



Title: Epidemiological characterization of high-risk cardiovascular factors using data collected "smart health kiosks" in participants of the "por tu corazón" project: intergender analysis through artificial intelligence strategies

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Editorial label ECORFAN: 607-8695
BECORFAN Control Number: 2021-01
BECORFAN Classification (2021): 131221-0001

Pages: 24
RNA: 03-2010-032610115700-14

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Holdings		
Mexico	Colombia	Guatemala
Bolivia	Cameroon	Democratic
Spain	El Salvador	Republic
Ecuador	Taiwan	of Congo
Peru	Paraguay	Nicaragua

Health challenges

Health challenges in Mexico and Worldwide:

- Overweight and Obesity
- Diabetes
- High Blood Pressure
- Hyperlipidemia
- Cardiovascular Disease
- Cancer
- Mental Disorders

Causes

- Current demographic change in its population (inversion of the population pyramid)
- Adoption of unhealthy habits, such as sedentarism, poor diet, smoking, and alcohol consumption

Worldwide Status (CVD)

WHO:

- Current main death cause → 17.3 million deaths
 - A coronary event each four seconds
 - A cerebrovascular event each five seconds
 - 1.5 to 5% of people with Arterial Hypertension die directly from that condition.
- Future main death cause → 23.3 million death by 2030

PAHO

- 20.7 millions deaths within 10 years from CVD attributable Arterial Hypertension
- 1/3 of deaths in Latin America and the Caribbean

Cardiovascular Disease (CVD)

Cardiovascular Diseases (CVD):

- Involved the heart and the blood vessels
 - Coronary Heart Disease
 - Cerebrovascular Disease
 - Peripheral Arteriopathies
 - Rheumatic Heart Disease
 - Heart Malformations
 - Deep Vein Thromboses
 - Pulmonary Embolism



Causes

Oxygen Supply/Necessity Imbalance in either the myocardium or the brain



Vessel obstruction often due to atherosclerosis



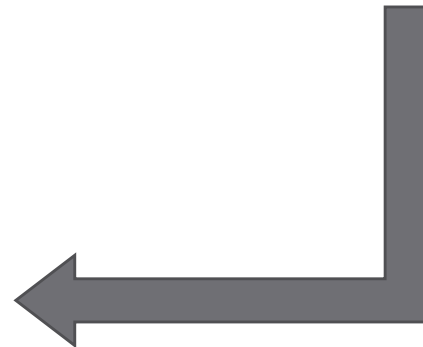
Anoxia



Heart attack or a Cerebrovascular disease.

