International Journal of Engineering Trends and Technology
ISSN: 2231 – 5381 /doi:10.14445/22315381/IJETT-V69I4P216

Volume 69 Issue 4, 107-117, April 2021

Observational Study of Fetal Heartbeat Characteristics In Pregnant Women Diagnosed With Covid -19 Treated At The Regional Maternal And Child Teaching Hospital El Carmen - Huancayo, 2020

Lina, Cárdenas-Pineda[#1], Nilda, Cantorin-Aliaga[*2], Leonardo, Leyva-Yataco[#3], Gabriela, Ordoñez- Ccora[&4], Claris, Pérez-Venegas[#5] , Zelmira, Flor De la Cruz Ramos[#6], Alicia Alva Mantari[>7]

[#]*Universidad Nacional de Huancavelica, Huancavelica, Perú*
[*]*Hospital Regional Docente Materno Infantil el Carmen, Junin, Perú*
[&]*Hospital Departamental de Huancavelica, Huancavelica, Perú*
[>]*Image Processing Research Laboratory (INTI-Lab), Universidad de Ciencias y Humanidades, Lima, Perú*

[1] lina.cardenas@unh.edu.pe,[2] ncantorinaliaga@gmail.com,[3]leonardo.leyva@unh.edu.pe,

Abstract *—This quantitative exploratory study is aimed at characterizing the fetal heartbeat (FHC) in pregnant women diagnosed with COVID - 19 treated at the Regional Maternal and Child Teaching Hospital El Carmen - Huancayo, 2020. Methodology: Observational, prospective, cross-sectional, descriptive, in 31 pregnant women, an observation card was used along with parameters of Fisher. Results: Slight COVID - 19 was found in the 31 pregnant women, 64.52% of whom were between 20 and 34 years old, while 93.55% were from the urban area, 90.32% were housewives, 48.39% were primiparous, and 38.71% were multiparous. The mean temperature was 36.9, blood pressure 111/71 mmHg, and saturation was 92.81%, baseline 90.32% was normal, tachycardia presented in 9.68%, variability was absent in 25.81%, minimal in 35.48%, and normal in 38.71%, no accelerations were observed in 25.81% and 1 - 4 accelerations in 51.61% and ⩾ 5 in 22. 58%, and decelerations of type III in 16.13%. When analyzing comorbidity vs no comorbidity, tachycardia was found in 11.11% vs 9.09%, absent variability 22.22% vs 27.27%, minimum variability 22.22% vs 40.91%, absent accelerations in 11.11% vs 31.82%, and decelerations of type III 11.11% vs 13.64%. Conclusions: Tachycardia was found in 9.68%, variability absent, and no accelerations in 25.81%, which indicates that a little more than 25% present signs of fetal hypoxia; therefore, antepartum and intrapartum monitoring is necessary.*

Keywords — *COVID - 19, Fetal Monitoring, Oxygen Saturation*

I. INTRODUCTION

The new coronavirus denominated COVID -19, produced by the SARS - CoV2 virus, primarily affects the respiratory system, a situation that decreases gas exchange in the maternal lung and causes deficient oxygen uptake by maternal hemoglobin in the arteries due to low availability and leads to a decrease in oxygen saturation (SpO2), which is measured with the pulse oximeter. Such event affects the oxygen supply from the mother to the intervillous space of the placenta, generating the decrease of this gas so that it can be transported to the fetus, generating hypoxemia and hypoxia at the fetal level, a fact that can be verified through continuous fetal monitoring that will be reflected with changes in the elements of the fetal heart rate (FHR); in case of early hypoxia, this is expressed by decreasing the variability, resulting in tachycardia, and absence of accelerations

The coronavirus problem, while new, requires our full attention, and as obstetricians, there is a need to start monitoring all aspects of sexual and reproductive health care carefully.

In this regard, in the present study, 31 pregnant women were observed, particularly the fetuses, through continuous fetal monitoring by 20 minutes throughout the month of August. For this purpose, the Fisher test, a test used to evaluate antepartum monitoring at the Perinatal Maternal Institute of Lima, Regional Hospital of Ayacucho, was used to evaluate the elements of the fetal heart rate, which yielded interesting results.

The results are presented in the following sections: Problem statement, literature review, theoretical framework, research methodology, and results, in which we present the tables, discussion, conclusion, and recommendations. These results are expected to contribute to generate knowledge and provide solutions in maternal health care.

II. PROBLEM STATEMENT

On March 11, 2020, World Health Organization (WHO) declared a pandemic for the new outbreak of coronavirus pneumonia (COVID-19), caused by Severe Acute Respiratory Syndrome-Coronavirus 2 (SARS-CoV-2) [1]. This virus has been spreading worldwide at an accelerated pace and has become a public health emergency with 49,578,590 confirmed cases of COVID-19, including 1,245,717 deaths worldwide as of November 8, 2020 [2],

of which the American continent contributes the largest number of cases according to the latest report of Pan American Health Organization (PAHO) [3]. On the other hand, in the Peruvian case, the number of confirmed cases is 917,503, and the number of deaths is 32,783. However, in the region of Junín, the number of positive cases is 17,362 and 709 deaths, according to data reported by PAHO [3]. Nevertheless, among all the reported cases, there are no specific data on the number of confirmed cases of COVID-19 in pregnant women.

In addition, during pregnancy, physiological and anatomical changes occur; and one of the changes to which the pregnant woman is subjected is in terms of her cardiorespiratory system, such as elevation of the diaphragm, increased oxygen consumption, edema of the respiratory tract mucosa, decreased lung volume, which, in the context of the pulmonary changes described above, easily predisposes to hypoxemic respiratory failure during pregnancy [4]. However, physiological dyspnea is caused by increased maternal oxygen demand due to increased metabolism, gestational anemia, and fetal oxygen consumption is common in pregnancy [5] and needs to be distinguished from pathological dyspnea.

In regard to COVID - 19 conditions during pregnancy, recent studies report that fetal complications include miscarriage (2%), intrauterine growth restriction (also known as IUGR; 10%), and preterm delivery (39%) [6]. On the other hand, a report from the Center for Disease Control indicated that pregnant women were more likely to receive intensive care (1.5% as opposed to 0.9%) and mechanical ventilation (0.5% as opposed to 0.3%) compared to non-pregnant patients [7]. Also, 2 systematic reviews of 252 and 538 pregnant women with COVID-19 found that 15-20% had preterm deliveries and 70%-85% were cesarean deliveries [8], [9], [10]. Therefore, COVID-19 in late pregnancy because of the physiological changes noted and the pathogenesis of coronavirus could indirectly affect fetal heart rate.

This disease, in its pathological course, mostly affects the respiratory system, which is a critical organ for gas exchange and depends on it that the mother is able to provide sufficient oxygen to the fetus. Considering the above, it is essential to evaluate the behavior of the elements of the fetal heart rate. Through electronic fetal monitoring [11] [12], a procedure that allows us to evaluate the nervous system of the fetus indirectly [12]. The fetus might experience states of hypoxia, caused not only by pregnancy problems but also by cardiac, pulmonary, and renal disease, or with hemoglobinopathy [13].

Nowadays, there is limited knowledge about the clinical impact of COVID-19 on the maternal, fetal and placental aspects of pregnancy which is why it is appropriate to perform studies that evaluate the intrauterine fetal status through the elements of fetal heart rate (FHR) so as to obtain further knowledge and to provide input to the protocol for the management of pregnant women with COVID-19.

