Specific weights of metabolic syndrome risk factors in patients attending the Hospital Integral "Jose María Morelos", according to the Binary Logistic Regression Model – study of cases and controls

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ABSTRACT  
Introduction. Metabolic syndrome is a group of disorders that occur at the same time and increase the risk of heart disease, stroke and type 2 diabetes mellitus. These disorders include high blood pressure, hyperglycemia, excess body fat around the waist, and abnormal cholesterol and triglyceride levels. Having just one of these conditions does not mean you have metabolic syndrome, but it does mean you are at increased risk for serious disease. And if you develop more of these conditions, the risk of complications such as type 2 diabetes mellitus and heart disease increases even more. Metabolic syndrome is increasingly common and up to one third of Mexican adults have it. If you have metabolic syndrome, or any of its components, radical lifestyle changes may be delayed. Binary logistic regression is one of the most expressive and versatile statistical tools available for data analysis in both clinical and epidemiology. Its origin dates back to the 1960s with the transcendental work of Cornfield, Gordon & Smith on the risk of suffering from coronary heart disease and, in the form we know it today, with the contribution of Walter & Duncan in which the subject of estimating the probability of occurrence of a certain event as a function of several variables is addressed. Its use has been universalized and expanded since the early eighties, mainly due to the computer facilities available since then. Objective. To evaluate multivariate specific weights of five risk factors (Abdominal obesity, Fasting blood glucose, Triglycerides, HDL–Cholesterol and LDL–Cholesterol). Material and methods. The epistemological approach corresponds to the quantitative, probabilistic or positivist approach. The study design corresponds to that of an analytical observational epidemiological case→control study with directionality effect→risk factors and prospective temporality. The criteria of the International Diabetes Federation (FDI) were used in the present work. Five hundred patients [100 (20.00%) cases and 400 (80.00%) controls] were studied. Any patient with Abdominal obesity ≥ 102 cm in the male gender and ≥ 88 cm in the female gender was labeled as a case. Any patient with Abdominal obesity ≤ 101 cm in the male gender and ≤ 87 cm in the female gender was labeled as control. Multiple controls from the same population base such as two or more controls per case can be used to increase the statistical power of the study. However, it is accepted that increased statistical power is gained only up to a rate of one case for every four controls (Gordis, 1996). In the evaluation of the specific weights of the five risk factors, the values of the Exponents β or Odds Ratios (OR) of the binary logistic regression model were used. Results. OR> 1 indicated the positive contribution of the risk factors Abdominal obesity, Fasting blood glucose, Triglycerides, HDL–Cholesterol and LDL–Cholesterol. Conclusion. The obtained values of the Exponents β or ORs point to the positive contribution in ascending numerical order of the risk factors HDL–Cholesterol (1.5966); Fasting Hematic Glucose (4.0735); Abdominal Obesity (4.6475); LDL–Cholesterol (13.4475); and Triglycerides (17.7779).  

Keywords: Specific Weights, Risk Factors, Metabolic Syndrome, Binary Logistic Regression Model.
1 INTRODUCTION

Metabolic syndrome is the name given to the group of metabolic alterations consisting of Abdominal obesity, decreased HDL–Cholesterol concentrations, elevated triglyceride concentrations, increased blood pressure and hyperglycemia. Metabolic syndrome is becoming one of the major public health problems of the 20th century1. Associated with a 5–fold increase in the prevalence of type 2 diabetes mellitus and a 2→3–fold increase in the prevalence of cardiovascular disease (Zimmet et al., 2001; Eckel et al., 2005; Zimmet et al., 2005), the metabolic syndrome is considered to be an important element in the current epidemic of type 2 diabetes mellitus and cardiovascular disease, such that it has become a major public health problem worldwide (Eckel et al., 2005). Premature morbidity and mortality due to cardiovascular disease and type 2 diabetes mellitus could completely unbalance the health budgets of many developed and developing countries. Metabolic syndrome is not a new disease; it was described at least 80 years ago (in the 1920s) by Kylin, a Swedish physician who defined the association between arterial hypertension, hyperglycemia and gout –a common and complex form of arthritis that can affect anyone. It is characterized by sudden and severe attacks of pain, swelling, redness and tenderness in one or more joints, often in the big toe (Kylin, 1923).

The binary logistic regression model is highly efficient because each observation provides information about all the factors included in the analysis (Fleiss, 1973). Binary logistic regression is one of the most expressive and versatile statistical tools available for data analysis in both clinical and epidemiology. Its origin dates back to the 1960s with the transcendent work of Cornfield, Gordon & Smith, 1961, and already, in the form in which we know it today, with the contribution of Walter & Duncan in which the subject of estimating the probability of occurrence of a certain event as a function of several variables is addressed (Walter; Duncan, 1967). Its use has been universalized and expanded since the early eighties, mainly due to the computer facilities available since then. Using the binary logistic regression model, the present work was aimed at evaluating the specific weights of five risk factors for metabolic syndrome in patients attending the Hospital Integral "Jose Maria Morelos" in the Mayan municipality of Jose Maria Morelos in the Mexican state of Quintana Roo, Mexico, in order to detect those risk factors that can be modified by public health interventions by the health authorities.

