ORIGINAL

Impact of COVID-19 Lockdown on cardiometabolic risk scales in Adults: A before and after Pandemic Lockdown Longitudinal Study

Impacto del confinamiento por COVID-19 en las escalas de riesgo cardiometabólico en adultos: un estudio longitudinal antes y después del confinamiento por la pandemia

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Abstract

Introduction: In December 2019 the first cases of SARS-CoV-2 virus infection were detected, with the months it became pandemic and forced most countries to establish a state of lockdown. The aim of this study is to evaluate the influence of unhealthy lifestyles during lockdown on different cardiometabolic parameters.

Methods: A prospective study was performed in 6.236 workers in a Spanish population between March 2019 and March 2021. Different cardiometabolic parameters were determined before and after pandemic lockdown.

Results: An increase in all the parameters analyzed in the post-lockdown period compared to the pre-lockdown period was observed. Conclusions. Lockdown has had a negative impact on cardiometabolic parameters in both sexes.

Key words: Covid-19, cardiometabolic parameters, confinement, disease.

Resumen

Introducción: En diciembre de 2019 se detectaron los primeros casos de la infección por el virus SARS-CoV-2, con el paso de los meses se transformó en pandemia y obligo a la mayoría de países a establecer el confinamiento de la población. El objetivo de este estudio es evaluar cómo influían los estilos de vida poco saludables que se produjeron durante el confinamiento en diferentes parámetros cardiometabólicos.

Material y métodos: Se realizó un estudio prospectivo en 6.236 trabajadores de una población española entre marzo de 2019 y marzo de 2021. Se determinaron diferentes parámetros cardiometabólicos antes y después del cierre por la pandemia.

Resultados: Se aprecia un incremento de todos los parámetros analizados en el periodo post-confinamiento frente al periodo pre-confinamiento. Conclusiones. El confinamiento ha tenido un efecto negativo sobre los parámetros cardiometabólicos en ambos sexos.

Palabras clave: Covid-19, parámetros cardiometabólicos, confinamiento, enfermedad.

Introduction

In January 2020, COVID-19 was classified as a Public Health Emergency of International Importance (PHEIC). In March of the same year, the World Health Organization (WHO) declared it a global pandemic[1]. Its rapid spread and the high severity of the virus made it a major public health problem worldwide. This, together with the shortage of effective drugs and vaccines, forced countries to establish restrictive measures in order to prevent the spread of the pandemic[2,3]. Enclosures, quarantines and even total isolation of some populations were established, which in April 2020 affected one out of every three people in the world[4]. In Spain, the Royal Decree 463/2020 of 14 March was published, declaring a state of emergency[5]. This decree forced the abandonment of work and educational tasks with the consequent increase in boredom that ended in loss of appetite or food binges[6,7]. Consumption of fish, fruits and vegetables decreased and consumption of sweet or salty snacks increased[8,9]. Sleep disorders also increased[10,11] and physical activity decreased, which caused a significant weight gain, which in Spain was estimated at 12.8%-44%[12]. This weight gain related to COVID-19 may lead to an increased risk of developing metabolic disorders in the future in the population with a previous diagnosis of the disease[13], but also in the population that had not previously suffered from it[14]. It is known that the population with previous pathology is more likely to present more severe symptoms if infected by the virus.

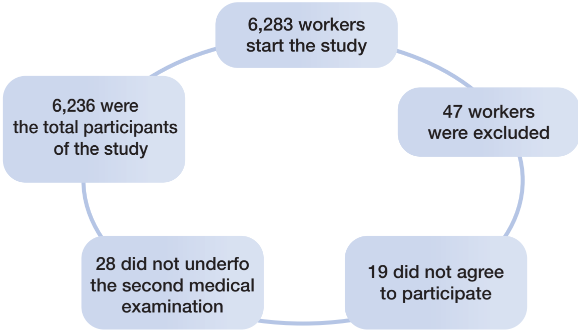
The aim of our study is to evaluate how lockdown and the unhealthy lifestyles associated with it can influence the values of different cardiometabolic parameters in a group of 6,236 workers in Spain, so that if at some point in the future a similar situation occurs, we can take appropriate preventive measures in order to reduce its side effects on people's health and the development of disease.

Methods

A prospective study was carried out in workers of the Autonomous Community of the Balearic Islands and the Valencian Community. The population of our study was made by workers who attended occupational medical examinations between March 2019 and March 2021; both included.