It is known that certain maternal pathologies, such as preeclampsia and anemia, have an influence on fetal heartbeat behavior. Currently, information on COVID-19 and pregnancy is scarce as there is not much information on the clinical impact of COVID-19 on the fetal and placental aspects of pregnancy.

Every pregnant patient with COVID-19 should be closely monitored, so optimal fetal monitoring should be facilitated, and this should not only be based on gestational age and maternal vital signs but also on the proper interpretation of electronic fetal monitoring. The results obtained will provide new knowledge and will help us to feed the guidelines for the management of pregnant women with COVID - 19. Moreover, the results of the present research will be useful to explore in-depth or to propose new research approaches.

III. LITERATURE REVIEW

Tang et al. [14], in the article "Characteristics and pregnancy outcomes of patients with severe pneumonia complicating pregnancy: a retrospective study of 12 cases and a literature review", pneumonia during pregnancy has been associated with increased maternal and fetal morbidity and mortality, and the findings showed that all 12 patients were in their second or third trimester. The patients had a higher prevalence of anemia (50%) and preeclampsia (25%) than common pregnant women. Late diagnoses were not uncommon. There were two maternal deaths resulting in a 17% mortality rate and two stillbirths. There was no choice of delivery in any of the four patients in their second trimester. There were six of the seven patients who presented after 28 weeks gestation and had live fetuses who underwent emergency deliveries. Preterm deliveries (6/7) and cesarean deliveries (5/7) were the two major adverse outcomes in the newborns.

Martínez et al. [15], in their research "Fetal heart rate in patients diagnosed with pregestational and gestational diabetes," 2005. Longitudinal and comparative study where the sample consisted of 46 patients who were divided into three groups: 15 patients with pregestational diabetes between 23 to 37 weeks, 11 patients with gestational diabetes between 26 to 37 weeks, and 20 pregnant women as a control group between 27 to 39 weeks, for the study an HP Model 1350, Series 50 XM cardiotocograph was used; and in the statistical analysis of the basal FHR and the amplitude of the transient rises, the one-way analysis of variance was used. The results were as follows: in the pregestational diabetes group, the basal FHR ranged from 120-165 beats; in the gestational diabetes group, the range was 115-160, and in the control group, the range was 110-170 beats.

Romero et al. [16], in their research "The fetal heart rate pattern in pregnant women diagnosed with iron deficiency anemia" 2003. Its objective was to describe the fetal heart rate (FHR) patterns in pregnant women diagnosed with iron deficiency anemia; a prospective study in which the sample consisted of 63 pregnant women divided into two groups: 43 patients diagnosed with iron deficiency anemia (10,7 g/dl of hemoglobin) and 20 normal pregnant women, the uterine contractility and FHR records were obtained

with an HP cardiotocograph, model 1350; series 50 XM, during a period of 90 to 120 min. The basal FHR of the anemic pregnant group was 142,81 beats/min, and in the normal group, it was 135,5 beats/min; the difference between means was significant (p = 0,0000). Regarding the amplitude of the large accelerations, it was found that in the problem group, it was 29.02 beats, compared to 24.81 beats in the control group; the difference between means was significant (p = 0,0000).

Romero et al. [17], in their research "Fetal heart rate in patients diagnosed with slight and severe preeclampsia" 2010. The objective was to calculate the value of basal fetal heart rate (FHR) indices and transient elevations, between 25 and 35 weeks of gestation, in patients diagnosed with slight and severe preeclampsia, and to compare the values obtained with a control group and determine whether the difference between basal FHR means and the amplitude of accelerations was significant or not; a prospective, comparative and exploratory study where the sample was composed of 40 patients divided into 3 groups: 10 patients with slight preeclampsia, 10 patients with severe preeclampsia, and a control group of 20 patients previously studied. Two studies were performed: Within the first 24 hours of the admission of the patient, a cardiotocogram was taken (the first study) and repeated within 24 hours of the beginning of labor or before the surgical intervention (the second study). Regarding basal FHR, they found that in the first study, the basal FHR values between the first and second groups were 135,5 and 138,69 and the values between the first and third groups were 135,5 and 137,66; the difference between means was 3 beats with the first group and 2 beats with the second group which was significant; and in the second study, they found that the mean values between the first and the second study were 135.5 and 142.63 and between the first and the third were 135.5 and 135.52, the difference was 7 beats with the first group, and there was no difference with the second, which was significant between the first and the second group. Regarding the accelerations in the first study, in the control group, the mean value was 24.81 beats, in the slight preeclampsia group, it was 23,03 beats, and in the severe preeclampsia group, it was 21,80 beats; the difference between means of groups 1 and 2 was one beat, and between groups 1 and 3 it was 3 beats, and these were significant; in the second study in the control group, the mean value was 24,81 beats, in the mild preeclampsia group it was 20,43 beats and in the severe preeclampsia group it was 16,78 beats; the difference between means was 4 beats between the first and second groups and 8 beats between the first and third groups being significant.

Romero et al. [18], in their research "Fetal heart rate in adolescent pregnant women," 2011. The aim of the study was to determine the basal fetal heart rate (FHR) values and the amplitude of accelerations in adolescent pregnant women in order to compare them with a control group. A longitudinal, prospective, comparative, and exploratory study, where the sample consisted of 40 patients divided into a problem group made up of 20 pregnant adolescents, and a control group made up of 20 patients with normal pregnancy; an HP cardiotocograph, model 1350, series 50XM was used. It was found that in the problem group, the FHR increased by 4 beats, and the amplitude decreased by 1 beat compared to the control group.

IV. THEORETICAL FRAMEWORK

In order to enter into the cell, SARS-C0V-2 attaches to receptors for angiotensin-converting enzyme 2 (ACE2) through its spike-like protein. During pregnancy, there is a significant increase in ACE2 mRNA in the kidney, placenta, and uterus, which may affect the vulnerability of the pregnant woman to COVID-19; on the other hand, changes in the immune and cardiorespiratory systems such as elevated diaphragm, increased oxygen consumption, mucosal edema of the respiratory tract, decreased lung volume during pregnancy increase the susceptibility of a woman to severe infections and hypoxic compromise. However, during pregnancy, there is physiologic dyspnea due to increased maternal oxygen demand due to enhanced metabolism, gestational anemia, and fetal oxygen consumption, and this must be distinguished from pathologic dyspnea.

In the majority of instances, the virus causes viral pneumonia as it enters through the respiratory tract causing type 2 pneumocyte injury, thereby generating a picture of viral pneumonia, and often this viral pneumonia progresses and stimulates a cytokine storm formation, and the patient progresses to respiratory distress syndrome and multiorgan dysfunction; in this sense, in the context of the pulmonary changes described above, hypoxemic respiratory failure during pregnancy is more easily predisposed [4], [6].

The oxygen taken up by the mother is transported by the blood to the intervillous space when the maternal

blood reaches the placenta, the molecular oxygen dissolved in the plasma diffuses through the syncytiotrophoblast and cytotrophoblast to the fetal plasma so that the oxygenated blood returns to the fetus through the umbilical vein [19].

Consequently, prolonged respiratory compromise due to maternal hypoxemic respiratory failure drives the release of potent vasoconstrictors such as endothelin-1, resulting in placental hypoperfusion and reduced oxygen supply to the fetus, thereby altering fetal well-being.