2 BACKGROUND

Marañón –founder of modern endocrinology in Spain– explicitly pointed out that arterial hypertension is a prediabetic state; this concept also applies to Abdominal obesity and there must be some form of general predisposition for the association of fasting hematic glucose with arterial hypertension,
Abdominal obesity and perhaps also with gout, so that diet is essential for the prevention and treatment of all these disorders (Prädiabetische Zustände, 1927).

In 1947, Vague published a now classic research paper in which he drew attention to the fact that the phenotype of obesity with excessive accumulation of adipose tissue in the upper body was associated with the metabolic disturbances seen in type 2 diabetes mellitus and cardiovascular disease (Vague, 1947).

Twenty years later, the simultaneous occurrence of type 2 diabetes mellitus, hyperinsulinemia, hypertriglyceridemia, and cardiovascular disease was documented (Avogaro et al., 1967).

The clinical importance of the metabolic syndrome was highlighted again twenty years later by Reaven (Reaven, 1988), who described the presence of a set of metabolic alterations whose central pathophysiological feature is insulin resistance. Reaven called this condition "Syndrome X" but, surprisingly, did not include Abdominal obesity; however, Abdominal obesity has been included in the concept of metabolic syndrome in all subsequent definitions (Balkau; Charles, 1999; WHO, 1999; Adult Treatment Panel III, 2001; Alberti et al., 2005; International Diabetes Federation, 2005). Since the first official definition of metabolic syndrome by the World Health Organization Working Group (WHO, 1999), several alternative definitions have been proposed. The most widely accepted have been those developed by the European Group for the Study of Insulin Resistance; Balkau and Charles, 1999; and by the Adult Treatment Panel III, 2001. Central to the definition of metabolic syndrome proposed by WHO was the biological and physiological description of insulin resistance (WHO, 1999). However, several limitations to the WHO definition were subsequently identified, the most important of which related to the need for the euglycemic clamp technique to determine insulin sensitivity. This complicated technique made it virtually impossible to use this definition in both clinical practice and epidemiological studies.

Considering that the WHO definition might be too complex for application in multiple contexts, since it was based primarily on insulin resistance, the European Group for the Study of Insulin Resistance developed a modified version of this definition to make it more user–friendly. This new version relied on fasting insulin concentrations instead of the hyperinsulinemic euglycemic "clamp" technique to determine insulin resistance (Balkau; Charles, 1999). The definition of the European Group for the Study of Insulin Resistance still retained insulin resistance as an essential component, since insulin resistance was considered to be the main etiological determinant of the metabolic syndrome. However, these investigators limited the use of the definition of the metabolic syndrome to cases in which insulin resistance could be simply and reliably quantified. Therefore, patients with diabetes were excluded from this definition, since the β–cell dysfunction that characterizes type 2 diabetes makes estimates of insulin sensitivity unreliable. The European Group for the Study of Insulin Resistance definition also introduced waist circumference (94 cm in men and 80 cm in women) as a measure of adiposity.
Two years later, the National Centers for Environmental Prediction introduced the definition of Adult Treatment Panel III. Proposed for application in clinical practice, this definition did not include a specific quantification of insulin sensitivity and adopted a less "glucocentric" approach, considering all the components of the metabolic syndrome equally. The quantification parameter for Abdominal obesity was still waist circumference, although with higher threshold values than those used in the definition of the European Group for the Study of Insulin Resistance (102 cm in men and 88 cm in women). The Adult Treatment Panel III definition became very popular due to its simplicity. Its components can be easily and systematically determined in most clinical and research settings. However, unlike the WHO definition, the Adult Treatment Panel III definition did not incorporate proinflammatory and prothrombotic variables as part of an expanded definition.

To further complicate the situation, the American Association of Clinical Endocrinology made a modification of the Adult Treatment Panel III definition. This new definition was based on the consideration that insulin resistance was the basic problem (Kylin, 1923).