A total of 6,283 workers were selected, of which 47 were excluded (19 of them because they did not want to participate in the study and the remaining 28 because they did not attend the second examination), so the study was conducted on a final sample of 6,236 workers. (See **Figure 1**).

Figure 1: Flowchart of participants.



Inclusion criteria:

- Age between 18-69 years.
- Having undergone a medical check-up.
- Belonging to one of the companies collaborating in the study.
- Accepting to participate in the study and ceding the data for study and analysis.

The analytical and anthropometric determinations were performed by the health personnel of the occupational health units. Uniformity in taking these measurements was previously standardized to avoid interobserver bias.

The determination of weight (kilograms) and height (centimeters) was obtained with a SECA 700 stadiometer with a SECA 220 telescopic stadiometer with millimeter divisions. Height was obtained with the person standing upright, back against the stadiometer and feet together.

Waist circumference was measured with a SECA model tape measure. The tape was placed parallel to the ground at the height of the last floating rib with the person standing with feet together, arms resting on both sides of the body and abdomen relaxed.

The hip circumference was measured with the same tape and the person in the same previous position. The measuring tape was placed horizontally at hip height.

Blood pressure was determined with the patient seated and using a sphygmomanometer.

The patient was placed in the supine position, and a calibrated automatic sphygmomanometer type OMRON M3 was used. Three measurements were taken at one-minute intervals and the mean was calculated.

The analytical determinations were performed after fasting for at least 12 hours. Samples were processed within 48-72 hours. Automated enzymatic methods were used to determine cholesterol, glucose and triglycerides. HDL was determined by precipitation with dextran sulfate. LDL levels were calculated using Friedewald's formula (LDL = total cholesterol-HDL-triglycerides/5).

All these parameters were expressed in mg/dL.

Metabolic syndrome (MS) was assessed using three different criteria: the National Cholesterol Education Program Adult Treatment Panel III (NCEP/ATP-III), the Joint Interim Statement (JIS) and the International Diabetes Federation (IDF) update[15].

Metabolic age is obtained from bioimpedance results obtained using a TANITA model monitor.
The following formulas were used to calculate the different atherogenic indexes[16]:
Castelli's atherogenic index=CT/cHDL.
Kannel atherogenic index=cLDL/cHDL.
Triglycerides/cHDL atherogenic index.

For each index, different cutoff points were established according to the existing data in the literature. The Castelli index was considered low risk[17] if the values were less than 4.5% in women and less than 5% in men, moderate risk between 4.5-7% in women and 5-9% in men, and high risk if they were higher than 7% and 9%, respectively. The Kannel index was low risk if it was less than 3% and high above that value. The triglyceride/HDL-CHDL index was considered elevated at 3% or higher.

The normalized weight-adjusted index (NWAI)[18] is calculated by applying the formula:

[(weight/10) – (10x height) + 10] with weight measured in kg and height in m.

Body Surface Index (BSI)[19]. BSA is calculated using the DuBois formula where w (weight) represents weight in kg and h (height) represents height in cm.

$$BSI = \frac{WEIGHT}{\sqrt{BSA}} \quad \text{and} \quad BSA = w^{0,425} * h^{0,725} * 0,007184$$

Visceral adiposity index (VAI) is calculated using different formulas for males and females[20].

Females:

$$VAI = \left(\frac{WC}{36,58 + (1,89 \times BMI)}\right) \times \left(\frac{TG}{0,81}\right) \times \left(\frac{1,52}{HDL}\right)$$

Males:

$$VAI = \left(\frac{WC}{39,68 + (1,88 \times BMI)}\right) \times \left(\frac{TG}{1,03}\right) \times \left(\frac{1,31}{HDL}\right)$$

Body adiposity index (BAI)[21] and abdominal volume index (AVI) are calculated using this formulas[22]:

AVI = [2 cm (waist) 2+0.7 cm (waist-hip)2]/1000
BAI = ((hip circumference)/ ((height)$^{1.5}$)-18),

A smoker was considered to be a person who had regularly consumed at least one cigarette each day during the previous month or who had quit smoking less than one year ago.

Physical activity was determined by means of the International Physical Activity Questionnaire (IPAQ), a self-administered questionnaire of seven questions that assesses the type of physical activity performed in the previous seven days[23].

Social class was determined by applying the proposal of the social determinants group of the Spanish Society of Epidemiology[24]. Three categories were considered: Class I: directors/managers, university professionals, sportsmen and artists; Class II: intermediate occupations and skilled self-employed workers; Class III: unskilled workers.