CVD Risk Factors

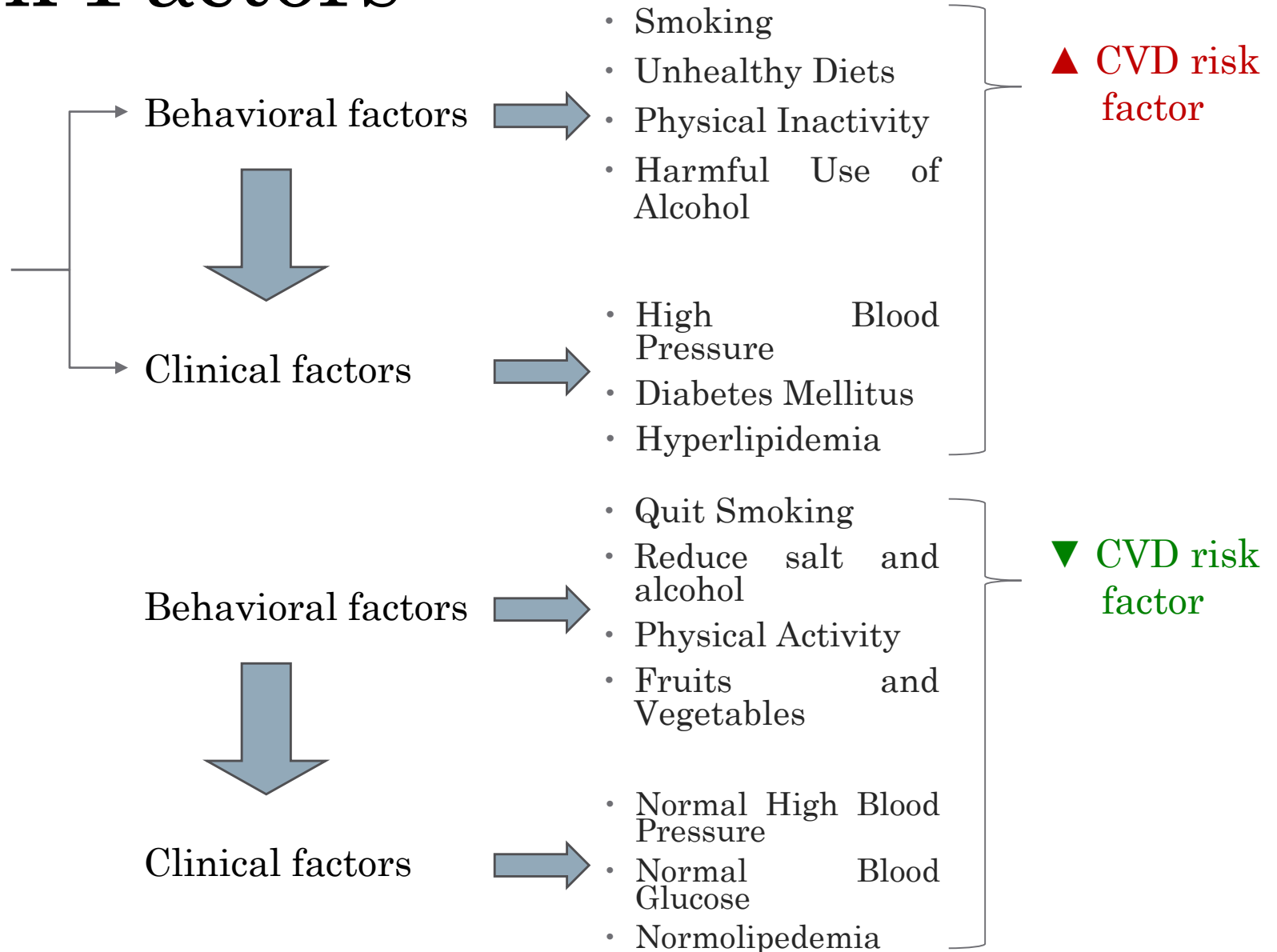
- Smoking
- Unhealthy Diets
- Physical Inactivity
- Harmful Use of Alcohol
- High Blood Pressure
- Diabetes Mellitus
- Hyperlipidemia



CVD Risk Factors

CVD Risk Factors

(FHS) A measurable element or characteristic that is causally related to an increase in the frequency of a disease and constitutes an independent and significant predictive factor of the risk of contracting a disease



Cardiovascular Risk (CVR)

Assessment

- Framingham Study
- SCORE
- American College of Cardiology / American Cardiology Association (ACC/ACA)

Cardiovascular Disease In Mexico

Status

- An increase in obesity, hypercholesterolemia, arterial hypertension and metabolic syndrome

Proposal

- CICESE → Smart Health Kiosk (KIS)
 - Generate Health Awareness
 - Promote the prevention of CVD
 - Recollect Somatometric, Clinical and Behavioral Data
 - ACC/ACA algorithm-based assessment
- Upjohn (Pfizer) → *Por tu Corazón*
 - Awareness strategy respecting CVD in the workplace
 - 30-74 year people from GDL, MTY and CDMX (15,000)

Electronic Medical Records (EMR)

- Part of the Big Data
- Analysis, Interpretation, and Transformation is needed to acquire clinical value
- Development of new technologies for even healthcare automatization, making the EMR an very unexploited tool in the healthcare field

Artificial Intelligence

- Examples:
 - Artificial Neural Network (ANN)
 - Machine Learning (ML)
- ML
 - Potential to processing immense quantities of data and to be trained with the use of millions of records without attention gaps
 - Provide comprehensive solutions for multi-view data
 - Generate predictive modeling with specific requirement by extracting and learning from patterns in the data
- ANN
 - Learning capacity due to multilayer neural networks with superior performance to traditional ML techniques

Statistical Features

- Mean square error (RMSE) and / or the mean absolute relative difference (MARD)
- Area under the Receiver Operating Characteristic Curve (AROC)
- Matthews Correlation Coefficient (MCC) values and the Clarke Error Grid (CEG)
 - MCC index returns a value in the range of $[-1, 1]$, where 1 is a perfect prediction and -1 is a misclassification
 - CEG metric assesses the clinical significance of the deviation from the estimated values

