AUDIovaPlCULTURE TO PREVENT ACUTE MYOCARDIAL INFARCTION AND OBESITY

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ABSTRACT
Overweight and obesity, according to the World Health Organization (WHO), are defined as an abnormal or excessive accumulation of fat that can harm health. The body mass index (BMI) is a simple index that is commonly used to classify overweight and obesity in adults. Overweight is a BMI greater than or equal to 25 and obesity is a BMI greater than or equal to 30; Mexicans face a high risk of cardiovascular diseases due to a high prevalence of risk factors such as obesity, due to their unhealthy lifestyles.

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1. Introduction

In the July 6, 2017 issue of the New England Journal of Medicine, members of the Global Burden of Disease 2015 Obesity Collaborators presented data on the global prevalence of overweight and obesity in youth and adults and its impact on health outcomes. Using a body mass index (BMI) of 25-29 to reflect overweight status and ≥30 to reflect obese status, in 2015 there were 603.7 million adults and 107.7 children from 195 countries who were classified as obese. This translates into an overall prevalence of 12.0% among adults and 5.0% among youth, with obesity globally estimated to have contributed to almost 4.0 million annual deaths and almost 5% of disability-adjusted life years from any cause; the majority of obesity-related deaths and disability-adjusted life years were due to cardiovascular diseases (Montalvo & Alejo, 2020). By 2016, worldwide, more than 1.9 billion adults aged 18 or older were overweight, of which more than 650 million were obese; in Mexico the 75.2% of the population of adults aged 20 years or older has a weight above what is recommended, distributed among women, 76.8% of whom 36.6% are overweight and 40.2% are obese, while in men it is 73.0%, of which 42.5% are overweight and 30.5% are obese (Dupotey, 2021).

This situation is alarming when knowing that the main cause of death in Mexico is cardiovascular disease (20.7%), which can be preventable. Acute Myocardial Infarction (AMI), usually referred to in simple terms as a heart attack, is most often caused by a decrease or interruption of blood flow to a part of the heart, leading to necrosis of the heart muscle (Carrillo and al., 2022). The available oxygen supply cannot meet the oxygen demand, resulting in cardiac ischemia. The decrease in coronary blood flow is multifactorial. Atherosclerotic plaques classically rupture and lead to thrombosis, which contributes to an acute decrease in blood flow in the coronary artery (Fiol et al., 2001), (Montes de Oca, 2022).

In Mexico, the prevalence of overweight and obesity has increased at an alarming rate in the last two decades; in 2018 at the national level, the percentage of adults aged 20 years and older with overweight and obesity was 75.2% (39.1% overweight and 36.1% obesity), a percentage that in 2012 was 71.3 percent.6 It is well known that obesity is an independent risk factor for cardiovascular disease (CVD) and one of the main causes of the increased risk of diseases such as dyslipidemia, resistance to insulin, high blood pressure (HTN) or hypertension and atherosclerosis in both adults. and children (Salinas, Schleef, Neira & Ortiz, 2022). According to INEGI in 2018, 88.4% of total deaths were due to diseases and health-related problems, highlighting cardiovascular diseases as the main cause of death in Mexico and the rest of the world; being directly related to atherosclerosis and its different risk factors (Revueltas et al., 2021).

Of the total deaths caused by cardiovascular diseases in 2018, 79,997 were men and 69,357 women, having a total of 149,368 cases; Ischemic pathologies represented 72.7% of these with 108,616 cases. In Mexico, cardiovascular diseases also represent the leading cause of death. The National Institute of Statistics and Geography (INEGI) reported 116,002 deaths in 2015, 70% due to acute myocardial infarction. Since 2013, the Organization for Economic Cooperation and Development (OECD) placed Mexico as the country with the highest 30-day mortality in people over 45 years of age due to acute myocardial infarction with 27.2%, compared to 7.9%. A decrease in general mortality has been observed; However, in 2015 a small increase of 58% was reported in our country (Izcovich et al., 2019).

It has been documented that up to 68% of young Mexican patients have more than three risk factors and in the first real-life study in the IMSS in patients with acute coronary syndrome up to 65% of the patients were high risk. Due to health problems, the three main causes of death for both men and women are: heart disease (141,619, 20.1%), diabetes mellitus (106,525, 15.2%) and malignant tumors (84,142, 12.0%). Of the total deaths caused by heart diseases, which amounts to 141,619 cases, ischemic deaths represented 71.9% with 101,877 cases, followed by hypertensive deaths with 16.4% (23,215 cases) and those related to pulmonary circulation and others. heart diseases with 11.1% (15,763 cases). Acute rheumatic fever and chronic rheumatic heart diseases together accounted for 0.6% (764 cases). This research is important because acute myocardial infarction is a relevant problem due to its frequency, cost of human lives and costs, as well as the problems that treatment entails for patients (Niño & Ballesteros, 2022).

