curr. Probl. Cardiol. 35 (2) (2010) 72–115.
[11] G.A. Roth, M.D. Huffman, A.E. Moran, V. Feigin, G.A. Mensah, M. Naghavi, C.J. Murray, Global and regional patterns in cardiovascular mortality from 1990 to 2013, Circulation 132 (17) (2015) 1667–1678.
[12] S. Mendis, P. Puska, B. Norrving, World Health Organization, Global atlas on cardiovascular disease prevention and control, World Health Organization, Geneva, 2011.
[13] World Health organization (WHO), Global Health Risks-Mortality and burden of disease attributable to selected major risks, Cancer, 2017 Feb 3.
[14] World Health Organization. Causes of death 2008: data sources and methods, World Health Organization, Geneva, Switzerland, 2011 Apr.
[15] T.A. Gaziano, Reducing the growing burden of cardiovascular disease in the developing world, Health Aff. 26 (1) (2007) 13–24.
[16] A. Glassman, K. Chalkidou, U. Giedion, Y. Teerawattananon, S. Tunis, J.B. Bump, A. Pichon-Riviere, Priority-setting institutions in health: recommendations from a center for global development working group, Global Heart. 7 (1) (2012) 13–34.
[17] D.E. Bild, D.A. Bluemke, G.L. Burke, R. Detrano, A.V. Diez Roux, A.R. Folsom, P. Greenland, D.R. JacobsJr, R. Kronmal, K. Liu, J.C. Nelson, Multi-ethnic study of atherosclerosis: objectives and design, Am. J. Epidemiol. 156 (9) (2002) 871–881.
[18] K.M. Anderson, P.M. Odell, P.W. Wilson, W.B. Kannel, Cardiovascular disease risk profiles, Am. Heart J. 121 (1) (1991) 293–298.
[19] D.C. Goff, D.M. Lloyd-Jones, G. Bennett, S. Coady, R.B. D'Agostino, R. Gibbons, P. Greenland, D.T. Lackland, D. Levy, C.J. O'Donnell, J.G. Robinson, 2013 ACC/AHA guideline on the assessment of cardiovascular risk, Circulation 129 (25 suppl 2) (2014) S49–S73.
[20] W.L. Fash, D.S. Stuart, evolution at Copan, Honduras, Classic Maya Political History: Hieroglyphic and Archaeological Evidence 22 (1991) 147.
[21] M. Ciruzzi, H. Schargrodsky, J. Rozlosnik, P. Pramparo, H. Delmonte, V. Rudich, D. Piskorz, E. Negri, S. Soifer, C. La Vecchia, Frequency of family history of acute myocardial infarction in patients with acute myocardial infarction, Am. J. Cardiol. 80 (2) (1997) 122–127.
[22] F. Lanas, A. Avezum, L.E. Bautista, R. Diaz, M. Luna, S. Islam, S. Yusuf, Risk factors for acute myocardial infarction in Latin America: the INTERHEART Latin American study, Circulation 115 (9) (2007) 1067–1074.
[23] M.W. Strufaldi, F.I. Souza, R.F. Puccini, M.D. Franco, Family history of cardiovascular disease and non-HDL cholesterol in prepubescent non-obese children, Revista da Associação Médica Brasileira. 62 (4) (2016) 347–352.
[24] P.M. Kearney, M. Whelton, K. Reynolds, P. Muntner, P.K. Whelton, J. He, Global burden of hypertension: analysis of worldwide data, Lancet 365 (9455) (2005) 217–223.
[25] H. King, R.E. Aubert, W.H. Herman, Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections, Diabetes Care 21 (9) (1998) 1414–1431.
[26] H. Schargrodsky, R. Hernández-Hernández, B.M. Champagne, H. Silva, R. Vinueza, L.C. Ayçaguer, P.J. Touboul, C.P. Boissonnet, J. Escobedo, F. Pellegrini, A. Macchia, CARMELA: assessment of cardiovascular risk in seven Latin American cities, Am. J. Med. 121 (1) (2008) 58–65.
[27] World Health Organization, Obesity: preventing and managing the global epidemic, World Health Organization, 2000.
[28] B.M. Popkin, Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases, Am. J. Clin. Nutr. 84 (2) (2006) 289–298.