Statistical Analysis

A descriptive study was carried out using the different categorical variables by calculating both the frequency and distribution. For the analysis of the quantitative variables, the mean and standard deviation were determined, and for the qualitative variables, the percentage was obtained. For the bivariate analysis, the X2 test (with Fisher's exact correction if necessary) and Student's t test were used when the samples were independent. Statistical analysis was performed with SPSS 28.0 (IBM, New York, NY, USA), accepting a statistical significance level of 0.05.

Ethical Considerations and Aspects

The study was approved by the Clinical Research Ethics Committee of Balearic Islands Health (Aproval Code: IB 4383/20). The participants received the information regarding the study and signed the informed consent before being included in the study. All procedures were performed in accordance with the ethical standards of the institutional research committee and with the 2013 Declaration of Helsinki.

Results

Table I shows the mean values of different anthropometric and clinical parameters in the periods between pre-lockdown and post-lockdown COVID-19. Statistically significant differences can be observed in all cases. Of the sample studied, 51.9% were women and 48.1% men.

There was an increase in all the anthropometric parameters (weight, BMI, waist and hip circumference and body fat) between both pre-lockdown and post-lockdown periods. Something similar occurred with the analytical parameters (hepatic and lipid profile) and the clinical parameters (systolic and diastolic blood pressure). In all cases the differences obtained were statistically significant.

For the qualitative variables, there was a statistically significant decrease of 11% in the percentage of people who regularly exercise and an increase of 2% in tobacco consumption. Both situations show that, during the months of lockdown and in both genders, a more sedentary lifestyle was adopted, probably due to the restrictive measures imposed by the authorities during the state of lockdown.

Table I: Characteristics of the population.

N=6236	Year 2018 Mean ± SD	Year 2019 Mean ± SD	Year 2020 Mean ± SD	p-value
Age (years)	41.1 ± 9.9	42.1 ± 9.9	43.1 ± 9.9	<0.001
Weight (kg)	71.7 ± 16.3	72.2 ± 16.4	73.8 ± 16.5	<0.001
BMI (kg/m²)	25.1 ± 4.7	25.3 ± 4,7	25.9 ± 4.7	<0.001
Waist circumference (cm)	82.8 ± 14.0	84.6 ± 14.1	87.6 ± 14.1	<0.001
Hip circumference (cm)	98.7 ± 9.4	99.8 ± 9.4	101.5 ± 9.5	<0.001
Waist to Height ratio	0.49 ± 0.08	0.50 ± 0.08	0.52 ± 0.08	<0.001
Waist to hip ratio	0.84 ± 0.10	0.85 ± 0.09	0.86 ± 0.09	<0.001
Body fat (%)	24.5 ± 9.1	25.3 ± 8.7	26.9 ± 8.8	<0.001
SBP (mmHg)	120.0 ± 16.8	121.3 ± 16.3	124.6 ± 16.3	<0.001
DBP (mmHg)	76.9 ± 10.7	78.2 ± 10.5	82.8 ± 10.6	<0.001
Glycaemia (mg/dL)	90.5 ± 16.4	91.9 ± 15.7	95.4 ± 15.8	<0.001
Total cholesterol (mg/dL)	190.7 ± 37.3	194.3 ± 35.3	202.8 ± 35.7	<0.001
HDL-c (mg/dL)	53.9 ± 13.7	53.1 ± 13.4	50.7 ± 13.7	<0.001
LDL-c (mg/dL)	117.4 ± 40.3	121.4 ± 38.5	131.0 ± 39.0	<0.001
Triglycerides (mg/dL)	96.8 ± 79.2	98.7 ± 78.5	105.8 ± 78.9	<0.001
ALT (U/L)	24.1 ± 28.5	25.7 ± 28.7	28.4 ± 28.7	<0.001
AST (U/L)	21.7 ± 15.5	22.7 ± 15.6	24.0 ± 15.7	<0.001
GGT (U/L)	25.8 ± 27.4	26.8 ± 27.4	28.9 ± 27.4	<0.001
	N (%)	**N (%)**	**N (%)**	**p-value**
Women	3236 (51.9)	3236 (51.9)	3236 (51.9)	
Men	3000 (48.1)	3000 (48.1)	3000 (48.1)	
Smokers	1176 (18.9)	1202 (19.3)	1302 (20.9)	<0.001
Physical exercise	2732 (43.8)	2600 (41.7)	2044 (32.8)	<0.001
Social class I	3664 (58.8)	3664 (58.8)	3664 (58.8)	
Social class II	812 (13.0)	812 (13.0)	812 (13.0)	
Social class III	1760 (28.2)	1760 (28.2)	1760 (28.2)	

BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL: high density lipoproteins; LDL: low density lipoproteins; ALT: alanine aminotransferase; AST: aspartate aminotransferase; GGT: gamma glutamyl transpeptidase.