The American Association of Clinical Endocrinology listed four factors as "identifying alterations" of the metabolic syndrome: elevated Triglyceride concentration, decreased HDL–Cholesterol concentration, increased blood pressure and increased glucose concentrations –both fasting and after glucose administration. Several factors such as Abdominal obesity, diagnosis of hypertension, gestational diabetes, cardiovascular disease, family history of Fasting blood glucose, non–European racial origin, age > 40 years and sedentary lifestyle were considered to increase the likelihood of metabolic syndrome. The American Association of Clinical Endocrinology excluded Abdominal obesity as a component of the metabolic syndrome because it considered Abdominal obesity to be a contributing factor to the development of insulin resistance rather than a consequence of it. By excluding Abdominal obesity as a core component of the metabolic syndrome, the American Association of Clinical Endocrinology definition generated numerous criticisms, given the large amount of data suggesting that Abdominal obesity is a major risk factor for Fasting blood glucose and cardiovascular disease (Alberti et al., 2005; Eckel et al., 2005).

These different definitions have not only presented differences in the proposed components, but also in the threshold values used to define each of the components, all of which has generated considerable confusion. This confusion has not only reduced the usefulness of the definitions in the clinical context, but has also made it difficult to compare the incidence of metabolic syndrome in different population groups.

A detailed review of the prevalence of the metabolic syndrome defined according to the various criteria proposed (Prädiabetische Zustände, 1927) has recently been published. A notable aspect has been the great difficulty encountered in establishing comparisons between prevalence data in different
populations. There is currently a wide variation in prevalence data when different criteria are used, which has served to underline the need for an international standardized definition.

Thus, the International Diabetes Federation has pointed out the urgent need to rationalize the wide variety of definitions developed for the metabolic syndrome. This need has been identified both in clinical practice and in research settings.

For all these reasons, the International Diabetes Federation asked its Epidemiological Working Group to create a group of experts from different regions of the world to establish a new global definition of the metabolic syndrome.

Thus, a consensus group was formed consisting of members of the International Diabetes Federation from all geographic regions and representatives of various professional organizations, including those that had proposed the previous definitions of the metabolic syndrome. The consensus group was chaired by two investigators (Alberti et al., 2005) and a list of the other members of the group is given at the end of the editorial. The goal was to establish a new set of criteria that could be used both epidemiologically and clinically worldwide to identify individuals with metabolic syndrome, better define the nature of the syndrome, and emphasize lifestyle modification and therapeutic strategies to reduce the long–term risk of cardiovascular disease and Fasting blood glucose.

An important component of this new initiative was the development of a set of guidelines to compensate for differences in waist circumference and adipose tissue distribution among different population groups, especially in people of Asian origin (Shiwaku et al., 2004; Tan et al., 2004; Eckel et al., 2005). The consensus group also developed a series of recommendations for the use of additional criteria that could be included in the study of the metabolic syndrome in research work. Finally, the International Diabetes Federation identified areas where further studies are needed, especially with regard to research on the etiology of the metabolic syndrome.

The International Diabetes Federation felt that there was an urgent need to create a simple and universally accepted diagnostic tool whose application in clinical practice would be sufficiently easy and which would not rely on parameters that can only be applied in research settings. This objective led to the proposal of the International Diabetes Federation regarding the development of a new definition in which Abdominal obesity represents a necessary requirement and in which –for the first time– threshold values are provided for defining obesity that are different in different ethnic groups (Alberti et al., 2005; International Diabetes Federation, 2005). The new International Diabetes Federation definition has taken into account the large amount of data indicating that abdominal adiposity is common to all components of the metabolic syndrome. Increased waist circumference –which is a well–accepted surrogate parameter for abdominal adiposity– is now considered a necessary prerequisite for establishing a diagnosis of metabolic syndrome. This consideration has the added advantage that the simple determination of waist
circumference represents a first screening test for the syndrome that can be performed simply and very cheaply anywhere in the world. Threshold values for waist circumference referring to different ethnic groups have been incorporated in the definition, since research studies have shown that the degrees of obesity for which the risk of other complications starts to increase are different in different population groups (Shiwaku et al., 2004; Tan et al., 2004; Eckel et al., 2005). For example, for South and Southeast Asians, the threshold values for men and women are 90 and 80 cm, respectively (Alberti et al., 2005). The recognition of these characteristics of the metabolic syndrome in people with impaired glucose metabolism and Fasting blood glucose is of particular importance because it indicates the need for active measures to reduce cardiovascular risk. As with many of the previous efforts to define diagnostic criteria for Abdominal obesity, Fasting blood glucose, hypertension and dyslipidemia, there is always the possibility that results from new research studies will force changes—including the incorporation of new components such as C–reactive protein, adiponectin and other adipokines (Alberti et al., 2005; International Diabetes Federation, 2005).

Fortunately, there are therapeutic regimens that can modify all these risk factors. Most importantly, reducing body weight and increasing physical activity decreases insulin resistance, improves glucose tolerance and other risk factors for cardiovascular disease—such as increased Triglycerides and hypertension (Tuomilehto et al., 2001; Knowler et al., 2002; Eckel et al., 2005). In patients in whom these measures do not produce good results, various pharmacological treatments can be used to specifically address each of the metabolic syndrome disorders, i.e. elevated blood pressure, increased Triglycerides, decreased HDL–Cholesterol concentrations and increased blood glucose. New drugs have also been introduced that can address two or more of the aforementioned alterations or, alternatively, that can facilitate the decrease in body weight. In addition, cessation of cigarette smoking and moderation in alcohol consumption are necessary.

