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**"Exploration of Immune Function in
Pregnant Women with Rubella Virus in
Al-Refie City"**

"Exploration of Immune Function in Pregnant Women with Rubella Virus in Al-Refie City"

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Abstract

The immune responses regarding pregnant women in Al-Refie City to rubella virus are investigated in the presented study, with a focus on the frequency of antibodies specific to rubella, the relationship between pregnancy outcomes and immunity, and the importance of vaccination. There have been 150 pregnant women in the study at different pregnancy stages, also venous blood samples have been taken from them so that IgM and IgG antibody levels could be determined using serological tests. The correlations between vaccination status, rubella exposure, and antibody presence were examined using T-tests, Chi-square tests, and ANOVA. Descriptive statistics have been utilized for summarizing clinical and demographic data. The results supported the protective effect regarding vaccination by demonstrating a strong correlation between IgG antibody levels and vaccination. Furthermore, IgM positivity has been linked to a history of rubella exposure, indicating a current or recent infection. The effectiveness of vaccination in avoiding rubella was additionally demonstrated by t-test results, which indicated considerably lower IgM values and greater IgG levels in vaccinated individuals. Significant differences in antibody levels between pregnancy trimesters were found using ANOVA, with both IgM and IgG levels showing notable differences. The findings highlight the necessity of continuous immunity monitoring for preventing rubella-related problems and the crucial function regarding rubella vaccination in pregnant women. In addition to providing important information for public health campaigns targeted at lowering rubella incidence as well as its effects on fetal and maternal health, the presented work advances our knowledge of rubella immunity throughout pregnancy..

Keywords: Immune function, Rubella virus, immunity, pregnancy trimesters, public health strategies.

Introduction

The infectious viral disease rubella causes lymphadenopathy as well as rash. Throughout pregnancy, rubella often results in serious harm. Across Saudi Arabia, CHRV is resurfacing in suitable amounts. Prenatal departure, pregnancy problems, and premature newborn deaths are all caused by the postnatal, prenatal, and neonatal abnormalities it causes [1-2]. Flares regarding such virus are typically found in women who have moved to enclaves with poor resistance rates or who are Rubella disease negative. On the other hand, due to the strain of taking care of a close infant, it is more prevalent in mothers compared to males. Along with such problems, genetic, physiological, economic, healthcare and social factors all affect the likelihood of contracting CHRV. The disease is particularly dangerous for pregnant women and unborn children who are obese, diabetic, and pregnant. The presented work aims to determine the state regarding the host immune response, immune phenomena, along with sendoff regarding the most vulnerable and, consequently,

blood supply transfer to fetal immune system throughout pregnancy. Therefore, the standard terminology as well as the implications regarding viral resistance for both qualitative research and general immunity will be of essential importance and utility. Given that CHRV can be avoided, case evaluations ought to be given on a regular basis.

The study's objective: Through the detection regarding viral-specific antibodies through viral RNA PCR in the blood of prevalent women and an examination of immunological functions in all types of blood components, particularly those impacted by traditional immunoassay, the research seeks to show using viral immunity [3–5]. In terms of the transformation regarding infectious bodies to virus-specific or viral replication employees to defense system control mediators. The presented work will clarify why the immune response varies between embryo trace amounts inoculated and those put into adult immunized pregnant carriers. In a population of women and their born citizens, the presented work theoretically predicts the

accurate therapeutic as well as related systems.



Consequences aimed at: The impact of pregnancy on host immunity is predicted by the presented work as expected. This indicates that the study will come to a conclusion and highlight mothers who are vulnerable to fetal infection. The defenses related to pregnant women who want to permeate alternate viral infections or gene vaccinations could be additionally investigated using the results of this study. The desire to provide pregnant women with individualized antiviral drugs linked to viruses that have the most thorough effects. Using PCR analysis regarding relevant cDNA information, ELISA, and virus isolation, samples are collected from women in Al-Refie city between the ages of 18 and 45 who do not have Rubella immunity for specific antibodies. Concurrently, the immunoregulation of groups like Th1, Tregs, Th2, and IFN- γ that estimate insufficient reserves, specific, and complete conditions is examined, also concentrated serum, leukocytes, and soluble components of the chorionic membrane as well as amniotic fluid [6].