Fetal Heart Rate

The cardiovascular apparatus is the first to function in the embryo; blood begins to circulate towards the end of the third week. This early development is required because the embryo must have an efficient mechanism for acquiring nutrients and eliminating waste products [19].

The fetal heartbeat is first observed by transvaginal ultrasound during the 4th.5 to 5th week of gestation; it can be detected from the 10th week with a doppler ultrasound, and with a standard stethoscope, the fetal heart is audible from 16 weeks, it ranges from 110-160 beats. [19], [20].

Throughout time, various fetal heart rate classifications have been proposed, such as those of Caldeyro Barcia, Hon, and the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) [21] (as shown in Table I).

TABLE I. FETAL FREQUENCY CLASSIFICATION

Variable	Calderyro Barcia	Hon	NICHD
Fetal heart rate - Normal (F)	120≤ F F<150	120≤ F F<160	110≤ F F<160
Weak Tachycardia (WT)	150≤ WT WT<160		T > 160
Mild Tachycardia (MT)	160≤ MT MT<180	160≤ MT MT<180	
Evident Tachycardia (ET)	180≤ ET	180≤ ET	
Weak Bradycardia (WB)	110≤ WB WB<120		B < 110
Mild Bradycardia (MB)	120≤ MB MB<150	100≤ MB MB<120	
Evident Bradycardia (EB)	EB<110	EB<100	

Fetal Heart Rate Elements

The elements or parameters of the fetal heart rate are four, which are: baseline, variability, acceleration, and deceleration. These are important as they allow us to make a thorough evaluation of the fetal heartbeat, and at the same time, reflect the state of the central nervous system (CNS) [22].

a) Baseline

The baseline is the average FHR recorded in 10 min at maternal rest, established outside the periodic changes, and the average is between 110 - 160 bpm. To determine the baseline, it is important to consider the recommendations of NICHD, which indicates that the mother should be in a period of rest if the heartbeat is stable, it should be in a window of 10 minutes, excluding accelerations and decelerations and periods of marked variability (>25 beats per minute - bpm), in addition, FIGO warns that pre-term fetuses tend to have values at the high end of this range and post-term fetuses at the low end (24).

When the baseline is altered, tachycardia (FHR greater than 160 beats for more than 10 minutes) or bradycardia (FHR less than 110 beats for more than 10 minutes, or less than 30 beats from baseline) may occur [22].

b) Variability

FHR variability is the oscillations or fluctuations from beat to beat that occur in amplitude or frequency; this variability and its alterations are considered a good indicator of fetal well-being.

The amplitude indicates the beat-to-beat differences of the fetal heart, and its normal value is 6 to 25 beats in amplitude. The variability may be decreased by the following events: congenital cardiac anomalies, by drugs that act as central nervous system depressants (morphine, diazepam, magnesium sulfate) and parasympatholytic agents (atropine and hydroxyzine) and central adrenergic agents (methyldopa). The jumping pattern, also known as excessive, marked, and exaggerated variability, manifests in the face of fetal hypoxemia, as a result of excessive vagal activity, is almost always accompanied by bradycardia, and is the result of cephalic compression of the mature, post-term fetus [11].

Hammacher established a classification of FHR variability according to the amplitude of the oscillations and clearly established the relationship between the decrease or absence of oscillations with fetal rest periods, the action of a central nervous system (CNS) depressant drug, and the presence of hypoxia [21].

Type 0 or silent rhythm: Oscillation of less than 5 beats in amplitude is due to any cause capable of producing fetal CNS depression, and its persistence is indicative of fetal hypoxia.

Type I or low wave rhythm: Oscillation of 5 to 10 beats in amplitude. It is considered a prepathological rhythm, although it is not currently given this value if it is the only abnormal parameter in the FHR recording.

Type II or normal undulatory rhythm: Oscillation of 10 to 25 beats of amplitude; it is of good prognosis.

Type III or jumping rhythm: Oscillation greater than 25 beats in amplitude is usually related to umbilical cord compressions and is potentially dangerous. Increased variability is the earliest sign of mild fetal hypoxia.

According to NICHD, it is classified as:

Absent: Undetectable amplitude

Minimal: Amplitude range between undetectable and ⩽ 5 bpm. Moderate: amplitude between 6 bpm and 25 bpm.

Emphasized: amplitude > 25 bpm (10).

On the other hand, the International Federation of Gynecology and Obstetrics (FIGO) classifies variability according to Table II:

TABLE II. CLASSIFICATION OF VARIABILITY BY THE INTERNATIONAL FEDERATION OF GYNAECOLOGY AND OBSTETRICS (FIGO) 2015

Classification	Values
Absent	Frequency <3 bpm. Undetectable amplitude
Minimal	Amplitude < o = a 5 bpm
Moderate, normal	Amplitude 6-25 bpm
Emphasized, severe, or jumping pattern	Amplitude > a 25 bpm

Source: Federation of Gynecology and Obstetrics (FIGO) 2015

c) Accelerations

Escalations or accelerations are transient increases in FHR above baseline with an amplitude of 15 beats and a duration of greater than 15 seconds not to exceed 10 minutes. Causes of FHR accelerations may be fetal movement, vaginal exploration, uterine contraction, or abdominal palpation. These are considered to have a good prognosis as they demonstrate the fetal capacity to adapt to the increased oxygen consumption required by the movements of the fetus [19].

The types of acceleration according to their relationship with uterine movements and contraction can be:

Non-periodic accelerations: These are accelerations that occur in response to fetal movements; these determine fetal reactivity and are what is sought in the non-stress test (NST).

Pure periodic accelerations: These are accelerations that occur simultaneously with uterine contractions.

Compensatory periodic accelerations: These are the accelerations that occur before a deceleration.

d) Decelerations

The decelerations are transient falls or decreases of the fetal heart rate by 15 beats per minute below the baseline for a duration of 15 seconds and no longer than 10 min. These decelerations are of four types: early decelerations, late decelerations, variable decelerations, and prolonged decelerations [19].

Early deceleration: Also known as precocious, type I and formerly called DIP I (intrapartum deceleration type I), it is a transient and low amplitude fall that coincides with the acme of uterine contraction. It is caused by an intense compression of the fetal head, which leads to endocranial hypertension that sharply and slightly restricts blood flow, causing cerebral and vagal center hypoxia, as a result of which the vagal stimulus is generated, causing symmetrical decelerations associated with the contraction. It is associated with a normal baseline, and this undergoes modification with atropine.

Late decelerations: Also called type II, formerly called DIP II (type II intrapartum decelerations), and correspond to those FHR drops that begin after the onset of the contraction, with a delay, both in its onset and in its acceleration, greater than 20 seconds, while its disappearance is subsequent to uterine relaxation. These are produced when the myometrial vessels are compressed by uterine contraction, generating a reduction of maternal blood flow in the intervillous space. Consequently, the oxygen pressure at the fetal level falls below its critical level (18 mmHg). Such decelerations are not normal; if they are the result of small contractions, it indicates severe placental compromise.

Variable decelerations: These can appear at any moment during the course of the tracing; their amplitude and duration can be very variable, justifying their name; their occurrence varies with each contraction. Such decelerations always correspond to accidents involving the umbilical cord, such as, for example, circular decelerations, compression of the umbilical vein, knots, etc.

Prolonged decelerations: These are the decrease in fetal heart rate, by 15 beats or more, in reference to baseline with a duration greater than or equal to two minutes and less than 10 minutes. It is produced by compression of the inferior vena cava or compression of the abdominal aorta (poseiro effect), true cord knot, and other funicular dystocias.