2. Development

The WHO defines overweight and obesity as an abnormal or excessive accumulation of fat that can be harmful to health. However, we cannot leave obesity only with an anatomical definition, as this disorder...
must also be defined as a systemic disease, multiorgan, metabolic and chronic inflammatory, determined by the relationship between the genomic and the environmental, phenotypically expressed by excess body fat, which carries a greater risk of morbidity and mortality. Obesity is a chronic disease that is associated with a wide range of complications that affect many different aspects of physiology, increasing the risk of morbidity from chronic disease, disability, depression, type 2 diabetes mellitus (T2DM), cardiovascular diseases, certain types of cancer and finally, mortality (Quintero & Sánchez, 2022).

The most widely used measure of overweight and obesity is the body mass index (BMI), a simple index to classify overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m²). BMI provides the most useful population measure of overweight and obesity, since it is the same for both sexes and for all ages of adults. BMI has some limitations related to the evaluation of fat mass, as well as the diagnosis of alterations related to overweight and obesity. It was introduced into research and clinical practice on the basis of the association between BMI and mortality, with a ‘healthy’ BMI range associated with the lowest level of mortality, which lies in the range between 18.5 and 25 kg/m². This range varies, for example, depending on age, ethnicity, and chronic diseases. So, BMI values greater than 25 kg/m², that is, between 25 and 29.9 kg/m² and greater than 30 kg/m², were defined as overweight and obesity (Mokhlesi et al., 2019).

In Figure 1 we see the classification according to body mass index:

![Figure 1. BMI classification](source: World Health Organization)

Detailed analyzes revealed considerable interindividual variations in the associations between BMI and subcutaneous adipose tissue (SAT) or visceral adipose tissue (VAT) or skeletal muscle mass or biomarkers of insulin resistance and inflammation or adipocyte secretory activity. It is evident that BMI cannot define either excessive fat accumulation or the functional alterations related to it. The most serious health consequences of obesity are hypertension, diabetes, myocardial infarction and major cardiovascular events. In particular, diabetes, a consequence of excess calories, shows a direct association with other comorbidities, such as hypertension, which is positively correlated due to vascular damage. For this reason, the prevalence of cardiovascular complications has reached 64% only in older American patients who are obese and diabetic, with the incidence of ischemic heart disease occurring in more than 30% of cases (García et al., 2021).

The following table shows the different comorbidities with which obesity is related:

<table>
<thead>
<tr>
<th>Respiratory</th>
<th>Obstructive sleep apnea, greater predisposition to respiratory infections, greater incidence of bronchial asthma and Pickwickian syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignancy</td>
<td>Cancers of the endometrium, prostate, colon, rectal, breast, gallbladder, gastric cardia, bile ducts, pancreas, ovary, kidney and possibly lung cancer</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Ischemic heart disease, essential hypertension, left ventricular hypertrophy, cor pulmonale, cardiomyopathy associated with obesity, accelerated atherosclerosis</td>
</tr>
<tr>
<td>Central nervous system (CNS)</td>
<td>Stroke, idiopathic intracranial hypertension, and meralgia paresthetica</td>
</tr>
</tbody>
</table>
**Obstetric and perinatal**
- Pregnancy-related hypertension, fetal macrosomia and pelvic dystocia

**Surgical**
- Increased surgical risk and postoperative complications, including wound infection, postoperative pneumonia, deep vein thrombosis, and pulmonary embolism

**Gastrointestinal (GI)**
- Gallbladder disease (cholecystitis, cholelithiasis), nonalcoholic steatohepatitis (NASH), fatty liver infiltration, and reflux esophagitis

**Orthopedic**
- Osteoarthritis, coxa vera, slipped femoral epiphyses, Blount's disease and Legg-Calvé-Perthes disease and chronic low back pain

**Metabolic**
- DM2, prediabetes, metabolic syndrome and dyslipidemia

**Reproductive (in women)**
- Anovulation, early puberty, infertility, hyperandrogenism and polycystic ovaries

**Reproductive (in men)**
- Hypogonadotropic hypogonadism

**Cutaneous**
- Intertrigo (bacterial and/or fungal), acanthosis nigricans, hirsutism and increased risk of cellulitis and anthrax