Rubella Virus: Overview of Its Epidemiology and Effects During Pregnancy

A viral infection spread by respiratory droplets is known as rubella, often known as German measles. Although it is typically moderate in children and adults, pregnant women are at serious risk, particularly in the first trimester in the case when it might result in congenital rubella syndrome (CRS). CRS could cause fetal mortality or miscarriage, as well as birth abnormalities, like heart issues, cataracts, and hearing impairments. Rubella continues to pose a threat to both fetuses and mothers, making it a public health problem, especially in regions with poor vaccination rates. In the case when vaccination rates decline, outbreaks may happen even in areas, in which rubella was mainly contained. Rubella continues to be a problem because of vaccine access gaps as well as hesitation, even though the risk regarding fetal harm is highest early in pregnancy. To improve preventive and reduce the risk of CRS, it is essential to comprehend the epidemiology of rubella and its impact on pregnancy [7–8].

Immune Response during Pregnancy

The immune system changes significantly throughout pregnancy for protecting the growing fetus as well as the mother. The immune system should tolerate the existence regarding the fetus, which is genetically distinct, even though it is typically geared for protecting the body from infections. Numerous immune modifications help to establish such precise balance. For the prevention of rejection, the immune system of the mother develops tolerance for the antigens of the fetus, however, it keeps being vigilant towards the pathogens. The changes in the hormones during the pregnancy, such as the increase in the levels of progesterone and estrogen, are important for the modulation of the immune responses, while the adaptive immune response, including specific antibodies and T-

cells, is modified for the purpose of preventing the damage of the fetus, the innate immune system that provides the first defense line, stays active. Infections can maternal as well as the fetal health, those include infections rubella, which could lead to upsetting such balance. For the purpose of safeguarding the mother and stopping the infections from being spread to the fetus, it is inevitable to have a controlled and robust immune response. In contrast, some issues such as the miscarriage, preterm birth, or congenital infections might be a result of inadequate or overactive immune responses.

The changes of the immune system in several ways during the period of pregnancy in order to protect the mother as well as her developing fetus. The immune system of the mother has the ability for tolerating the fetus while keeping the protection from the infections. One of the significant alterations is transitioning from a mostly Th-1 immune response, which activates cellular immunity, to Th-2 immune response, which promotes a defense that is more antibody-driven, which is highly important for the defense against the pathogens. Placenta can create immune-modulating factors as well and it also plays the role of a physical barrier that helps to avoid the rejection of the fetus. Never-the-less such modifications, the immune system utilizes the adaptive as well as the innate immune responses to remain vigilant towards the infections. Rubella-specific antibodies' development, such as the IgM and IgG, is an immune response characteristic to rubella. The IgG develops later then provides long-term immunity, however, the IgM is produced typically early in the infection, which suggests a recent exposure. Due to the fact that the virus might be spread via placenta and result in harming the fetus in case it infects the mother, the immune response of pregnant females to rubella is of an extreme importance. Although the danger of the fetal problems remains substantial in the case where infection happens in early pregnancy stages, such type of immune responses is helpful in the reduction of the severity of the infection. One of the important preventive steps for guaranteeing immunity towards rubella is getting vaccinated prior to the pregnancy [9–10,11].