Since the International Diabetes Federation proposed its new definition, some very interesting and controversial developments have taken place. The American Diabetes Association and the European Association for the Study of Diabetes have published an unprecedented joint report on the metabolic syndrome (Kahn et al., 2005).

Based on a review of the criteria originally used by WHO, 1999, and by the Adult Treatment Panel III, 2001, this joint report asks three questions: 1) Is it really a syndrome? –Especially since its precise cause is unknown; 2) Does its definition serve a useful purpose; and 3) Is it not a way of unnecessarily labeling and medicalizing people?

An important part of the position taken in this joint report is based on semantic issues. The International Diabetes Federation and the cardiovascular community are strongly united in the view that this group of risk factors closely related to cardiovascular disease and Fasting Blood Glucose is an
excellent reason to define a syndrome. There are many examples of diseases that have been given a
designation despite insufficient knowledge about their cause(s). The International Diabetes Federation
believes that the definition of the metabolic syndrome serves a useful purpose in identifying individuals
–both in the general population and in the clinical setting– who are at elevated risk for cardiovascular
disease and First degree relative, especially when using the new criteria proposed by the International
Diabetes Federation as outlined above.

The growing epidemic of type 2 diabetes mellitus and cardiovascular disease worldwide –
especially in developed countries– appears to be sufficient reason to identify and treat individuals with
the metabolic syndrome. The authors consider that the new criteria of the International Diabetes
Federation –which have recently been published in Lancet (Alberti et al., 2005) are not the last word. It
is hoped that they will be useful in identifying individuals at increased risk and also that research studies
based on these criteria will allow the definition of predictive indexes with better diagnostic capacity.

On the other hand, it is very important to highlight the fact that following the criticisms offered by
the American Diabetes Association/European Association for the Study of Diabetes, the American Heart
Association and the National Heart, Lung, and Blood Institute have published scientific statements on the
metabolic syndrome (Grundy et al., 2005) in which an updated Adult Treatment Panel III classification is
included. The updated Adult Treatment Panel III classification does not consider the criterion of increased
waist circumference necessary in patients with three other risk factors. The Adult Treatment Panel III
definition also contemplates a decrease in the waist circumference threshold value for risk –particularly
in persons of Asian–American origin. This updated version of the Adult Treatment Panel III definition
(Grundy et al., 2005) and the new criteria proposed by the International Diabetes Federation (Alberti et
al., 2005) make it possible to establish the diagnosis of metabolic syndrome in basically the same patients.

Moreover, not only are the criteria of the Adult Treatment Panel III and the International Diabetes
Federation virtually identical, but so are their recommendations regarding clinical management.

In summary, the new International Diabetes Federation definition addresses both clinical and
research needs. It also represents an affordable diagnostic tool suitable for application in different
population groups worldwide and establishes a list of possible additional criteria that should be included
in epidemiological and other research studies on the metabolic syndrome.

3 GENERAL OBJECTIVE

To evaluate multivariate specific weights of five risk factors (Abdominal obesity, Fasting blood
glucose, Triglycerides, HDL–Cholesterol and LDL–Cholesterol) in the metabolic syndrome in patients
attending the Hospital Integral "Jose Maria Morelos" of the Mayan municipality of Jose Maria Morelos in the Mexican state of Quintana Roo, Mexico.

3.1 SPECIFIC OBJECTIVES

To evaluate the contribution of specific weights using the values of the β Exponents or Odds Ratios (OR) of five risk factors in metabolic syndrome using the binary logistic regression model and the hypothesis test or Wald Chi–Square ($\chi^2_W$) test of statistical significance; and predict the value of the probability of metabolic syndrome (effect, dependent variable or response variable "Y") by constructing a binary logistic regression model, given values of causes, independent variables or explanatory variables ($X_1, X_2, X_3, X_4, X_5$).

4 FORMULATION OF HYPOTHESES

**Null hypothesis (H₀):** The values of the Exponents β or Odds Ratios (OR) are $=1$ indicating a null contribution (OR= 1) or a negative contribution (OR< 1), respectively. Additionally, there is no statistically significant evidence at the significance level or 5% significance level to suppose that the effect (metabolic syndrome) and the risk factors (Abdominal obesity, Fasting blood glucose, Triglycerides, HDL–Cholesterol and LDL–Cholesterol) are associated.