[29] F. Müller, L. Wehbe, Smoking and smoking cessation in Latin America: a review of the current situation and available treatments, Int. J. Chron. Obstruct. Pulmonary Dis. 3 (2) (2008) 285.
[30] W.M. Loker, The rise and fall of flue-cured tobacco in the Copán Valley and its environmental and social consequences, Hum. Ecol. 33 (3) (2005) 299–327.
[31] R. Uauy, C. Albala, J. Kain, Obesity trends in Latin America: transiting from under-to overweight, J. Nutr. 131 (3) (2001) 893S–899S.
[32] C. Filozof, C. Gonzalez, M. Sereday, C. Mazza, J. Braguinsky, Obesity prevalence and trends in Latin-American countries, Obes. Rev. 2 (2) (2001) 99–106.
[33] P. Aschner, R. Buendía, I. Brajkovich, A. Gonzalez, R. Figueredo, X.E. Juarez, F. Uriza, A.M. Gomez, C.I. Ponte, Determination of the cutoff point for waist circumference that establishes the presence of abdominal obesity in Latin American men and women, Diabetes Res. Clin. Pract. 93 (2) (2011) 243–247.
[34] A. Misra, J.S. Wasir, N.K. Vikram, Waist circumference criteria for the diagnosis of abdominal obesity are not applicable uniformly to all populations and ethnic groups, Nutrition 21 (9) (2005) 969–976.
[35] R. Vinueza, C.P. Boissonnet, M. Acevedo, F. Uriza, F.J. Benitez, H. Silva, H. Schargrodsky, B. Champagne, E. Wilson, CARMELA Study Investigators, Dyslipidemia in seven Latin American cities: CARMELA study, Prevent. Med. 50 (3) (2010) 106–111.
[36] P.W. Wilson, R.B. D'Agostino, D. Levy, A.M. Belanger, H. Silbershatz, W.B. Kannel, Prediction of coronary heart disease using risk factor categories, Circulation 97 (18) (1998) 1837–1847.
[37] S. Mendis, Cardiovascular risk assessment and management in developing countries, Vascular Health Risk Manage. 1 (1) (2005) 15.
[38] R.B. D'Agostino, R.S. Vasan, M.J. Pencina, P.A. Wolf, M. Cobain, J.M. Massaro, W. B. Kannel, General cardiovascular risk profile for use in primary care: the Framingham Heart Study, Circulation 117 (6) (2008) 743–753.
[39] A.P. DeFilippis, R. Young, C.J. Carrubba, J.W. McEvoy, M.J. Budoff, R.S. Blumenthal, R.A. Kronmal, R.L. McClelland, K. Nasir, M.J. Blaha, An analysis of calibration and discrimination among multiple cardiovascular risk scores in a modern multiethnic cohort, Ann. Intern. Med. 162 (4) (2015) 266–275.
[40] C. McGorrian, S. Yusuf, S. Islam, H. Jung, S. Rangarajan, A. Avezum, D. Prabhakaran, W. Almahmeed, Z. Rumboldt, A. Budaj, A.L. Dans, Estimating modifiable coronary heart disease risk in multiple regions of the world: the INTERHEART Modifiable Risk Score, Eur. Heart J. 32 (5) (2010) 581–589.
[41] S. Mendis, L.H. Lindholm, G. Mancia, J. Whitworth, M. Alderman, S. Lim, T. Heagerty, World Health Organization (WHO) and International Society of Hypertension (ISH) risk prediction charts: assessment of cardiovascular risk for prevention and control of cardiovascular disease in low and middle-income countries, J. Hypertens. 25 (8) (2007) 1578–1582.
[42] M. Cortes-Bergoderi, R.J. Thomas, F.N. Albuquerque, J.A. Batsis, G. Burdiat, C. Perez-Terzic, J. Trejo-Gutierrez, F. Lopez-Jimenez, Validity of cardiovascular risk prediction models in Latin America and among Hispanics in the United States of America: a systematic review, Revista Panamericana de Salud Pública Revista Panamericana de Salud Pública 32 (2012) 131–139.
[43] P. Brindle, A. Beswick, T. Fahey, S. Ebrahim, Accuracy and impact of risk assessment in the primary prevention of cardiovascular disease: a systematic review, Heart 92 (12) (2006) 1752–1759.