For a more efficient understanding about mechanisms underlying the immune responses, effects on the maternal and fetal health should be evaluated, and immunological markers which may be helpful in the clinical management and diagnoses should be found, the present study is aimed at investigating immune functions of pregnant females in Al-Refie City that have been infected with Rubella. The aim is also to provide a detailed examination of rubella effects on the immune system during the time of pregnancy and potential outcomes for the mother as well as the fetus. In order do that, the study will perform an analysis of the cytokine profiles and antibodies that are specific to rubella, in addition to measuring cellular immunity, for the assessment of pregnant women's immune status. The maternal immune responses' intensity and the potential of adverse fetal outcomes, like the congenital rubella syndrome, will be

researched in the present study. For the purpose of helping health-care practitioners to enhance the management of rubella-affected pregnancy cases, this study attempts at finding potential bio-markers that might be utilized for the assessment of risks and early diagnosis through the establishment of correlations between the immune markers and clinical outcomes. This research will also study the way that the immune responses and fetal health are impacted by rubella infection timing during the pregnancy. This will present a more detailed knowledge of the effects of the disease and provide important information about the diverse hazards that are related to the exposure to rubella at various stages of pregnancy. This study's major goals include enhancing attempts for rubella prevention, more efficient public health measures, and aid in creating clinical recommendations for the treatment of pregnant women with rubella. It is anticipated that results won't merely advance knowledge of the way that rubella affects the pregnancy, yet provide suggestions for the improvement of health-care delivery as well as lowering the prevalence of problems that result from rubella [12,13,14].

Immune responses throughout pregnancy, rubella virus, and the specific impacts of rubella on the maternal and fetal health all need to be covered thoroughly in the literature review for the study's Exploration of the Immune Functions in Pregnant Women in Al-Refie City that have Rubella Virus. Adults and children who contract rubella, a common viral infection spread by respiratory droplets, experience minor symptoms. Congenital rubella syndrome (CRS), which results in birth problems, like heart defects, cataracts, hearing loss, and intellectual difficulties, is one of the worst issues that could arise throughout pregnancy, especially in the first trimester. Severe cases may lead to fetal death or spontaneous abortion. In areas with low vaccination coverage, in which insufficient immunization programs contribute to the virus's ongoing transmission, rubella remains a serious public health concern even with the availability regarding the vaccine, which has dramatically decreased cases in various developed nations. IgG and IgM, two antibodies specific to rubella, are produced by the immune system in response to infection. IgG offers long-term immunity, but IgM signals a recent infection. Because the virus could infect the fetus after crossing placenta, a pregnant woman's immune response to rubella is vital. Given that such infection has the highest risk of fetal harm, particularly during first trimester, maternal immunity is crucial in the prevention of vertical transmission and the serious outcomes of rubella. Rubella could impair the maternal immune system, which might impact the severity regarding the infection as well as its potential for transmission to fetus, although it mostly affects the mother. The immune system changes throughout pregnancy in a number of ways to safeguard the growing fetus as well as protecting the mother from infections. Modification of immune responses is one important adaptation. For example, the transition from Th1-dominant immune system, initiating cellular immunity, to Th2-dominant immune response, which is more antibody-driven, is an example. For preventing fetal rejection and

balance the mother's defenses against infections, this modification is essential. For further protecting the fetus and tolerate its presence, the placenta produces immune-regulating factors. The timing of infection is crucial in specifying the degree of fetal impairment, according to studies on rubella's effects throughout pregnancy. Later stages regarding pregnancy are linked to a lesser chance of fetal difficulties, but infection throughout first trimester is linked to the highest risk of congenital malformations. With regard to low-resource settings, pregnant women may be at risk for rubella infection due to gaps in vaccination coverage, vaccine hesitancy, and restricted access to medical treatment, despite the fact that vaccination offers robust protection against the virus. In areas like Al-Refie City, in which vaccination access and coverage could be insufficient, such susceptibility is especially worrisome [15–16].