**Alternative hypothesis, working hypothesis or research hypothesis (H₁):** The values of the Exponents β or Odds Ratios (OR) are $> 1$ indicating a positive contribution (OR> 1). Additionally, there is statistically significant evidence at the significance level or 5% significance level to suppose that the effect (metabolic syndrome) and the risk factors (Abdominal obesity, Fasting blood glucose, Triglycerides, HDL–Cholesterol and LDL–Cholesterol) are associated.

5 MATERIAL AND MÉTHODS

5.1 EPISTEMOLOGICAL APPROACH

1. quantitative approach, probabilistic approach or positivist approach (Hernandez et al., 2017);
2. study design;
3. analytic observational epidemiological case–control study with directionality effect→risk factors and prospective temporality (Hernandez et al., 2017).
5.2 UNIVERSE OF STUDY

Cases and controls that met the inclusion criteria occurred at the Hospital Integral "Jose Maria Morelos" of the Ministry of Health during the period from July 2015 to June 2017 were recorded. The total number of registered cases was 100 (20.00%) and 400 (80.00%) controls.

The Mexican state of Quintana Roo is divided into ten municipalities, seven of which were created in 1974 in conjunction with the elevation to the rank of State of the Federation of the former Federal Territory of Quintana Roo; the eighth municipality, Solidaridad, was created in 1993; the ninth municipality, Tulum, in 2008; and the tenth municipality, Bacalar, in 2011. The origin of the municipalities of the state of Quintana Roo comes from the old initial division of the territory into three delegations: Cozumel, Santa Cruz de Bravo (today Felipe Carrillo Puerto) and Payo Obispo (today Chetumal). Even though the 1917 Constitution established that the basis of the political organization of the states is the Free Municipality, the Federal Territories continued to be divided into delegations until their respective elevation to the rank of states. On February 2, 2011 the creation of the tenth municipality of Quintana Roo, Bacalar, was announced, with territory segregated from Othon Pompeyo Blanco. On February 21, 2008 the Congress of Quintana Roo approved the draft bill for the creation of the municipality of Tulum, which obtained its territory from the current municipality of Solidaridad and includes the Tulum National Park and parts of the Sian Kan Biosphere Reserve; this was formally ratified when on March 13 the Congress of Quintana Roo unanimously approved the creation of the municipality of Tulum.

5.3 OPERATIONAL DEFINITIONS OF THE VARIABLES

**Case.** Any patient with Abdominal obesity $\geq 102$ cm in the male gender and $\geq 88$ cm in the female gender.

**Control.** Any patient with Abdominal obesity $\leq 101$ cm in the male gender and $\leq 87$ cm in the female gender.

**Metabolic syndrome.** Metabolic syndrome is defined as the clinical situation in which a patient presents three or more of the following conditions: 1) Abdominal obesity $\geq 102$ cm in the male gender and $\geq 88$ cm in the female gender); 2) Fasting blood glucose $\geq 110$ mg/dL); 3) cholesterol–HDL $\leq 45$ mg/dL in the male gender and $\leq 55$ mg/dL in the female gender; 4) high Triglycerides $\geq 150$ mg/dL; and 5) elevated blood pressure (systolic blood pressure $\geq 130$ mmHg or diastolic blood pressure $\geq 85$ mmHg).
Thus, the patient with metabolic syndrome may present three, four or five of these risk factors, with the intensity of each of them varying, giving him or her a different, but always high, risk of arterial disease.  

**Hypertension.** It is a common problem that can be serious if left untreated. Sometimes it causes no symptoms and the only way to detect it is by measuring blood pressure. To establish the diagnosis of arterial hypertension, measurements must be taken on two different days and on both readings the systolic blood pressure must be ≥ 130 mmHg and the diastolic blood pressure ≥ 85 mmHg.

**Abdominal obesity.** Overweight and obesity are defined as an abnormal or excessive accumulation of fat that may be detrimental to health. Body mass index (BMI) is a simple indicator of the relationship between weight and height that is frequently used to identify overweight and obesity in adults. It is calculated by dividing a person's weight in kilograms divided by the square of his or her height in meters (kg/m²). For adults, WHO defines overweight and obesity as follows:

1. overweight: 25.00 kg/m² ≤ BMI ≤ 29.99 kg/m²; and
2. obesity: BMI ≥ 30.00 kg/m².

**Insulin resistance.** Insulin resistance is invariably accompanied by an increased demand for insulin so that the body can maintain euglycemia.

**Dyslipidemia.** According to the World Health Organization it is a disease caused by an increase in the concentration of Cholesterol and Triglycerides in the blood; this limits the blood supply (process that carries blood to an organ or a wound).