**Extremity**
- Venous varicosities, venous and/or lymphatic edema of the lower extremities

Source: Own elaboration, 2023

In the obese, 30-day mortality after hospitalization for myocardial infarction reached 16% without diabetes and 19% in those with diabetes in the US alone. In 2012 there were more than 110,000 deaths from diseases cardiovascular. Mortality due to comorbidities and weight gain itself is a prominent fact throughout the world in different populations. This result suggests that pre-obesity and obesity alone are associated with increased mortality (Salinas et al., 2022). There is the inability of BMI to differentiate visceral and subcutaneous fat mass and even lean body mass; BMI is a predictor of lean body mass rather than adiposity in patients with heart failure, suggesting that some patients with normal BMI represent increased visceral adiposity with decreased lean body mass; It is conceivable that the disproportion of adiposity rather than BMI is critically associated with the accumulation of cardiovascular risk factors such as insulin resistance, hypertension, and low-grade systemic inflammation (Ramos, 2022).

Mexico is the second country with the highest obesity in adults in the world, after the United States according to the Organization for Economic Co-Operation and Development (OECD); Obesity is the main public health problem in Mexico and has been increasing over the last 30 years. In the last national survey (2018), 36.1% of adults had obesity (BMI ≥30 kg/m²), with a substantially higher prevalence in women than in men (40.2% vs 30.5%). The results also showed that only 23.5% of the adult population was at a healthy weight (BMI ≤25 kg/m²), with even fewer adults in the 40-49 age group (15.4%). Furthermore, central obesity (≥94 cm in men or ≥80 cm in women) was present in 81.6% of all adults (>90% for adults aged 50 to 70 years) and morbid obesity increased by 96.5% from 2000 to 2018 (Ulloa, 2022).

Acute myocardial infarction (AMI), commonly known as heart attack, is pathologically defined as the irreversible death of myocardial cells caused by ischemia. Clinically, myocardial infarction is a syndrome that can be recognized by a set of symptoms, with chest pain being the hallmark of these symptoms in most cases, supported by biochemical laboratory changes, electrocardiographic (ECG) changes or findings in imaging modalities capable of detecting myocardial injury and necrosis. The Fourth Universal Definition of Myocardial Infarction proposes that the term acute myocardial infarction (AMI) should be used only when there is acute myocardial damage with clinical evidence of acute myocardial ischemia.

The diagnosis of AMI requires an increase or decrease in troponin values and the presence of at least one of the following criteria: symptoms of acute myocardial ischemia; new ischemic electrocardiographic (ECG) findings; development of new abnormal Q waves; imaging evidence of loss of viable myocardium or abnormal motion of either wall due to an ischemic cause; or identification of a
coronary thrombus on angiography. If this is not the case, the proposal is to refer only to myocardial damage (Dupotey, 2021).

Acute myocardial infarction is one of the main causes of death in the world, the prevalence of the disease approaches three million people worldwide. It can be divided into two categories, non-ST segment elevation MI (NSTEMI) and ST segment elevation MI (STEMI); Both obesity and atherosclerosis are considered chronic inflammatory diseases. Lipids, oxidized LDL particles and free fatty acids activate the inflammatory process and trigger the disease. Inflammation is responsible for all steps toward atherosclerosis, from early endothelial dysfunction to atherosclerotic plaques that cause complications, and is linked to obesity, insulin resistance, and type 2 diabetes. Fat tissue releases adipocytokines, which they induce insulin resistance, endothelial dysfunction, hypercoagulability and systemic inflammation. In visceral obesity, inflammatory adipocytokines are elevated to higher levels. Furthermore, increased C-reactive protein level is associated with an increased risk of myocardial infarction (González, Vázquez & Gómez, 2021).

Hypercholesterolemia is considered one of the main triggers of atherosclerosis resulting in changes in arterial endothelial permeability that allow the migration of lipids, especially LDL-C, into the arterial wall. Circulating monocytes adhere to endothelial cells that express adhesion molecules and selectins, migrate by diapedesis in the subendothelial space, monocytes acquire characteristics of macrophages and become foamy macrophages. LDL particles oxidize and become strong chemoattractants. Most coronary thrombi are caused by plaque rupture (55.65%), followed by erosions (30-35%) and, less frequently, calcified nodules (2-7%). Rupture-prone plaques typically contain a large, soft, lipid-rich necrotic core with a thin (≤65 µm), inflamed fibrous cap. Other common features include expansive remodeling, large plaque size (>30% of plaque area), plaque hemorrhage, neovascularization, inflammation of the adventitia, and "punctate" calcifications (Montalvo & Alejo, 2020).