When analyzing the cardiometabolic risk scales (metabolic age, metabolic syndrome, waist triglyceride index, waist weight index, atherogenic index, normalized weight adjusted index, body surface index, visceral adiposity index, body adiposity index and abdominal volume index) a statistically significant increase in the mean results of all of them is observed during lockdown. If we focus on the pre-lockdown and post-lockdown differences, the worsening of all of the percentages of the different scales studied stands out, with the NWAI scale being the worst: going from values of 0.05% pre-lockdown to values of 0.16% post-lockdown; the VAI also stood out, with an increase of 0.1% to 0.5% compared to pre-lockdown values, as can be seen in **table II**.

Table II: Changes in mean values of different cardiometabolic risk scales in 2018, 2019, and 2020.

	Year 2018 Mean (SD)	Year 2019 Mean (SD)	Year 2020 Mean (SD)	p-value	Difference 2018-2019 Value (%)	Difference 2019-2020 Value (%)	p-value
ALLY metabolic age	-4.3	-3.6	-2.0	<0.001	0.7 (16.4)	1.7 (45.7)	<0.001
Nº factors MS ATPIII	1.0	1.2	1.6	<0.001	0.2 (17.3)	0.4 (27.9)	<0.001
Cholesterol/HDL-c	3.8	3.9	4.3	<0.001	0.1 (3.4)	0.4 (10.8)	<0.001
LDL-c/HDL-c	2.4	2.5	2.8	<0.001	0.1 (4.8)	0.3 (14.6)	<0.001
Triglycerides/HDL-c	1.9	2.0	2.3	<0.001	0.1 (3.6)	0.3 (13.9)	<0.001
Cholesterol-HDL-c	136.7	141.2	152.1	<0.001	4.5 (3.2)	10.9 (7.8)	<0.001
NWAI	0.32	0.37	0.53	<0.001	0.05 (14.7)	0.16 (43.6)	<0.001
Body surface index	38.9	39.0	39.4	<0.001	0.1 (0.3)	0.4 (1.1)	<0.001
Visceral adiposity index	2.9	3.0	3.5	<0.001	0.1 (5.5)	0.5 (16.4)	<0.001
Body adiposity index	27.3	27.8	28.6	<0.001	0.5 (1.9)	0.8 (2.8)	<0.001
Abdominal volume index	28.5	29.7	31.7	<0.001	1.2 (4.2)	2.0 (6.7)	<0.001

ALLY Avoidable lost life years. MS ATPIII Metabolic syndrome Adult Treatment Panel III. HDL-c High density lipoprotein-cholesterol. LDL Low density lipoprotein-cholesterol. NWAI Normalized Weight Adjusted Index.

Table III assesses the changes in the prevalence of the different values of the insulin resistance and non-alcoholic fatty liver disease scales analyzed pre-lockdown and post-lockdown due to the COVID-19 pandemic, revealing statistically significant results with a difference of more than 2% between the years before and after pandemic in both groups as well as between patients with type 2 diabetes and non-diabetic patients. However, the highest variations in both groups are found in the lipid accumulation product scale and in the fatty liver disease scale, with a greater worsening in the NAFLD prevalence scales compared to the insulin resistance scales. It is noteworthy that all the formulas experienced greater worsening in the non-diabetic group compared to in the diabetic group. The worst values of the different analyzed scales occurred in the metabolic score for insulin resistance (METS-IR) followed by the lipid accumulation product scale and the fatty liver disease scale. These alterations are affected in the same order in diabetic patients; however, their percentage scores are much lower.

Table III evaluates the changes in the prevalence of the different values of the cardiometabolic risk scales analyzed before and after COVID-19 pandemic, showing statistically significant differences between both groups in all cases. The greatest variations were found in diabesity, Triglycerides/HDL-c high, Cholesterol/HDL-c moderate-high and lipid triad.

Table III: Changes in prevalence of high values of different cardiometabolic risk scales in 2018, 2019, and 2020.