**Cholesterol–HDL.** HDL stands for high-density lipoproteins. It is sometimes called the "good" cholesterol because it transports cholesterol from other parts of the body to the liver. The liver then removes the cholesterol from the body. High Density Lipoproteins are those that transport free cholesterol and phospholipids from the tissues to the liver. Because HDL can remove cholesterol from the arteries and transport it back to the liver for excretion, they are commonly referred to as "good" cholesterol.

**Cholesterol–LDL.** LDL stands for Low Density Lipoproteins. LDL–Cholesterol is considered to be the "bad" cholesterol, as it contributes to fatty acid deposits in the arteries (atherosclerosis). This narrows the arteries and increases the risk of heart attacks, strokes and peripheral artery disease.

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1 Available at: https://www.webconsultas.com/sindrome–metabolico/que–es–el–sindrome–metabolico–3602
2 Available at: https://www.who.int/es/news–room/fact–sheets/detail/hypertension
3 Available at: https://www.who.int/es/news–room/fact–sheets/detail/obesity–and–overweight
4 Available at: https://www.intramed.net/contenidover.asp?contenidoid=88298
6 Available at: https://www.google.com.mx/search?q=hdl&sxsrf=apwo8wxdrrjcz9oeewytrf88k4tw86–mjrg%3a1683757588182&source=hp&ei=fbpc23chljgkpippossqag&iflsig=aoeireoaaaaazfwojtrft8k4tw86–mjrg%3a1683757588182
**Triglycerides.** Triglycerides are the most common type of fat in the body. They store excess energy from the diet. A high Triglyceride level combined with high LDL–Cholesterol and/or low HDL–Cholesterol levels is linked to the accumulation of fatty deposits in the artery walls, which increases the risk of heart attack and stroke\(^8\).

The data were analyzed with IBM SPSS Statistics for Windows, version 22. Continuity correlation tests (χ²) were performed to assess the statistical differences between the characteristics of the participants. The calculation of the OR was estimated using binary logistic regression analysis in which the presence of metabolic syndrome was entered as the dependent variable and the five risk factors (Abdominal obesity, arterial hypertension, Triglycerides, HDL–Cholesterol and LDL–Cholesterol) as independent variables.

The significance level of the results obtained in the hypothesis contrast was \(p \leq 0.0500\).

<table>
<thead>
<tr>
<th>Abnormal values</th>
<th>ATP III</th>
<th>WHO</th>
<th>AACE</th>
<th>IDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglycerides ≥ 150 mg/dL</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>HDL–Cholesterol &lt; 40 mg/dL in men and &lt; 50 mg/dL in women</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>LDL–Cholesterol ≥ 130 mg/dL→159 mg/dL</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Blood pressure &gt; 130/85 mmHg</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Insulin resistance (IR)</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Fasting blood glucose &gt; 100 mg/dL</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Glucose 2 hours=140 mg/dL</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Abdominal obesity ≥ 102 cm for men, and ≥ 88 cm for women</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Body Mass Index ≥ 30.00 kg/m²</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Microalbuminuria</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk factors and diagnosis</td>
<td>3 + IR</td>
<td>≥ 2</td>
<td>Clinical criteria</td>
<td>Abdominal obesity</td>
</tr>
</tbody>
</table>

Table 1. The components of the metabolic syndrome taking into account its definition, according to the Adult Treatment Panel III (ATP III) of the National Cholesterol Education Program, the World Health Organization (WHO), the American Association of Clinical Endocrinology (AACE), and the International Diabetes Federation (IDF).


5.4 TECHNIQUES AND PROCEDURES

The information was collected at the Clinical Archives Department of the Hospital Integral "Jose Maria Morelos" of the Ministry of Health during the study period. The data were collected from the patients' clinical records.

5.5 DATA PROCESSING

The data were reviewed (quality control of the information); classified (in qualitative and quantitative scales); computerized (IBM SPSS Statistics for Windows, Version 22 software was used); presented (in tables and graphs); summarized (the corresponding summary measures were used for data classified in qualitative and quantitative scales); analyzed and interpreted. For the elaboration of the graphs Microsoft Office Excel 365 and Harvard Graphics ChartXL for Windows, version 3.02, were used.

Finally, to estimate the association between the response variable and the explanatory variables, a binary logistic regression analysis was performed. The results are presented in Table 2.