Justification

- Cardiovascular risk
 - Predict the future, based on mathematical algorithms following prospective studies to predict that individuals will develop cardiovascular disease throughout their lives, in a predetermined period.
- CVD are the main causes of morbidity and mortality in the Mexico
 - KIS / *“Por tu Corazon”*

Problem

- What are the main factors associated with the presence of cardiovascular risk (high, medium or low) in workers from various institutions in Mexico that participate in the “Por Tu Corazón” project?

Objective

- To establish the initial outcome of the “Por tu Corazon” Project respecting the CVDs health position on the work environment from diverse institutions with information collected through "Smart Health Kiosks" (KIS, after its Spanish acronym) in a sample of 734 persons.

Research Methodology

- The collection of real-world data using large platforms can be buggy, that is, despite the volume, the data can be missing or mislabeled. 24
- Data obtained in the clinical setting sometimes show missing data and erroneous information. This results in non-physiological discontinuities. To mitigate these events, the data must be processed. 27
- The data collected for this project is retrospective during the “Por tu Corazón” project capture period, where all patient identification information is rendered anonymous before the data is provided to researchers. These data include demographic information, anthropometric values, clinical laboratory measurements and some relevant clinical aspects. In addition to these individual data, there is a calculation of the cardiovascular risk of each patient.

Sample

- The sample of 734 individuals participating in the initial phase of the “Por tu Corazon” Project.
- The former sample features consist in adults between 30 and 74 years of age, from the central, northern and bajío regions in public and private institutions that participate in the “Por tu Corazón” Project.
- The calculation is based on the number of variables and observations for those variables. Proposing as a minimum requirement the existence of 10 observations for each variable.

Sample

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- Adults between 30 and 74 years of age
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- Public and private institutions that participate in the “Por tu Corazón” Project.
- The calculation is based on the number of variables and observations for those variables.
- Proposing as a minimum requirement the existence of 10 observations for each variable.

Results

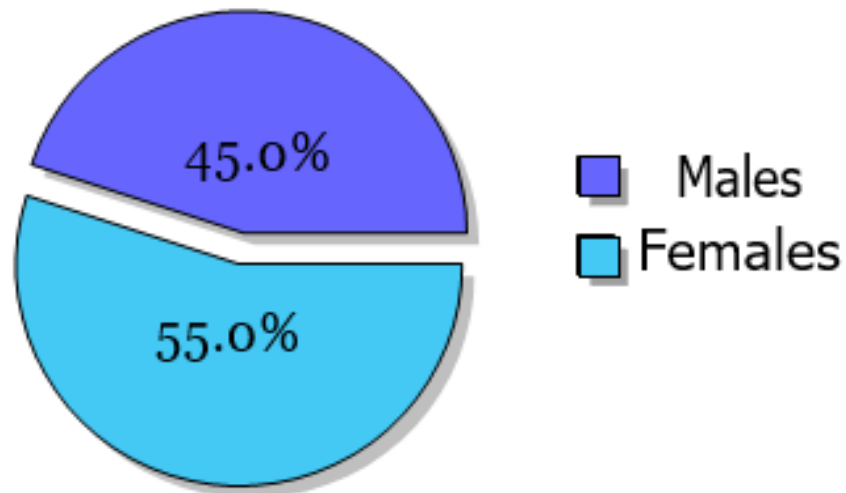


Figure 2: The proportion of males and females.

Variable	Average	SD*	RSD**
Age (years)	36.9	11.8	32.0%
Total cholesterol (mg / dL)	147.5	35.4	24.0%
HDL cholesterol (mg / dL)	47.2	12.4	26.3%
Triglycerides (mg / dL)	171.3	91.5	53.4%
LDL cholesterol (mg / dL)	70.7	27	38.2%
Systolic pressure (mmHg)	122.3	15.9	13.0%
Diastolic pressure (mmHg)	79	10.4	13.2%
Glucose (mg / dL) (Not always fasting) ^(a)	109.6	34.7	31.7%
Abdominal perimeter (cm)	92	15.4	16.7%
Weight (kg)	73.4	15.3	20.8%
Size (height, m)	1.63	0.08	4.9%
BMI	27.4	4.5	16.4%
Cardiovascular risk (%)	3.5	5.7	162.9%
Cardiovascular age (years)	34.9	16	45.8%