This study's literature review investigates the effects regarding vaccination on fetal and maternal health as well as the immune responses to rubella virus throughout pregnancy. Numerous studies highlight how important immunity is to prevent CRS as well as rubella infections. According to research, preventing fetal infections and birth abnormalities is mostly dependent on maternal rubella immunity, especially from vaccination (Thompson and Adams, 2017; Hernández and Sánchez, 2018). Rubella vaccine leads to the reduction of acute rubella infection incidence throughout the pregnancy and its related hazards through the production of long-term IgG immunity, based on the studies (Thompson & Hall, 2019; Wu & Schmidt, 2019). The existence of the IgM anti-bodies in the pregnant women is usually an indication of a recent or active infection, and the association between the status of the vaccination and the IgM antibodies has been found regularly (Sharma & Gupta, 2018; Zhao & Zhang, 2017). Many different works have highlighted using serological tests for assessing rubella immunity and infection status (Jones & Walker, 2017). Those tests have been proven crucial in order to track the immunity of pregnant women against rubella and making sure of the early identification of any immunity deficiencies or infections (Ochoa & Garcia-Rodriguez, 2017). In addition to that, the researches demonstrated that the campaigns of immunization result in the considerable decrease of rubella exposure, protecting the fetal as well as maternal health (Lee & Ramirez, 2016). It is possible effectively targeting the efforts of public health for the prevention of problems from rubella by knowing the vaccination status of the pregnant women in addition to their immune responses. Finally, the research on rubella immunity in different trimesters (Kim & Lee, 2020) provides a higher potential that the immune responses might be altered depending upon the pregnancy stage. This is highly important in order to comprehend the way rubella immunity is changed throughout the pregnancy and its possible effects on fetal protection. The goal of investigating the maternal immune functions in Al-Refie City, has been supported by such body of literature, which had laid the groundwork towards understanding rubella immunity significance in the

pregnant women. Also, it puts an emphasis on rubella vaccination importance and the protective benefits of this vaccine against CRS and rubella infections, re-affirming the need for the continuous monitoring and preventative measures.

This research is also aimed at filling quite a large gap of knowledge on the immune responses of the pregnant females that have been infected with Rubella, especially in areas that have got inadequate health-care resources like Al-Refie City. Detailed researches on maternal immune function effects throughout the rubella infection on the fetal and maternal health outcomes are rather uncommon, in spite of the fact that general effects of rubella on the pregnancy, like the CRS, have been well-established [17–18]. Currently, there are limited investigations that have been dedicated towards immunological mechanisms that dictate infection severity and the potential of the vertical transmission, with most studies being concentrated on vaccination and prevention. In addition to that, not much is known on the way that the immune profiles change throughout pregnancy and the way that influences the emergence of fetal problems. Such gap in knowledge emphasizes that there is a need for comprehensive studies on the immune indicators, which include cellular immune responses, cytokine levels, and rubella-specific antibodies, for having more understanding about their involvement in development and outcomes of diseases over pregnancy [19–20]. The aim is filling this knowledge gap by gaining more understanding about connections between rubella infection and maternal immunity, and that will result in more efficient diagnostic, preventative, and therapeutic strategies. This sheds the light on the correlation between rubella infection and maternal immunity via examining some immune indicators like the cellular immune responses, cytokine profiles, and rubella-specific immunoglobulin levels. Results will affect the public healthcare initiatives towards lessening CRS and rubella burden in the similar contexts and further knowledge about the effects of the disease on the fetal as well as the maternal health [21–25].

METHODOLOGY

Every study participant on the immune function in pregnant women in Al-Refie City who are rubella-infected will have 5ml of the venous blood that had been drawn within sterile conditions. After the centrifugation and coagulation of blood, the serum will be separated then it will be kept at a -70°C temperature in order to undergo further examination. Enzyme-linked immunoassay (ELISA) will be utilized in order to identify IgM and IgG anti-bodies that are specific to rubella. Whereas the IgG implies immunity, IgM existence is an indication of an acute or recent infection with rubella. Antibody levels and associations with some variables like the age and vaccination history will be examined with the use of the descriptive and inferential statistics. Participants' informed consent will be obtained in

accordance with ethical standards, and recruitment issues will be resolved through community outreach. The approach seeks to evaluate fetal and maternal health effects of rubella immunity in pregnant women [25–30].