The syndrome of the inferior vena cava occurs during pregnancy at the end of the second trimester, and it is characterized by a duration equal to or longer than two minutes, and its recovery is slow. The pregnant uterus becomes large and heavy enough to compress the inferior vena cava and the abdominal aorta in the supine position. It occurs in around 1 in 10 pregnant women at term with the following symptoms: hypotension, tachycardia, diaphoresis, nausea, vomiting, abdominal pain, dyspnea, dizziness, and restlessness. Management consists of change of position to left lateral decubitus (DLI), hydration, oxygen therapy, search for the cause, and correction.

Poseiro effect is regional hypotension suffered by the mother only in the abdominal and lower part, which produces alterations in the fetal heart rate, occurring especially in the third trimester of pregnancy and during labor. It is triggered by compression of the abdominal aorta and primitive iliac arteries in more than 50% of its caliber, producing a decrease in maternal blood flow to the intervillous spaces of the placenta and hypotension of the lower limbs, it is asymptomatic, so it is considered more dangerous, as it can go unnoticed [23].

Fetal movements

Fetal movements (FM) will be considered an effective parameter in the study of fetal well-being due to the fact that, in association with transient increases in FHR, it is the key point of the Non-Stressful Test (NST) as its assessment is based on fetal reactivity to movements. In situations such as hypoxia and moments prior to fetal death, there is a decrease in the MF [24].

The non-stimulated fetal movement begins from the seventh week of gestation and becomes more complex and coordinated towards the end of pregnancy. On the other hand, between 20 and 30 weeks, the general movements of the body are perceived as organized, and the fetus begins to show cycles of rest and activity, where four behavioral states are established in most fetuses, these being as follows:

a) State 1F is of rest (quiet sleep) with a narrow oscillatory fetal heart rate band.

b) State 2F comprises overt and frequent body movements, continuous eye movements, and wider fetal heart rate oscillation.

c) State 3F includes continuous eye movements in the absence of body movements and no heart rate accelerations.

d) State 4F includes vigorous body movements with continuous eye movements and fetal heartbeat accelerations [19].

Fetuses spend most of their time in the 1F and 2F states; it should also be noted that a determining factor of fetal activity is the waking and sleeping cycles. On the other hand, a woman who is multiparous may perceive fetal movements for the first time between 16 and 18 weeks of gestation, while a primigravida perceives them at around 20 weeks of gestation [19].

For cardiotocographic evaluation, there are two types of fetal movements:

a) Individual fetal movements: These are movements of short duration, that is, no more than 5 seconds. These are easily detected by the pregnant woman and the examinator on palpation, and a single well-defined wave is seen in the cardiotocography recording. It is subdivided into:

Isolated movement, also known as simple movements.

Repetitive movements [23].

b) Multiple fetal movements: Also known as rolling movements, in the cardiotocography recording 2 or more waves are linked so that they appear as a mountain range composed of several ridges of varying amplitude and duration, which are divided into:

Short Multiple Movements (10sec).

Multiple long movements (20 sec) (23).

Antepartum fetal monitoring

One of the prenatal tests to assess fetal health is antepartum fetal electronic fetal monitoring or NST, which is used to confirm intact fetal brainstem function by assessing the fetal heartbeat with a monitor. Fetal health is confirmed if the basal FHR is within normal parameters and there are periodic increases in them, which are usually associated with MF [11].

NST can be performed from the 28th week of pregnancy for no less than 20 minutes. This test is based on the presence of an atrial autorhythmic pacemaker, which in normal conditions, the FHR is increased or decreased in the beat to beat ratio, all this due to the influence of impulses coming from the sympathetic-parasympathetic autonomic nervous system originated in the brain stem. This fetal reaction, or reactivity, indicates that fetal autonomic function is intact, and the loss is associated with fetal sleep and central nervous system depression [12].

There are different interpretations of NST results at the international level, such as FIGO, the Spanish Society of Gynecology and Obstetrics (SEGO), NICHID, DUBLIN, American College of Gynecology, and Obstetrics (ACOG), as well as the FISHER score [23]. There are different interpretations of NST results at the international level, such as FIGO, the Spanish Society of Gynecology and Obstetrics (SEGO), NICHID, DUBLIN, American College of Gynecology, and Obstetrics (ACOG), as well as the FISHER score [23]. They all used the same parameters for evaluation of the fetal monitoring tracing, which are: baseline, variability, accelerations, and decelerations with the exception of fetal movement, included in Fisher's test. In Peru, the Fisher test and the NICHD test are used for the interpretation of NST results.

The Fisher score values of the NST (Table III), applied at the National Maternal-Perinatal Institute, contribute to decision making during obstetric management with a clinical approach in all pregnant women, with scores of 8-10 being classified as physiological values with a favorable prognosis; doubtful between 5-7; and pathological fetal status with a score less than or equal to 4 [21].

TABLE III. FISHER TEST

Classification	Values		
	0	1	2
Baseline	< 100 > 180	100 – 119 161 – 180	120 - 160
Variability	< 5	5 – 9 o > 25	10 – 25
Accelerations	0	1 – 4 sporadic or periodic	≥ 5
Decelerations	Decelerations type II > 50% Decelerations type III > 60%	Decelerations type II < 50% Decelerations type III < 60%	Absents
Fetal movements	0	1 - 4	≥ 5

Source: Perinatal Maternal Institute (2010) Clinical Practice Guide and Procedures in Obstetrics and Perinatology.

For the interpretation of the result as Reactive NST: reflects fetal heart reactivity patterns present and normal fetal heart rate parameters, and Non-Reactive: means the absence of fetal heart rate accelerations versus fetal movement and absence of fetal motor activity [23].

COVID – 19

World Health Organization (WHO) declared a pandemic the new outbreak of coronavirus pneumonia (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [2]. COVID-19 has been considered a self-limiting type of infectious disease, and most cases with slight symptoms can recover within 1 to 2 weeks [25].

The most common symptoms of COVID-19 include dry cough, fever, and myalgia or tiredness; whereas the less common symptoms are diarrhea, headache, loss of sense of smell or taste; on the other hand, severe symptoms are shortness of breath or feeling short of breath and chest pain or pressure [26]–[28].

The main source of infection in patients with COVID-19, which is transmitted through droplets generated during coughing and sneezing by symptomatic patients but can also occur in asymptomatic persons [29].

Individuals who are in close contact with patients or subclinically symptomatic infected persons are part of the high-risk population since, as it is an emerging infectious disease, people of all races and ages are generally susceptible. However, persons with basic underlying disorders such as asthma, diabetes, cardiovascular disease, and cancer are particularly susceptible to SARS-CoV-2 [30].

Regarding the diagnosis, a suspected case is defined as a patient with fever, sore throat, cough; or a person that had contact with patients with confirmed COVID-19 infection, cases may be asymptomatic or even without fever; meanwhile, a confirmed case is a suspected case with a positive molecular test [31].

To date, the FDA has not approved any specific antiviral treatment or vaccine to counteract COVID-19, so treatment is based on standard care consisting of isolation and prevention measures, supportive care for symptoms and complications, and advanced organ support in patients with severe disease [28].