*Standard Deviation **Relative Standard Deviation

Results

Variable	Average	SD*	RSD**
Age (years)	35.9	11.5	32.0%
Total cholesterol (mg / dL)	151.1	34.4	22.8%
HDL cholesterol (mg / dL)	51.3	13	25.3%
Triglycerides (mg / dL)	154.2	81	52.5%
LDL cholesterol (mg / dL)	71.2	25.3	35.5%
Systolic pressure (mmHg)	116	13.7	11.8%
Diastolic pressure (mmHg)	76.2	9.8	12.9%
Glucose (mg / dL) (Not always fasting) ^(a)	108.4	33.1	30.5%
Abdominal perimeter (cm)	87.2	12.1	13.9%
Weight (kg)	66.4	12.1	18.2%
Size (height, m)	1.57	0.06	3.8%
BMI	26.7	4.6	17.2%
Cardiovascular risk (%)	2	2.7	135.0%
Cardiovascular age (years)	31.5	15.6	49.5%

*Standard Deviation **Relative Standard Deviation

Variable	Average	SD*	RSD**
Age (years)	38.2	11.9	31.2%
Total cholesterol (mg / dL)	143	36	25.2%
HDL cholesterol (mg / dL)	42.2	9.5	22.5%
Triglycerides (mg / dL)	192.3	98.9	51.4%
LDL cholesterol (mg / dL)	70.2	29.2	41.6%
Systolic pressure (mmHg)	130	14.9	11.5%
Diastolic pressure (mmHg)	82.4	10.1	12.3%
Glucose (mg / dL) (Not always fasting) ^(a)	111.1	36.5	32.9%
Abdominal perimeter (cm)	98	17	17.3%
Weight (kg)	82.1	14.3	17.4%
Size (height, m)	1.69	0.06	3.6%
BMI	28.3	4.3	15.2%
Cardiovascular risk (%)	5.4	7.5	138.9%
Cardiovascular age (years)	39.1	15.5	39.6%

*Standard Deviation **Relative Standard Deviation

Results

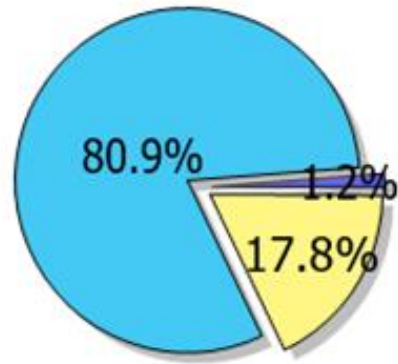
Question	Amount	Percentage
Have you been diagnosed with hypertension blood by any doctor?	47	6.3%
Have you been prescribed treatment for hypertension?(b)	35	74.4%
Are you taking the treatment indicated by the doctor? ^(b)	33	70.2%
Smoking	110	14.9%
Have you been diagnosed with diabetes by any doctor?	32	4.3%
Has your doctor prescribed treatment for diabetes? ^(c)	10	31.2%
Are you taking the treatment indicated by the doctor?(c)	0	0.0%
¿Have you been diagnosed with high cholesterol by any doctor?	103	14.0%
Has your doctor prescribed treatment for high cholesterol? ^(d)	53	51.4%
Are you taking the treatment indicated by the doctor? ^(d)	34	33.0%

Results

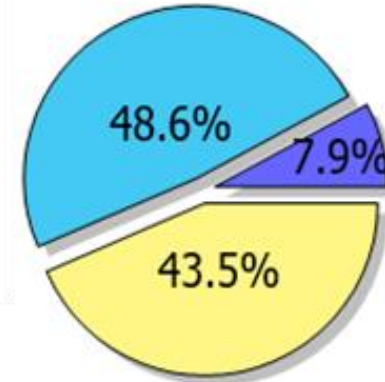
Question	Amount	Percentage
Have you been diagnosed with hypertension blood by any doctor?	27	6.6%
Have you been prescribed treatment for hypertension?(b)	19	70.3%
Are you taking the treatment indicated by the doctor? ^(b)	18	66.6%
Smoking	52	12.8%
Have you been diagnosed with diabetes by any doctor?	19	4.7%
Has your doctor prescribed treatment for diabetes? ^(c)	6	31.5%
Are you taking the treatment indicated by the doctor? ^(c)	0	0.0%
¿Have you been diagnosed with high cholesterol by any doctor?	52	12.8%
Has your doctor prescribed treatment for high cholesterol? ^(d)	25	48.0%
Are you taking the treatment indicated by the doctor? ^(d)	15	28.8%