The Joint ESC/ACCF/AHA/WHF Working Group further classified MI into 5 types based on the underlying cause (Table 2):

| Tipo 1 (IM espontáneo): | Relacionado con rotura, ulceración, fisuras, erosión o disección de la placa aterosclerótica con trombo intraluminal en una o más de las arterias coronarias, lo que conduce a disminución del flujo sanguíneo del miocardio y da lugar a necrosis de miocitos |
| Tipo 2 (secundario a un desequilibrio isquémico): | Consecuencia de mayor demanda de oxígeno o disminución del suministro como disfunción del endotelio coronario, espasmo, embolia, taquiarritmias o bradiarritmias |
| Tipo 3 (muerte valores de biomarcadores no disponibles): | Muerte cardíaca repentina e inesperada antes de que se puedan extraer muestras de sangre para los biomarcadores o antes de que aparezcan en la circulación |
| Tipo 4a (MI relacionada con la intervención coronaria percutánea [PCI]): | Elevación de los valores de biomarcadores a más de 5 veces el 99 percentil o aumento de valores superiores al 20% si los valores de referencia son elevados pero estables.1 síntomas sugestivos de isquemia miocárdica; 2 nuevos cambios de ECG isquémico; 3 pérdida angiográfica de la permeabilidad de una arteria coronaria principal; o 4 demostración de nueva pérdida de miocardio viable |
| Tipo 4b (MI relacionado con trombosis stent): | MI asociado con trombosis de la endoprótesis como se detecta por la angiografía coronaria o autopsia en el contexto de la isquemia miocárdica en combinación con un aumento y/o la caída de los biomarcadores cardíacos con al menos un valor por encima del 99 percentil URL |
| Tipo 5 (relacionado con la arteria coronaria de bypass de injerto): | Elevación de valores de biomarcadores cardíacos más de 10 veces el 99 percentil URL. Además, 1 nuevas ondas Q patológicas, 2 nuevo injerto documentado por angiografía u oclusión de la arteria coronaria, o 3 evidencia de nueva pérdida de miocardio viable o nueva anomalía regional del movimiento de la pared por imágenes |

Source: Own elaboration, 2023.
Mexico has positioned itself as the country with the highest mortality attributed to myocardial infarction among members of the Organization for Economic Cooperation and Development (OECD), with a rate of 27.2% compared to the average of 7.9%. At just over 33%, the adult obesity rate in Mexico is the second highest in the OECD, being a well-known risk factor for many chronic diseases. High obesity rates, along with other factors such as the lack of progress in reducing mortality from circulatory diseases, high mortality rates from traffic accidents and homicides, as well as persistent barriers to access to quality care, explain why gains in life expectancy in Mexico have been slower in recent years (Quintero & Sánchez, 2022).

Acute occlusion of one or several large epicardial coronary arteries for more than 20 to 40 minutes can cause acute myocardial infarction, is usually thrombotic, and is due to the rupture of a plaque formed in the coronary arteries; Occlusion leads to a lack of oxygen in the myocardium, resulting in rupture of the sarcolemma and relaxation of the myofibrils. Prolonged ischemia results in myocardial necrosis, spreading from the sub-endocardium to the sub-epicardium. The infarcted area heals through scar formation and the heart remodels, characterized by dilation, segmental hypertrophy, and cardiac dysfunction. Areas of myocardial infarction may be subepicardial if there is occlusion of smaller vessels by thromboembolism originating from coronary thrombi. Occlusion of the left main coronary artery usually results in a large anterolateral infarct, whereas occlusion of the left anterior descending coronary artery causes necrosis limited to the anterior wall.

Biomarkers, such as cardiac troponin and natriuretic peptides (NPs), associated with acute coronary syndromes and heart failure, respectively, play an important role. Cardiac troponin (cTn), expressed as three similar isoforms (I, C and T), is the biomarker of choice for diagnosis because it is the most sensitive and specific biochemical marker of myocardial ischemia/necrosis. Among the isoforms, the most specific markers of acute coronary syndromes are cardiac troponin I (cTnI) and cardiac troponin T (cTnT), whose elevations have become a predominant indicator of acute myocardial infarction (AMI) and are considered The "Gold Standard" in the diagnosis of AMI. Natriuretic peptides (NPs), composed of three structurally similar peptides, atrial natriuretic peptide (ANP), B-type (or brain) natriuretic peptide (BNP), and C-type natriuretic peptide (CNP), play an important role and are elevated largely in response to increased wall stretching due to volume or loading stress in the IC. Men tend to have heart attacks earlier than women. Women's heart attack rate increases after menopause, but is not the same as men's. Still, heart disease is the leading cause of death for both men and women.