In Peru, the specific treatment for COVID-19, according to studies carried out in different countries, consists of Chloroquine, Hydroxychloroquine, Azithromycin, Lopinavir/ritonavir, among others. The schemes suggested by the National Scientific Societies are as follows:

- Chloroquine phosphate of 500 mg every 12 hours for 7-10 days, oral administration.
- Hydroxychloroquine of 200 mg every 8 hours for 7-10 days, oral administration.
- Hydroxychloroquine of 200 mg every 8 hours for 7-10 days, orally + Azithromycin 500 mg on the first day followed by 250 mg every 24 hours for 5 days, oral administration [32].

On the other hand, the Ministry of Health indicates prevention measures in the community such as Social distancing, frequent handwashing with soap and water or

an alcohol-based lotion, the practice of respiratory hygiene and cough etiquette, mandatory use of masks to circulate on public roads, pneumococcal and influenza vaccination in populations with risk factors [32].

COVID – 19 and pregnancy

Pregnant women experience physiological changes that result in alterations of the immune system. This does not necessarily make them more susceptible to viral infection; therefore, their response to COVID-19 may be similar to any other viral infection [33]. On the other hand, pregnant women with COVID-19 have a higher incidence of preterm delivery, low birth weight, cesarean section, and hospitalization in the NICU compared to the overall population [34]; and fetal complications of COVID-19 include miscarriage (2%), intrauterine growth restriction (IUGR; 10%) and preterm delivery (39%) [6].

Pulse oximetry (SpO2) relies on the difference in the absorption of light waves by oxygenated and deoxygenated hemoglobin. The oximeter has a diode that emits red to near-infrared light waves and a microprocessor that can identify and separate the pulsatile (arterial) from the non-pulsatile (venous) component, and in accordance with the absorption of the light waves, calculate the arterial oxygen saturation (SaO2) of the pulsatile (arterial) hemoglobin using the average of repeated measurements over a period of time. The result obtained is the percentage of oxygen saturation of hemoglobin in arterial blood (SaO2) because it is measured with a pulse oximeter named SpO2 [35].

Parameters of normal oxygen saturation can be visualized in Table IV:

TABLE IV. ARTERIAL OXYGEN SATURATION AT DIFFERENT ALTITUDES IN THE POPULATION OF COLOMBIA

Altitude above sea level (by meters)	SaO_2 Men Average (IC 95%)	SaO_2 Women Average (IC 95%)
970	94,8 (94,1 – 95,4)	96,4 (95,7 – 97,1)
1520	95,5 (94,9 – 96,1)	95,6 (94,9 – 96,2)
1728	95,7 (95,3 – 96,2)	96,1 (95,6 – 96,6)
1923	95,1 (94,3 – 95,8)	96,0 (95,6 – 96,3)
2180	95,2 (94,6 – 95,9)	95,4 (94,9 – 95,9)
2600	93,6 (93,2 – 94,0)	94,4 (94,1 – 94,8)

Source: Nutr. Hosp. 2015; 32(5): 2309 – 2318, extracted from "Use and Interpretation of Pulse Oximetry" (37)

TERMS DEFINITION

Fetal heart rate: This is the fetal heartbeat per minute, and it is considered normal when it is between 110 bpm and 160 bpm. These beats consist of four elements: baseline, variability, accelerations, and decelerations.

COVID – 19: Severe acute respiratory syndrome caused by coronavirus 2 (SARS-CoV-2).

VARIABLE: Fetal heartbeat characteristics of pregnant women diagnosed with COVID - 19.

Variable Operationalization: Table V summarizes the form of the variable and its operationalization.

V. METHODOLOGY AND RESULTS

The type of research was observational, descriptive, and prospective as the information was collected during the month of August, and it was cross-sectional because the data were collected at a single point in time [36]. As is appropriate at this level, we will only observe how the event was developed, in this particular case, the behavior of the fetal heartbeats of the pregnant women diagnosed with COVID - 19.

TEMPORAL AND SPATIAL SCOPE

The Regional Maternal and Child Teaching Hospital "El Carmen" is located in Jr. Puno, with an area of 6,892.90 between Huancavelica Avenue and Puno Street in the district of Huancayo, province of the same name in the Junin region. It was created in 1847 when the country was governed by Ramon Castilla and Marquesado, and the Hospital was founded on July 5; it always had an economic deficiency, so much so that many honorable people of Huancayo and many communities in the valley decided to collaborate with the maintenance of the Hospital, for example, Mr. Mariano Giraldez, Juan Carvo fight as deputies for several taxes to pass to the hospital, the officials resigned to their assets as Mr. Demetrio Galvez. In 1908 the Franciscan Mothers began to provide their services under the invocation of the "Virgen Del Carmen." In 1933 Huancayo became the capital of the Department. In 1940 the Beneficence appropriated all the land due to the loss of documentation during the war with Chile. The population assigned to its care is 13,534 pregnant women during the year 2020. This facility maintains the category III - E and has the following services in the field of maternal and perinatal health: obstetric and pediatric emergency services 24 hours a day, and in the health services provider unit (UPS) outpatient services portfolio for maternal care 12 hours a day and has 24 clinics for maternal and pediatric care. The UPSs for gynecology, obstetrics, neonatology, pediatrics, dentistry, ophthalmology, preventive oncology, psychoprophylaxis, physical therapy and rehabilitation, traumatology, CRED, immunization, PPFF, ESNITS, TBC, TARGA, adolescent, psychology, nutrition, social work. In hospitalization: gynecology, ARO I, AROII, normal puerperium, surgical puerperium, fetal medicine, UTHE, dilation room, delivery room, neonatology. Pediatrics, specialized clinical, specialized surgical, recovery, surgical center, sterilization center, maternal and child intensive care, pediatric dentistry, clinical pathology and pathological anatomy, diagnostic imaging, blood bank, pharmacy.

As a result of the pandemic, services have been reorganized, creating a differentiated triage for sample collection and delivery of results before admission to the hospital, where if a pregnant woman coming for control or comes for an emergency is positive for COVID - 19, there is exclusive staff for their care and also implemented a special area for emergency care, childbirth and a hospitalization area where patients are attended by dedicated staff.

This differentiation was made to control the in-hospital transmission of the virus and thus ensure the health of all patients who come to the hospital; likewise, in the transport area, there is a specific ambulance for the transfer of COVID-19 patients to other institutions with a higher resolution capacity.

Some strategies within the institution were modified to reduce in-hospital infection, including early discharge, reducing hospital stay to avoid contact with other patients and health professionals. The population treated are beneficiaries of integral health insurance.

TYPE OF INVESTIGATION: The type of research was observational, descriptive, and prospective since the information was gathered in August; it is cross-sectional because the data were taken at a single point in time [36]. As is proper at this level, the only observation is how the event developed, in this case, the behavior of the fetal heartbeats of the pregnant women diagnosed with COVID-19.

LEVEL OF RESEARCH: The research is descriptive, focusing on the study of fetal heart rate in a unique and special condition in pregnant women diagnosed with mild COVID - 19. It has not yet been reviewed; therefore, it was considered to start the study at this level [36].

POPULATION, SAMPLE, AND SAMPLING: Population: It consisted of all hospitalized pregnant women diagnosed with COVID - 19, from the COVID hospitalization service, which were attended during the month of August 2020, which was a total of 180 pregnant women. It should be noted that the diagnosis of COVID - 19 was made with the quick serology test, which detects the presence of immunoglobulins IgM and IgG in maternal blood.