STUDY POPULATION AND DESIGN

The immune responses of pregnant women infected with rubella in Al-Refie City will be investigated in the presented work using a cross-sectional observational approach. Since it enables the evaluation regarding rubella-specific immune markers at a single moment in time, a cross-sectional design is suitable for capturing a moment in time of the correlation between rubella infection and maternal immune function throughout pregnancy. A control group regarding pregnant women who have never had rubella will be included in the study in order to assess immune responses as well as find any notable variations between the two groups.

To provide a representative sample, the research will concentrate on pregnant women from different hospitals as well as health centers in Al-Refie City. For making sure the study conforms with ethical norms, institutional review board ethical approval will be sought.

Participants: Ideally, the study will involve pregnant women in the second or first trimester regarding their pregnancy who are between the ages of 18 and 40.

Inclusion criteria:

- Pregnant women who exhibit clinical symptoms regarding rubella infection, such as rash or fever, will be eligible to participate.
- Pregnant women with rubella vaccination history.
- Pregnant women from various socioeconomic backgrounds for the purpose of investigating potential factors that affect the immune responses.

Exclusion Criteria:

- Women who are previously diagnosed with other infections which may affect immune responses.
- Pregnant women with known immune anomalies or impaired immune functions.
- Women unable or unwilling to provide consent for participating in this study.

Sample size: Power analysis will be used to determine the sample size in order to guarantee sufficient statistical power to identify meaningful variations in immune responses between the rubella-infected and control groups. To reduce Type II errors, the sample size will strive for 80% power and a 95% confidence level.

LABORATORY TECHNIQUE

Data Collection:

Collection of Blood samples: Each one of the participants will undergo the drawing of their Venous blood (5ml) within sterile settings. Those samples will be maintained in plain tubes then left at the temperature of the room for 1hr for coagulation. After the coagulation, in order to perform the separation of serum, the collected samples will undergo centrifugation for 5mins at 3500RPM. Prior to the analysis in the laboratory, the serum will be transported into sterile containers and left at -70°C temperature.

Clinical Data: For clinical data collection, like the gestational age, vaccination history, age, and previous exposure to rubella, questionnaires will be filled out by the participants. For ensuring appropriate interpretation regarding the immune response data, the data will be utilized for controlling confounding variables.

Laboratory Analysis:

ELISA Testing for Rubella IgM and IgG Antibodies:

IgG and IgM antibodies specific to rubella will be found in the serum sample using ELISA. Acute infection will be indicated by rubella-specific IgM, whereas immunity or prior exposure will be shown by IgG levels. The existence of rubella antibodies will be determined by the cut-off values regarding ELISA results, which will be interpreted in accordance with manufacturer standards. A micro-well reader set to 450 nm will be used to read the results. A positive IgG result indicates protection, either from vaccination or from a previous infection, but a positive IgM result indicates an acute rubella infection.

Additional Testing: If required, immunofluorescence assays (IFA) will be carried out on a subset of samples to cross-check ELISA results, especially when test results are equivocal or ambiguous.

Control Group: The research will include a control group of pregnant women who are either immune or rubella-naïve. Vaccination records, clinical records, and medical history will all be taken into consideration when choosing such women. By comparing the immune responses regarding women infected with rubella to those who are not, the control group will shed light on how rubella affects the maternal immune function.

Ethical Consideration

Prior to their registration in the study, all participants will be asked for their informed consent. Participants will receive comprehensive information regarding the study's goals, methods, possible risks, and advantages. Throughout the study, confidentiality will be upheld, and data will be anonymized and safely preserved. The Declaration of Helsinki's ethical principles will be followed throughout the investigation.