3. Materials and methods

In this research, the method used has focused on documentary analysis (Arias, 2012). This author comments that this process is based on the search, compilation, analysis, criticism and interpretation of secondary information, obtained and compiled by other researchers in different documentary sources. The most important thing about this study is to relate the data that exists for a certain construct, generating a panoramic vision that allows providing adequate solutions to the problem posed (Rivera, Carrillo, Forgiony, Nuván & Rozo, 2018).

In accordance with the above, the article addresses concepts related to obesity and acute myocardial infarction that occur in the adult population in Mexico. In this review article, it can be highlighted that a rigorous selection of works available in the Google Scholar, Redalyc, Dialnet, Web of Science and Scopus databases was carried out, published during the periods 2019-2023. As a starting point and following the logical order of the search, the terms “obesity” and “mild myocardial infarction” were used, filtering them with commas and asterisks, obtained in Google Scholar 23970 search results, in Redalyc 22219, Dialnet 14.780, Web of Science 2,795 and Scopus 11490.

4. Results and discussion

According to all the studies and the information compiled, it was demonstrated that there is a relationship between acute myocardial infarction and obesity in adult patients in Mexico, with hypercholesterolemia and dyslipidemia being the cause of the formation of atherosclerotic plaques which rupture and occlude a artery, as well as the criteria that acute myocardial infarction must have according to the fourth definition to be considered as such (Shamah et al., 2020). Although BMI is the most used method to measure obesity, it is not the most accurate and has errors due to the extent of the fat since it does not discriminate whether it is peripheral or visceral. Based on the information analyzed,
it can be considered that obesity is a pandemic, due to the figures mentioned by the WHO since 2016 where the annual increase is 13% worldwide, which leads to high economic expenses in each country, taking as an example the countries of the European Union where they spend approximately 7% of their healthcare budgets on obesity-related diseases (Jankowski, 2021).

Acute myocardial infarction is a major problem worldwide, present in all countries, including those in the first world, especially Germany, England, France, as well as Switzerland. It is not only a pathology that takes the lives of many patients, but it is also a great spending by the government where, just to mention England, the expenses generated are around £6.8 billion (Ulloa et al., 2022). Although in most European countries research is being done and efforts are being made to resolve this problem, however, in countries like Russia where there is a high mortality rate related to acute myocardial infarction, due to the risk factors present in the population. As is the case of alcoholism, obesity, as well as smoking, there are no studies or research on the subject, contrary to England and Germany where they have given much importance to both the problem of obesity and acute myocardial infarction where they relate both risk factors (Aldeán, 2021).

In the case of the United States, the main focus is the relationship that exists between the prevalence of acute myocardial infarction with the expenses that the government will have with respect to public health; Canada also presents research focused on prevalence and social expenses. In addition, they also differentiate which gender is most affected, with the woman having some protection at the beginning due to hormonal factors, and then losing it at the beginning of menopause, however, the gender that The most affected is still the male (Sánchez, Ripalda & Bastidad, 2022). In Mexico, the prevalence of obesity is increasing at an alarming rate, which despite the government’s efforts to try to solve this problem has not been able to be reduced, resulting in the appearance of diseases such as hypertension, diabetes, dyslipidemia and hypercholesterolemia that ultimately leads to acute myocardial infarction, with cardiovascular diseases also being the main causes of death in our country (González, Vázquez & Gómez, 2021).

5. Conclusions

It was concluded that there is a relationship between acute myocardial infarction and obesity, with older adults with obesity being those who also have a high risk of suffering from this condition in Mexico, especially the male sex who has the highest prevalence worldwide. The bibliographic review demonstrated that age plays an important role in acute myocardial infarction, with those over 60 years of age having the highest prevalence rate, with the male gender being the most affected with a higher prevalence of this factor both in hospital admissions and in deaths. However, more research is needed in the country in this regard, because the recent SARS-COV-2 pandemic caused a deterioration in the health of people with chronic degenerative diseases.
References