Sample and sampling: The sample consisted of 31 pregnant women who met the inclusion criteria; therefore, the sampling was by convenience, i.e., those who met the following inclusion criteria:

1. Diagnosis of COVID - 19, by serological or molecular test.
2. Cardiotocographic record
3. Pregnant women aged 36 - 41ss.
4. Pregnant women who have indicated antepartum monitoring.

Pregnant women from 36 to 41ss are taken in order to have a homogeneous sample because the fetal heart rate varies according to gestational age, in preterm and post-term.

INSTRUMENT AND DATA COLLECTION TECHNIQUE: An observation card was used as an instrument to collect the information, which helped us to see the behavior of the fetal heartbeat of pregnant women diagnosed with COVID - 19. The technique used was the observation for 20 to 30 minutes of the fetal heartbeat, through a continuous recording of the fetal heart rate, and analysis of the cardiotocographic tracing, according to Fisher parameters, which was developed by an obstetrician specialized in fetal electronic monitoring.

DATA ANALYSIS TECHNIQUES AND PROCESSING: The data gathered were arranged in a database and analyzed using a Microsoft Excel 2016 spreadsheet. The results were processed using descriptive statistics, presenting the data in one- and two-entry tables with absolute and percentage frequency distributions.

TABLE V. VARIABLE OPERATIONALIZATION

CONCEPTUAL DEFINITION	OPERATIONAL DEFINITION	DIMENSIONS	INDICATORS	ITEMS	VALUE	Variable type
It is the behavior of the FHR parameters, and its evaluation is performed through electronic fetal monitoring, either before delivery or intrapartum, that allows assessing fetal wellbeing.	It is the behavior of FHR parameters obtained in pregnant women of 36 weeks or more evaluated within 20 minutes using the Fisher test.	Status of the patient at the time of the examination	Age Origin Occupation Comorbiditie s Degree of Covid-19 Vital functions Gestational age	Age	In years	Discrete Quantitative
				Origin	Rural-urban	Nominal qualitative
				Occupation	Diverse	Nominal qualitative
				Comorbidities	Diverse	Nominal qualitative
				Degree of COVID-19	Slight Moderate Severe	Ordinal Qualitative
				Vital Functions	Temperature Blood pressure Oxygen saturation	Discrete and continuous numerics
				Ventilation	Environment Oxygen	Nominal qualitative
		Fetal heart rate	Valuation of the fetal heart rate elements	Baseline	Numeric	Numeric Discrete
				Variability	Numeric	Numeric Discrete
				Accelerations	Numeric	Numeric Discrete
				Decelerations	Numeric	Numeric Discrete

TABLE VI. GENERAL CHARACTERISTICS OF HOSPITALIZED PREGNANT WOMEN DIAGNOSED WITH COVID – 19, TREATED AT THE REGIONAL MATERNAL AND CHILD TEACHING HOSPITAL EL CARMEN, 2020

Pregnant women characteristics	Total number of pregnant women	
	2020	
	f = 100	%
Age Group		
15 - 19	5	16.13
20 – 34	20	64.52
≥ 35 a 40	6	19.35
Parity		
Primiparous	15	48.39
Multiparous (2 - 3 children)	12	38.71
Great multiparous	4	12.90
Provenance		
Urban	29	93.55
Rural	2	6.45
Occupation		
Housewife	28	90.32
Self-Employed	2	6.45
Public Employee	1	3.23

Table VI shows that most of the pregnant women diagnosed with COVID-19 are aged between 20-34 years, of which 19.35% are older than 35 years, while 16.13% are teenagers. The majority (93.55%) live in urban areas, while only 6.45% come from rural areas, 90.32% are housewives, 6.45% are self-employed, and 3.23% are public employees. Finally, regarding parity, 48.39% are primiparous, 38.71% are multiparous, and 12.90% are great multiparous.

TABLE VII. CLINICAL CHARACTERISTICS OF PREGNANT WOMEN DIAGNOSED WITH COVID – 19, ACCORDING TO COMORBIDITY AT THE REGIONAL MATERNAL AND CHILD TEACHING HOSPITAL EL CARMEN, 2020

COMORBILITY				
Clinical Characteristics	**None**	**Hypertension**	**Diabetes**	**Total**
	N =22	**N =8**	**N =1**	**N=31**
Temperature (ºc)	36.9	36.8	36.5	36.9
SBP (mmHg)	105	127	110	111
DBP (mmHg)	66.09	85	60	71
SpO2 (%)	92.82	92.75	90	92.81

Table VII shows the main clinical characteristics monitored at the time of cardiotocographic registration by comorbidity. The average temperature was 36.9 ºC in pregnant women without comorbidity, and in pregnant women, with hypertension, it was 36.8 ºC, while the average temperature in pregnant women with diabetes was 36.5 ºC. The mean blood pressure in pregnant women without comorbidity was 105 mmHg systolic and 66.09 mmHg diastolic; in pregnant women with hypertension, it was 127 mmHg systolic and 85 mmHg diastolic; pregnant women with diabetes had 110 mmHg systolic and 60 mmHg diastolic. The mean oxygen saturation (SpO2), measured with the pulse oximeter, was 92.82% in pregnant women without comorbidity, 92.75% in women with hypertension, and 90% in pregnant women with diabetes.

TABLE VIII. PERFORMANCE OF FETAL HEART RATE ELEMENTS IN PREGNANT WOMEN WITH A DIAGNOSIS OF COVID – 19, TREATED AT THE REGIONAL MATERNAL AND CHILD TEACHING HOSPITAL EL CARMEN, HUANCAYO 2020

FHR elements	Total number of pregnant women with COVID-19	
	2020	
	N = 31	%
Baseline		
110 – 160	28	90.32
161 – 180	3	9.68
Variability		
< 5	8	25.81
5 to 9	11	35.48
10 to 25	12	38.71
Acceleration		
0	8	25.81
1 -4, or periodicals	16	51.61
≥ 5	7	22.58
Decelerations		
Not present	26	83.87

Table VIII assesses the performance of the elements of the fetal heart rate of the pregnant women with COVID - 19, and it can be seen that the baseline of 90.32% remained within normality, while 9.68% presented tachycardia. Regarding variability, 25.81% had no variability, 35.48% had minimal variability, and 38.71% had normal variability. Concerning accelerations, 25.81% had no accelerations, 51.61% had 1 to 4, 22.58% had 5 or more. Finally, deceleration type III was found in 16.13%.

TABLE IX. PERFORMANCE OF FETAL HEART RATE ELEMENTS IN PREGNANT WOMEN WITH A DIAGNOSIS OF COVID – 19, TREATED AT THE REGIONAL MATERNAL AND CHILD TEACHING HOSPITAL EL CARMEN, HUANCAYO 2020.

VITAL SIGNS	COMORBILITY			
	NONE N = 22		HYPERTENSION AND DIABETES N = 9	
	N	%	N	%
Baseline				
110 – 160	20	90.91	8	88.89
161 – 180	2	9.09	1	11.11
Variability				
< 5	6	27.27	2	22.22
5 to 9	9	40.91	2	22.22
10 to 25	7	31.82	5	55.56
Acceleration				
0	7	31.82	1	11.11
1 - 4, or periodicals	11	50.00	5	55.56
≥ 5	4	18.18	3	33.33
Decelerations				
Not present	19	86.36	8	88.89
Type - III	3	13.64	1	11.11

In Table IX, the behavior of the FHR is analyzed with respect to comorbidity. Baseline tachycardia was found in 11.11% of the group with comorbidity compared to 9.09%

in the group without comorbidity. Variability was absent in 22.22%, minimal in 22.22%, and within normal parameters in 55.56%, while in the group without risk, it was absent in 27.27%, 40.91% presented minimal variability, and 31.82% had normal variability. Accelerations in the group with comorbidity were absent in 11.11%, 55.56% presented 1 to 4 accelerations, and 33.33% had five or more accelerations. Type III decelerations were found in 11.11% in the group with comorbidity and in 13.64% in the group without comorbidity.