Question	Amount	Percentage
Have you been diagnosed with hypertension blood by any doctor?	20	6.0%
Have you been prescribed treatment for hypertension?(b)	16	80.0%
Are you taking the treatment indicated by the doctor? ^(b)	15	75.0%
Smoking	58	17.5%
Have you been diagnosed with diabetes by any doctor?	13	3.9%
Has your doctor prescribed treatment for diabetes? ^(c)	4	30.7%
Are you taking the treatment indicated by the doctor? ^(c)	0	0.0%
¿Have you been diagnosed with high cholesterol by any doctor?	51	15.4%
Has your doctor prescribed treatment for high cholesterol? ^(d)	28	54.9%
Are you taking the treatment indicated by the doctor? ^(d)	19	37.2%

Results



- Cardiovascular age equal to chronological age
- Cardiovascular age less than chronological age
- Cardiovascular age greater than chronological age



- Cardiovascular age equal to chronological age
- Cardiovascular age less than chronological age
- Cardiovascular age greater than chronological age

Results

df=732 $t_{\alpha=0.05}^{100}=1.984$	Δ average	s2p	sp	t	$t > t_{\alpha=0.05}^{100}$
Age (years)	2.300	11.680	3.418	9.070	Yes
Total cholesterol (mg / dL)	8.100	35.119	5.926	18.421	Yes
HDL cholesterol (mg / dL)	9.100	11.427	3.380	36.281	Yes
Triglycerides (mg / dL)	38.100	89.045	9.436	54.415	Yes
LDL cholesterol (mg / dL)	1.000	27.053	5.201	2.591	Yes
Systolic pressure (mmHg)	14.000	14.239	3.774	50.001	Yes
Diastolic pressure (mmHg)	6.200	9.935	3.152	26.510	Yes
Glucose (mg / dL)	2.700	34.628	5.885	6.184	Yes
Abdominal perimeter (cm)	10.800	14.302	3.782	38.488	Yes
Relative Abdominal Perimeter	0.075	0.162	0.403	2.506	Yes
Weight (kg)	15.700	13.089	3.618	58.486	Yes
Size (height, m)	0.120	0.060	0.245	6.602	Yes
BMI	1.600	4.465	2.113	10.205	Yes
Cardiovascular risk (%)	3.400	4.857	2.204	20.791	Yes
Cardiovascular age (years)	7.600	15.555	3.944	25.970	Yes

Discussion

- Difference between each of the genders respecting the cardiovascular age (being the percentage of females which their cardiovascular age is higher than their chronological age of 17.8% and of 43.5% for males in the same respect).
- Each feature of this information is distinct between genders, indicating that men have significantly higher risk of suffering of a CVD, at least in the Mexican work environment.

Discussion

- Multiples factors could be acting respecting this gender gap.
 - Men are less likely to participate and endure in dieting to lose weigh in comparison with women.
 - Men are more than twice as likely of suffering a myocardial infarction than women.
 - Estrogen may provide protection against CVD (postmenopausal women undergoing hormone replacement treatment have a 50% reduction in risk of a coronary event)
- Regardless of if the cause is either biological or behavioral, the importance of studying and considering the gender gap of CVR is pivotal to improve the healthcare provided to the people in the work environment.

Conclusion

- The data reveals that there is a difference between genders regarding CDR, being significantly higher in men than in women (43.5% vs 17.8%).
- Additionally, all the risk factors respecting the CVD are higher in men than in women, hinting to be the cause of the CDR between genders. However, further research must be done if this is had either biological causes such as the estrogen protective role in CVD or if there are behavioral aspects between men and women which could tip the balance regarding this issue.
- Moreover, there may be both biological and behavioral aspects respecting this difference, which means that a more wholesome approach regarding CDR and cardiovascular prevention should be applied.



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