Table 2. Results of the binary logistic regression analysis according to explanatory variables. Jose Maria Morelos, Quintana Roo, Mexico. July/2015–June/2017

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Estimated logistic coefficients (β)</th>
<th>Estimated standard errors (E.E.)</th>
<th>χ²w</th>
<th>df</th>
<th>Probabilities</th>
<th>Odds Ratios</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglycerides</td>
<td>2.8730</td>
<td>1.3463</td>
<td>4.5695</td>
<td>1</td>
<td>0.0325</td>
<td>17.7779</td>
<td>1.2702–248.8168</td>
</tr>
<tr>
<td>HDL–Cholesterol</td>
<td>0.4670</td>
<td>0.2190</td>
<td>4.5630</td>
<td>1</td>
<td>0.0327</td>
<td>1.5966</td>
<td>0.0394–2.4526</td>
</tr>
<tr>
<td>LDL–Cholesterol</td>
<td>2.5984</td>
<td>0.8887</td>
<td>8.5486</td>
<td>1</td>
<td>0.0035</td>
<td>13.4425</td>
<td>2.3551–76.7276</td>
</tr>
<tr>
<td>Fasting blood glucose</td>
<td>1.4045</td>
<td>0.4009</td>
<td>12.2760</td>
<td>1</td>
<td>0.0005</td>
<td>4.0735</td>
<td>1.8567–8.9367</td>
</tr>
<tr>
<td>Abdominal obesity</td>
<td>1.5363</td>
<td>0.3023</td>
<td>25.8328</td>
<td>1</td>
<td>0.0000</td>
<td>4.6475</td>
<td>2.5700–8.4046</td>
</tr>
</tbody>
</table>

χ²w= Wald Chi–Square statistic; df= Degrees of freedom; and 95%CI= Interval estimate at the 95% confidence level.

Source. Own elaboration using the formula of the Binary Logistic Regression Model P(Y=1|X₁, X₂, X₃, X₄, X₅)= Exponent (£) β₀ + (β₁*X₁) + (β₂*X₂) + (β₃*X₃) + (β₄*X₄) + (β₅*X₅) / 1 + Exponent (£) β₀ + (β₁*X₁) + (β₂*X₂) + (β₃*X₃) + (β₄*X₄) + (β₅*X₅)

5.6 LOGISTICS MODEL

If the response variable is denoted by "Y" it can be assumed, then, that "Y" takes the values 0 or 1; zero denotes non–occurrence and 1 denotes the occurrence of the event (metabolic syndrome). If X₁, X₂, X₃, X₄, X₅ are explanatory variables related to the occurrence of "Y" the following logistic model specifies, then, that the conditional probability of occurrence of the event (i.e., that Y= 1) given the values X₁, X₂, X₃, X₄, X₅, is:

P(Y=1|X₁, X₂, X₃, X₄, X₅)= Exponent (£) / 1 + Exponent (£). (1)
where:

\[ P(Y=1) = \text{Probability of metabolic syndrome}; \text{ and.} \]

\[ \text{Exponent (}\ell\text{)} = \beta_0 + (\beta_1 \cdot X_1) + (\beta_2 \cdot X_2) + (\beta_3 \cdot X_3) + (\beta_4 \cdot X_4) + (\beta_5 \cdot X_5) \]

Table 3 shows the values of the estimated logistic coefficients (\(\beta\)) according to explanatory variables.

Table 3. Estimated logistic coefficients according to explanatory variables. Jose Maria Morelos, Quintana Roo, Mexico. July/2015–June/2017

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Estimated logistic coefficients ((\beta))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant or intercept</td>
<td>(B_0 = -4.8318)</td>
</tr>
<tr>
<td>(X_1) = 0.0716</td>
<td>(B_1 = 0.9093)</td>
</tr>
<tr>
<td>(X_2) = 0.0327</td>
<td>(B_2 = 1.0321)</td>
</tr>
<tr>
<td>(X_3) = 0.1296</td>
<td>(\beta_3 = 0.3852)</td>
</tr>
<tr>
<td>(X_4) = 0.0947</td>
<td>(\beta_4 = 1.7064)</td>
</tr>
<tr>
<td>(X_5) = 0.0000</td>
<td>(\beta_5 = 1.5363)</td>
</tr>
</tbody>
</table>

Source. Own elaboration using the formula of the Binary Logistic Regression Model

\[ P(Y=1|X_1, X_2, X_3, X_4, X_5) = \text{Exponent (}\ell\text{)} \beta_0 + (\beta_1 \cdot X_1) + (\beta_2 \cdot X_2) + (\beta_3 \cdot X_3) + (\beta_4 \cdot X_4) + (\beta_5 \cdot X_5) / 1 + \text{Exponent (}\ell\text{)} \beta_0 + (\beta_1 \cdot X_1) + (\beta_2 \cdot X_2) + (\beta_3 \cdot X_3) + (\beta_4 \cdot X_4) + (\beta_5 \cdot X_5) \]

Therefore, substituting in the formula we obtain:

\[ P(Y=1|X_1, X_2, X_3, X_4, X_5) = \text{Exponent (}\ell\text{)} \beta_0 + (\beta_1 \cdot X_1) + (\beta_2 \cdot X_2) + (\beta_3 \cdot X_3) + (\beta_4 \cdot X_4) + (\beta_5 \cdot X_5) / 1 + \text{Exponent (}\ell\text{)} \beta_0 + (\beta_1 \cdot X_1) + (\beta_2 \cdot X_2) + (\beta_3 \cdot X_3) + (\beta_4 \cdot X_4) + (\beta_5 \cdot X_5) \]