VI. DISCUSSION

Viral causes of pneumonia have been found to severely affect the pregnancy process, increasing maternal and fetal morbidity and mortality [14]; however, in the case of COVID-19 pneumonia, a higher incidence of spontaneous abortion (2%), intrauterine growth restriction (IUGR; 10%) and preterm delivery (39%) was observed [6]. Likewise, Smith [34] states that low birth weight and cesarean section are increased in this group. Fetal heartbeat has not been studied in pregnant women with COVID-19, which requires detailed observation, as was performed in the present study. The 31 pregnant women observed had slight COVID - 19, most of them were in optimal reproductive age (20-34 years) as 64.52%of the cases, in which the minimum age identified was 15 years and the maximum 40 years. The 93.55% were from urban areas, 90.32% were dedicated to their homes, 48.39% were primiparous, and 38.71% were multiparous, 12.90% were great multiparous. It is noteworthy that, due to their origin and occupation, they were probably exposed to the virus at the time of acquiring food (supermarket, market, stores). Therefore, in order to avoid this situation, it is necessary to insist on preventive measures for all pregnant women in each prenatal care.

Within the clinical characteristics by comorbidity, the mean temperature was within the normal range in the three cases, the mean blood pressure was slightly elevated in the group of hypertensive pregnant women as expected 127/85 mmHg, compared to 105/66.09 mmHg in the group without comorbidity, and the pregnant woman with diabetes presented 110/60 mmHg. In all cases, oxygen saturation decreased, with a mean of 92.82% in pregnant women without comorbidity, 92.75% in pregnant women with hypertension, and 90% in pregnant women with diabetes. Values below the normal average for the altitude in women (94.4%) [35]. None of the 31 pregnant women received oxygen assistance. The fetal heart rate showed that variability was absent in 25.81%, was minimal in 35.48%; as for accelerations, 25.81% did not present, 51.61% presented accelerations between 1 to 4, and 22.58% presented 5 or more, as we can see the findings are consistent with fetal hypoxemia and hypoxia in a considerable percentage [21], this suggests that the oxygen supply is diminished, a condition that is reflected in the mother's oxygen saturation, indicating that on average only 92% of her hemoglobins are carrying oxygen, thereby limiting adequate delivery at the level of the intervillous space of the placenta, which reduces the delivery of oxygen to the fetus. Type III decelerations have also been identified in 16% of pregnant women, an event related to funicular compression [23], a situation that requires greater research. When analyzing by comorbidity, it is appreciated that the normal baseline predominated in both groups; however, the tachycardic baseline is shown slightly higher 11.11% in the group with comorbidity compared to 9.09% in the group without comorbidity, the absent and minimal variability was presented in 22.22% of pregnant women with comorbidity compared to 27. 27% and 40.91% without comorbidity, this finding imply that the decreased variability is due to the decrease in oxygen saturation, which may be caused by the attack of the SARS - CoV2 virus to the respiratory system, limiting the mother's gas exchange at the level of the maternal lungs, thus decreasing the arterial oxygen pressure (PaO2). Among the characteristics of the fetal heartbeat, tachycardia was found in 9.68%, with no variability in 25.81%, minimal variability in 35.48%, while 25.81% did not present acceleration, accelerations of 1 - 4 were observed in 51.61%, which indicates that a little more than 25% of the pregnant women with COVID - 19, the delivery of maternal oxygen to the fetus was altered. Therefore, these findings suggest that all pregnant women with COVID - 19 require strict fetal monitoring and daily NST should be indicated, due to the pathogenicity of the disease, before deciding the route of delivery, a stress test should be indicated, and in case of labor it should be with intralabor monitoring.

VII. CONCLUSIONS

All the 31 pregnant women presented slight COVID - 19, 64.52% were between 20 and 34 years of age, with a minimum age of 15 years and a maximum age of 40 years; 93.55% were from urban areas, while 90.32% were dedicated to their homes, 48.39% were primiparous, and 38.71% were multiparous. Among the clinical characteristics, it was found that the mean temperature was within normal, blood pressure was slightly higher in the group with hypertension 127/85 mmHg, in contrast to 105/66.09 mmHg, in pregnant women without comorbidity, oxygen saturation (SpO2) was 92.82% in pregnant women without comorbidity and 92.75% in pregnant women with hypertension while in pregnant women with diabetes it was 90%. The baseline presented tachycardia in 9.68% of cases, and variability was absent in 25.81%, minimal in 35.48%; as for accelerations, 25.81% did not present any, while 51.61% presented accelerations between 1 and 4, and variable or type III decelerations were observed in 16.13%. When analyzing by comorbidity, a lower proportion of negative indicators is shown in the group with comorbidity, variability absent in 27.27% against 22.22% and minimal 40.91%, against 22.22%; acceleration absent 11.11% against 31. 82%, 55.56% had accelerations from 1 to 4 versus 50%, type III decelerations were observed in 11.11% versus 13.64% in the group without comorbidity, except that fetal tachycardia was found in 11.11% compared to 9.09% in the group without comorbidity. The characteristics of the fetal heartbeats of the pregnant women with mild COVID - 19, tachycardia in 9.68%, absent variability in 25.81%, minimal in 35.48%, 25.81%

did not present acceleration, accelerations of 1 - 4 were observed in 51.61%, which indicates that a little more than 25% presented signs of fetal hypoxia, making it necessary to monitor before and during labor and delivery.

REFERENCES

[1] WHO Director-General's opening remarks at the media briefing on COVID-19 - (2020)., https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020 (accessed Feb. 15, (2021).

[2] Brote de enfermedad por el Coronavirus (COVID-19) - OPS/OMS | Organización Panamericana de la Salud., https://www.paho.org/es/temas/coronavirus/brote-enfermedad-por-coronavirus-covid-19 (accessed Feb. 01, 2021).

[3] Coronavirus disease (COVID-19) – World Health Organization., https://www.who.int/emergencies/diseases/novel-coronavirus-2019 (accessed Feb. 15, (2021).

[4] Y. Liu, H. Chen, K. Tang, and Y. Guo., Clinical manifestations and outcome of SARS-CoV-2 infection during pregnancy, J. Infect.,(2020), doi: 10.1016/j.jinf.2020.02.028.

[5] C. Nelson-Piercy, I. Vlaev, K. Harris, and R. Fischer-Betz, "What factors could influence physicians' management of women of childbearing age with chronic inflammatory disease? A systematic review of behavioral determinants of clinical inertia, BMC Health Serv. Res., 19(2019) doi: 10.1186/s12913-019-4693-x.

[6] P. Dashraath et al., Coronavirus disease 2019 (COVID-19) pandemic, and pregnancy Am. J. Obstet. Gynecol., 222(6)(2020) 521–531, doi: 10.1016/j.ajog.2020.03.021.

[7] S. Ellington, Characteristics of Women of Reproductive Age with laboratory-confirmed SARS-CoV-2 Infection by Pregnancy Status — the United States, (2020), MMWR Morb. Mortal. Wkly. Rep., 69(2020), doi: 10.15585/mmwr.mm6925a1.