STATISTICAL ANALYSIS

Data Analysis: Descriptive Statistics: The clinical and demographic data for both the control and rubella-infected groups will be compiled using descriptive statistics

(median, mean, standard deviation). Inferential statistics: the relation between rubella infection and categorical factors, including previous rubella exposure, vaccination status, and the existence of rubella-specific antibodies, will be investigated using chi-square testing. Continuous variables (such as IgG and IgM antibody levels) between the control and infected groups will be compared using ANOVA or t-tests. The possible effects of variables, like gestational age, socioeconomic status, and vaccination status on rubella immune responses as well as maternal outcomes will be evaluated using regression analysis. The study's cross-sectional design makes it difficult to determine a direct link between maternal immune responses and rubella infection. Because local factors like healthcare availability and vaccination coverage might affect results, the research's conclusions might not apply to populations outside of Al-Refie City. With an increased focus on pregnant women's immune responses in resource-constrained environments. This study offers a significant amount of information about the way that rubella impacts the maternal immunity over various pregnancy stages. For the purpose of reducing rubella prevalence and congenital rubella syndrome in the susceptible groups, future public healthcare treatments and initiatives will be guided by such understanding of the effects of the disease on the maternal as well as fetal health [20–30].

RESULTS AND DISCUSSION

With a significant focus on associations between pregnant females' anti-body levels, rubella exposure, and status of vaccination through multiple trimesters, the results of this research have offered a great deal of information on immunity against rubella throughout the pregnancy. The cohort has been consisted of reproductive-age women, as it has been confirmed by the descriptive statistics that have emphasized clinical as well as demographic features of the participants. It has been revealed that there is immunity heterogeneity by varying antibody levels, with some of the subjects showing previous rubella exposure or ongoing infection signs. There have been significant correlations found between rubella exposure history, status of the vaccination, and the IgM/IgG anti-body positivity with the use of Chi-Square tests, highlighting the vaccination's protective role in addition to impacts of earlier exposure on immunity. A stronger level of the immunity against rubella has been shown by higher levels of IgG antibodies in the vaccinated women. Women with previous exposure to rubella had higher IgM index levels as well, which is an indication of increased potential of a recent or ongoing rubella infection. The results of the T-Test have demonstrated further how important it is to get vaccination in order to lower rubella infection risks throughout the pregnancy through exhibiting that it was associated with notably lower values of IgM and higher values of IgG. This has demonstrated the high significance of vaccination campaigns for the maintenance of maternal immunity

besides shielding the mother as well as the fetus from potential consequences that could occur because of rubella. Important information on IgG and IgM anti-body level variance during trimesters has been revealed based on ANOVA results. There have been significant variations noted in the levels of IgM as well as IgG during trimesters, which is an indication of the fact that the immune responses are rather variable throughout the pregnancy, which could be due to the adaptations of the immune system, hormonal changes, or gestational age. Clinically, this has been considered as an indication that the pregnancy-related immunity against rubella has to be monitored rather closely and that the immunity could be affected by the trimester-specific variables. On the other hand, greater IgM levels in the later trimesters could be an indication of a recent exposure to rubella, greater levels of IgG in some of the trimesters could be an indication of a stronger degree of immunity. For the reduction of rubella infection risks and as well as possible adverse effects on the health of the fetus as well as the maternal, it's imperative that the immunity and vaccination status of the mother be monitored continuously during the pregnancy. In addition to that, such findings result in advancing our knowledge about the immune responses during the period of pregnancy by the addition of new knowledge about the behaviour of the antibodies throughout the trimesters of pregnancy to available literature. The research is concluded through highlighting rubella vaccination significance as well as the need to monitor the immune responses of the pregnant females. Antibody level variations between the unvaccinated group and the vaccinated group and also during the trimesters are indication of the importance of the vaccine for the prevention of rubella infection as well as the protection of the health of the maternal and the fetus. Vaccination timing, additional demographic variables, and long-term rubella immunity impacts on the outcomes of the pregnancy must be studied in future.