Table 4. Probabilities of a patient having metabolic syndrome according to explanatory variables. Jose Maria Morelos Quintana Roo, Mexico. July/2015–June/2017

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Probabilities (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDL–Cholesterol</td>
<td>0.0116</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>0.0194</td>
</tr>
<tr>
<td>HDL–Cholesterol</td>
<td>0.0219</td>
</tr>
<tr>
<td>Abdominal obesity</td>
<td>0.0357</td>
</tr>
<tr>
<td>Fasting blood glucose</td>
<td>0.0421</td>
</tr>
</tbody>
</table>

Source. Own elaboration using the formula of the Binary Logistic Regression Model

\[ P(Y=1|X_1, X_2, X_3, X_4, X_5) = \text{Exponent (}\ell\text{)} \beta_0 + (\beta_1 \cdot X_1) + (\beta_2 \cdot X_2) + (\beta_3 \cdot X_3) + (\beta_4 \cdot X_4) + (\beta_5 \cdot X_5) / 1 + \text{Exponent (}\ell\text{)} \beta_0 + (\beta_1 \cdot X_1) + (\beta_2 \cdot X_2) + (\beta_3 \cdot X_3) + (\beta_4 \cdot X_4) + (\beta_5 \cdot X_5) \]

For example, a patient's probability of having metabolic syndrome when his only risk factor is fasting hematic glucose corresponds to 0.0421 = 4.21% = 42.1‰ = 421 x 10,000, that is, out of every 10,000 patients with fasting hematic glucose only 421 have the probability of having metabolic syndrome. And so on.
Graph 1. Values of the probabilities in descending numerical order of a patient having metabolic syndrome according to explanatory variables. Jose Maria Morelos Quintana Roo, Mexico. July/2015–June/2017

Graph 2. Values in descending numerical order of the Exponents B or Odds Ratios according to explanatory variables. Jose Maria Morelos Quintana Roo, Mexico. July/2015–June/2017

Source. Prepared by the authors based on the data in Table 2.

6 DISCUSSION

With respect to the binary logistic regression analysis for patients attending the Hospital Integral "Jose Maria Morelos" of the Mayan municipality of Jose Maria Morelos in the Mexican state of Quintana Roo, the values obtained from the OR indicate the positive contribution in ascending numerical order of the explanatory variables HDL–Cholesterol (1.5966); Fasting hematic glucose (4.0735); Abdominal obesity (4.6475); LDL–Cholesterol (13.4475); and Triglycerides (17.7779).
The determinants of the metabolic syndrome that could be modified through public health interventions, health education programs and healthy lifestyle changes are HDL–Cholesterol; Fasting blood glucose; Abdominal obesity; LDL–Cholesterol; and Triglycerides.

7 PERSPECTIVES

1. recommend to the health authorities the development and implementation of Health Education Programs whose main objective is to encourage the population of men and women (18 and over) to develop attitudes and behaviors that will enable them to participate in the prevention of metabolic syndrome in order to protect themselves from risks that endanger their health;

2. to elaborate a new research project that contemplates the realization of an analytical observational epidemiological study of cases and controls nested in a cohort. This will allow to know in greater detail the contribution of the specific weights of the risk factors in the development of metabolic syndrome in the Mayan municipality of José María Morelos in the Mexican state of Quintana Roo, Mexico; and

3. after the implementation of Health Education Programs – aimed at the promotion and prevention of metabolic syndrome – by the health authorities proceed to the statistical comparison of the metabolic syndrome rate obtained in the present study with the metabolic syndrome rate corresponding to the period from July 2018 to June 2020. The expected is to obtain statistically significant evidence at the 5% significance level to conclude that the 2018-2020 metabolic syndrome rate is significantly lower with respect to the 2015-2017 metabolic syndrome rate.

8 CONCLUSIONS

The obtained values of the Exponents β or ORs point to the positive contribution in ascending numerical order of the risk factors HDL–Cholesterol (1.5966); Fasting Hematic Glucose (4.0735); Abdominal Obesity (4.6475); LDL–Cholesterol (13.4475); and Triglycerides (17.7779). The results of the values of the $\chi^2$ statistic ($\alpha= 0.0500$; df= 1)$\geq 3.8416$ and the probability $p\leq 0.0500$ indicate that there is statistically significant evidence at the 5% significance level to conclude that there is an association between the response variable or effect (metabolic syndrome) and the explanatory variables, rejecting the null hypothesis ($H_0$) and accepting the alternative hypothesis, working hypothesis or research hypothesis ($H_1$).
REFERENCES