[8] F. Elshafeey et al., A systematic scoping review of COVID-19 during pregnancy and childbirth, Int. J. Gynaecol. Obstet. Off. Organ Int. Fed. Gynaecol. Obstet., 150(1) 47–52, Jul. 2020, doi: 10.1002/ijgo.13182.

[9] S. Goodacre et al., Selecting pregnant or postpartum women with suspected pulmonary embolism for diagnostic imaging: the DiPEP diagnostic study with decision-analysis modeling., Health Technol. Assess. Winch. Engl., 22(47)(2018) 1–230, doi: 10.3310/hta22470.

[10] B. J. F. Huntley, E. S. Huntley, D. Di Mascio, T. Chen, V. Berghella, and S. P. Chauhan, Rates of Maternal and Perinatal Mortality and Vertical Transmission in Pregnancies Complicated by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-Co-V-2) Infection: A Systematic Review, Obstet. Gynecol., 136(2)(2020) 303–312 doi: 10.1097/AOG.0000000000004010.

[11] Prefacio | Gomella Neonatología: Tratamiento, procedimientos, problemas durante la guardia, enfermedades y fármacos, 8e | AccessMedicina | McGraw-Hill Medical., https://accessmedicina.mhmedical.com/content.aspx?bookid=2928&sectionid=246260430 (accessed Feb. 15, 2021).

[12] R. M. Grivell, Z. Alfirevic, G. M. Gyte, and D. Devane, Antenatal cardiotocography for fetal assessment, Cochrane Database Syst. Rev., 9, (2015), doi: 10.1002/14651858.CD007863.pub4.

[13] C. A. Ducsay, R. Goyal, W. J. Pearce, S. Wilson, X.-Q. Hu, and L. Zhang, Gestational Hypoxia and Developmental Plasticity, Physiol. Rev., 98(3)(2018) 1241–1334, doi: 10.1152/physrev.00043.2017.

[14] P. Tang, J. Wang, and Y. Song, Characteristics and pregnancy outcomes of patients with severe pneumonia complicating pregnancy: a retrospective study of 12 cases and a literature review, BMC Pregnancy Childbirth, 18(1)(2018) 434, doi: 10.1186/s12884-018-2070-0.

[15] O. Martínez-López et al., Frecuencia cardíaca fetal en pacientes con diagnóstico de diabetes pregestacional y gestacional, Clínica E Investig. En Ginecol. Obstet., 32(1)(2005) 19–26, J doi: 10.1016/S0210-573X(05)73468-7.

[16] G. Romero-Salinas, G. Oropeza, C. Castillo, A. Guerrero, G. Barrientos, and M. Torres, El modelo de la frecuencia cardíaca fetal en embarazadas con diagnóstico de anemia ferropénica, Clínica E Investig. En Ginecol. Obstet., 30(2)(2003) 42–52, doi: 10.1016/S0210-573X(03)77229-3.

[17] G. Romero-Salinas et al., La frecuencia cardíaca fetal en pacientes con diagnóstico de preeclampsia leve y grave, Clínica E Investig. En Ginecol. Obstet., 37(1)(2010) 2–13 doi: 10.1016/j.gine.2009.02.003.

[18] G. Romero-Salinas et al., La frecuencia cardiaca fetal en embarazadas adolescentes, Clínica E Investig. En Ginecol. Obstet., 38(6)(2011) 222–228.

[19] Williams Obstetricia 24º Ed. por Cunningham, F. Gary - 9786071512772 - Journal, Ediciones Journal - libros profesionales para lasalud.https://www.edicionesjournal.com/Papel/9786071512772/Williams+Obstetricia+24º+Ed (accessed Feb. 15, 2021).

[20] V. A. Hernández et al., Principios de medicina materno fetal. Santander, (2018).

[21] O. F. Dueñas-García and M. Diaz-Sotomayor, Controversias e historia del monitoreo cardiaco fetal, Rev. Investig. Clínica, 63(6)(2011) 659–663.

[22] L. C. Roura, Obstetricia y medicina materno-fetal. Ed. Médica Panamericana, (2007).

[23] L. C. i Roura et al., Tratado de ginecología y obstetricia. (2014).

[24] J. E. Martín López, C. Beltrán Calvo, and R. Rodríguez López, "Efectividad de la electrocardiografía fetal frente a la pulsioximetría para la determinación del bienestar fetal, Clínica E Investig. En Ginecol. Obstet., 42(4)(2015) 157–164 doi: 10.1016/j.gine.2014.04.002.

[25] Epidemiology Working Group for NCIP Epidemic Response, Chinese Center for Disease Control and Prevention, [The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China], Zhonghua Liu Xing Bing Xue Za Zhi Zhonghua Liuxingbingxue Zazhi, 41(2)(2020) 145–151, doi: 10.3760/cma.j.issn.0254-6450.2020.02.003.

[26] N. Chen et al., Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study, The Lancet, 395(10223)(2020) 507–513, doi: 10.1016/S0140-6736(20) 30211-7.

[27] C. Huang et al., Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China, The Lancet, 395(10223)(2020) 497–506, doi: 10.1016/S0140-6736(20)30183-5.

[28] F. Jiang, L. Deng, L. Zhang, Y. Cai, C. W. Cheung, and Z. Xia, Review of the Clinical Characteristics of Coronavirus Disease 2019 (COVID-19), J. Gen. Intern. Med., 35(5)(2020) 1545–1549, doi: 10.1007/s11606-020-05762-w.

[29] C. Rothe et al., Transmission of 2019-nCoV Infection from an Asymptomatic Contact in Germany, N. Engl. J. Med., 382(10)(2020) 970–971 doi: 10.1056/NEJMc2001468.

[30] Y. Jin et al., Virology, Epidemiology, Pathogenesis, and Control of COVID-19, Viruses, 12(4)(2020), doi: 10.3390/v12040372.

[31] T. Singhal, A Review of Coronavirus Disease-2019 (COVID-19), Indian J. Pediatr., 87(4)(2020) 281–286 doi: 10.1007/s12098-020-03263-6.

[32] Prevención, diagnóstico y tratamiento de personas afectadas por COVID-19 en el Perú." https://www.gob.pe/institucion/minsa/informes-publicaciones/473587-prevencion-diagnostico-y-tratamiento-de-personas-afectadas-por-covid-19-en-el-peru (accessed Feb. 15, 2021).

[33] H. Akhtar, C. Patel, E. Abuelgasim, and A. Harky, COVID-19 (SARS-CoV-2) Infection in Pregnancy: A Systematic Review, Gynecol. Obstet. Invest., 85(4)(2020) 295–306, doi: 10.1159/000509290.

[34] V. Smith et al., Maternal and neonatal outcomes associated with COVID-19 infection: A systematic review, PLOS ONE, 15(6)(2020) e0234187, doi: 10.1371/journal.pone.0234187.

[35] LUIS FERNANDO CORREA SERNA - MINISTERIO DE SALUD Y PROTECCION SOCIAL - SIGEP - Función Pública., https://www.funcionpublica.gov.co/web/sigep/hdv/-/directorio/M101065-8006-4/view (accessed Feb. 15, 2021).

[36] D. J. Supo and M. H. Zacarías, METODOLOGÍA DE LA INVESTIGACIÓN CIENTÍFICA: Para las Ciencias de la Salud y las Ciencias Sociales. 2020.