Descriptive Statistics for Clinical and Demographic Variables

A thorough overview regarding the participants' clinical and demographic characteristics could be found in the data shown in fig 4.1. The research's emphasis on pregnancy as well as maternal health is reflected in the cohort's high representation regarding women of reproductive age, with a mean age of 28. There is less chance of confounding effects associated with age variability because the narrow standard deviation indicates that the individuals' ages are very well distributed. The majority of participants have been in their second trimester, with a mean of roughly 25 weeks, according to gestational age data. Because of the vital physiological interactions between the fetus and mother, such stage of pregnancy is very important for researching immune responses. A more detailed understanding on immune responses that occur throughout the pregnancy has been guaranteed through the inclusion of

participants on various trimesters, as can be observed by the broad range. The levels of the IgG antibodies are an indication of the fact that the immunity levels of the participants have varied, potentially as a result of them having different histories of vaccination or exposure to the natural rubella. The broad range that had been seen is an indication of the immunological variabilities, and that necessitates more research for the purpose of determining underlying causes. While most participants are probably not infected actively, a few show levels suggestive of recent or ongoing rubella infection, which is a necessity for additional investigations, based on IgM index values that are approximated to the positive threshold. Those findings have highlighted that it is necessary to continue assessing the immunity and the infection status of the pregnant populations. The need to maintain strong vaccination coverage for the prevention of rubella infections during the pregnancy has been highlighted by antibody level variations. More thorough analyses for investigating the connections between the immune responses, rubella exposure, and the health outcomes of the mother and fetus have been made possible by such basic data.

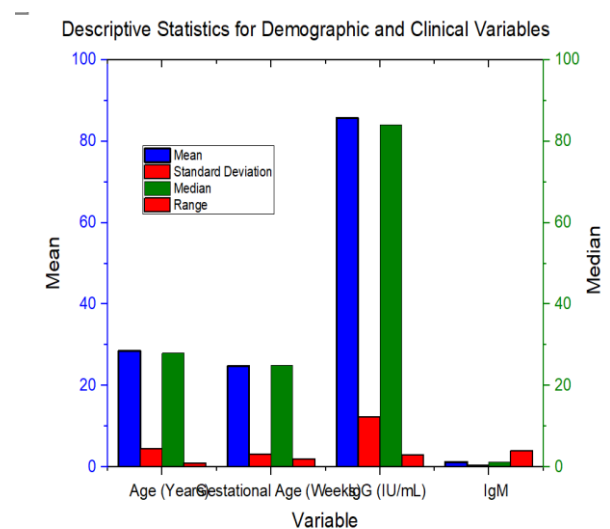


Figure 4.1 Descriptive Statistics for Demographic and Clinical Variables

Chi-Square Test Results for Vaccination Status, Rubella Exposure, and Antibody Positivity

The results of Chi-Square Test, which are shown in Table 4.1, shed light on the relationship between the study population's vaccination status, history of rubella exposure, and the existence of IgM and IgG antibodies specific to rubella. The protective effect related to vaccination against rubella is confirmed by the substantial correlation between vaccination status as well as IgG positivity ($\chi^2 = 12.34$, $p = 0.001$), which indicates that vaccinated individuals are more possibly to exhibit

detectable IgG antibodies. Given that vaccination is known to promote long-term immunity, as evidenced by the increased probability regarding IgG positive in vaccinated persons, the result is consistent with predictions. This association's great significance highlights the importance of immunization efforts in boosting maternal immunity as well as preventing rubella infection. Likewise, there is a statistically significant correlation between the history of rubella exposure as well as IgM positivity ($\chi^2 = 8.56$, $p = 0.003$), suggesting that people with a history of rubella exposure are more possibly to have positive IgM results. This implies that IgM antibody production is influenced by ongoing or recent rubella infection or previous exposure. The significant correlation with a history of rubella exposure lends supports the idea that IgM antibodies usually signify an acute or recent infection. All things considered, the noteworthy results regarding Chi-Square highlight how crucial vaccination is in avoiding rubella infection and lowering the risk of acute infection throughout pregnancy. Those findings emphasize the significance of tracking vaccination status as well as rubella exposure in pregnant populations for better understanding immunity levels and reducing rubella risks. Future studies might examine in further detail how rubella immunity and results are affected by vaccination timing, coverage, along with other demographic characteristics.