	Year 2018	Year 2019	Year 2020		Difference 2018-2019	Difference 2019-2020	
	Mean (SD)	Mean (SD)	Mean (SD)	p-value	Value (%)	Value (%)	p-value
ALLY metabolic age >5	30.1	31.6	34.5	<0.001	1.5 (5.0)	2.9 (9.2)	<0.001
MS ATPIII	9.9	13.9	20.9	<0.001	4.0 (40.4)	7.0 (50.4)	<0.001
MS IDF	12.4	17.0	25.0	<0.001	4.6 (37.1)	8.0 (47.1)	<0.001
Cholesterol/HDL-c moderate-high	16.4	18.2	29.5	<0.001	1.8 (11.0)	9.3 (62.1)	<0.001
LDL-c/HDL-c high	23.4	26.6	37.5	<0.001	3.2 (13.7)	10.9 (41.0)	<0.001
Triglycerides/HDL-c high	16.8	17.1	21.9	<0.001	0.3 (1.8)	4.8 (28.1)	<0.001
Cholesterol-HDL-c high	56.2	62.3	72.1	<0.001	6.1 (10.9)	9.8 (15.7)	<0.001
Atherogenic dyslipidemia	3.4	4.2	6.6	<0.001	0.8 (23.5)	2.4 (57.1)	<0.001
Lipid triad	0.6	0.9	2.4	<0.001	0.3 (50.0)	1.5 (66.7)	<0.001
Diabesity	0.6	0.6	1.0	<0.001	0.0 (0.0)	0.4 (66.7)	<0.001

ALLY Avoidable lost life years. MS ATPIII Metabolic syndrome Adult Treatment Panel III. MS IDF Metabolic syndrome International Diabetes Federation. HDL-c High density lipoprotein-cholesterol. LDL Low density lipoprotein-cholesterol.

Discussion

Changes in lifestyle have been observed in recent decades, with an increase in sedentary lifestyle and a worsening of eating and sleeping patterns. Due to the pandemic and the state of lockdown, this situation has been aggravated[25].

In our study, we observed a decrease in physical activity and an increase in tobacco consumption associated with lockdown, which can be translated into an increase in the cardiometabolic parameters analyzed. These data corroborate our previous studies26,27 and the data obtained by Cicero et al28 and Khan et al29. Lockdown has affected both the health of previously healthy individuals and those with previous pathologies by increasing cardiovascular risk factors and metabolic diseases[30,31].

Low HDL cholesterol levels, increased waist circumference, elevated triglycerides and blood glucose and high blood pressure values constitute what is known as the metabolic syndrome, which is considered a global measure of cardiometabolic disease. In our studies all these parameters have worsened during lockdown as seen in our results, which can be translated into an increase in the prevalence of metabolic syndrome and other cardiometabolic scales; these data agree with those found by other authors such as Cinque et al[32]. This situation is important since studies such as the one by Ghoneim et al[33] show that people with cardiometabolic disorders are more susceptible to being infected by COVID-19 and also present more complications in case of infection. Furthermore, these cardiometabolic complications have led to an increase in morbidity and mortality as well as a higher risk of infection by COVID-19 and a worse prognosis in the event of infection and requiring hospitalization[34,35].

The results obtained in this study show that the state of lockdown led to a statistically significant deterioration of different health indicators, causing a worsening of cardiometabolic risk factors and the presence of new pathologies that have led to an increase in morbidity and mortality. These data agree with those obtained by other authors[36].

It is important to be aware of the effects of lockdown on health, since, due to globalization, it is necessary to be alert to the risk of new pandemics that may force the health authorities to impose new lockdowns. The reduction in cardiometabolic diseases is important not only because of its effect on cardiovascular health but also because it increases the risk of infection by COVID-19.

There are studies that compare the effects of the pandemic and COVID-19 infection on cardiometabolic parameters, but we have not found any study that compares as many parameters in the same population as in our study. In addition, all the studies consulted had smaller sample sizes than ours.

Strengths and limitations

As limitations, we highlight the fact that the study corresponds to a specific geographical area, in a Caucasian working population, which could limit the generalization of the results to other areas where lifestyles may be different. Selection bias is another limitation of our study, since it is limited to workers who voluntarily attended company medical check-ups during those years. Therefore, the results are not applicable to other populations, and it would be necessary to carry out specific studies.

Conclusions

The state of lockdown due to COVID-19 has caused a worsening of different health parameters, with a negative influence on cardiometabolic risk factors as well as a worsening of healthy lifestyle habits, thus worsening the health of the population. This situation should alert us to the fact that, as a consequence of globalization, new lockdowns associated with new pandemics could occur.

Conflict of Interest

The authors declare that no competing interests exist.

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