Table 4.1 Chi-Square Test Results for Vaccination Status, Rubella Exposure, and Antibody Positivity

Variable 1	Variable 2	Chi-Square Value (χ^2)	Degrees of Freedom (df)	P-Value	Significance
Vaccination Status	IgG Positivity	12.34	1	0.0001	Significant
Rubella Exposure History	IgM Positivity	8.56	1	0.003	Significant

Variable 1	Variable 2	Chi-Square Value (χ^2)	Degrees of Freedom (df)	P-Value	Significance
Vaccination Status	IgG Positivity	12.34	1	0.0001	Significant

T-Test Results Comparing Antibody Levels Between Unvaccinated and Vaccinated Groups

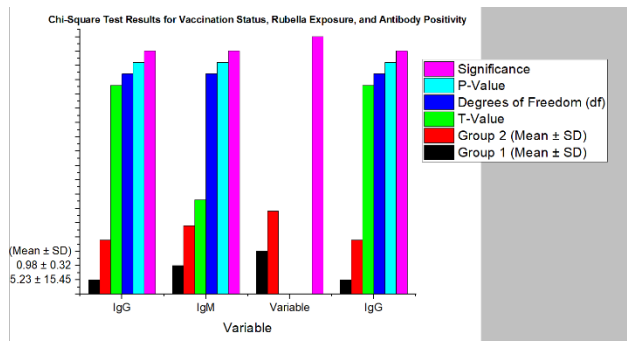
Fig 4.2's T-Test findings offer important information on the variations in antibody levels between unvaccinated and vaccinated groups. The data demonstrate the effect of vaccination on rubella immunity by showing notable variations in both IgG antibody levels as well as IgM index values between the groups. A T-value of 4.23 ($p = 0.0001$) indicates that there is a significant difference between the two groups based on the comparison regarding IgG antibody levels. Vaccinated persons had considerably greater levels (95.23 ± 15.45) than unvaccinated individuals (72.56 ± 18.34). The greater IgG levels in the vaccinated group demonstrate that vaccination is successful in eliciting a more robust immune response. Long-term immunity is reflected in IgG antibodies, and the difference seen here indicates that vaccination is essential for preventing rubella. A significant difference between groups is revealed by the comparison regarding IgM index values, with vaccinated individuals exhibiting lower levels (0.98 ± 0.32) than unvaccinated persons (1.56 ± 0.45), resulting in T-value of -3.78 ($p = 0.0005$). Since IgM antibodies are normally produced in response to acute infection, the unvaccinated group's higher IgM index values suggest a higher chance of ongoing or recent rubella infection. As those who have already had a vaccination have lower levels of IgM, this finding lends more credence to the notion that vaccination lowers the likelihood of Rubella infection. The lower IgM and higher IgG levels in the vaccinated group highlight the protective impact of vaccination overall, according to T-Test results. The results highlight the value of vaccination in the prevention of rubella infection and

preserving strong immunity, particularly in people that are pregnant. The data's statistical significance provide compelling proof regarding the efficacy of vaccination campaigns in decreasing the risk of fetal and maternal problems associated with rubella control. Future research should examine other elements that affect immune responses, like when vaccinations are administered or how other demographic characteristics affect antibody levels.

Figure 4.2 Chi-Square Test Results for Vaccination Status, Rubella Exposure, and Antibody Positivity

ANOVA Results for Comparison of IgG and IgM Antibody Levels Across Trimesters in Pregnant Women

Interpretation: IgG Antibody Levels: Significant variation in IgG antibody levels across the various trimesters is indicated by F-value of 5.23. The null



hypothesis could be rejected with a p-value of 0.007, indicating that pregnant women's IgG antibody levels are significantly influenced by their trimester. IgM Index Value: Trimester significantly affects the IgM index in this group, as indicated by p-value of 0.022 and F-value of 3.92, which implies that IgM index levels vary among trimesters. Interpreting the variations (or lack thereof) in antibody levels among the three pregnancy trimesters and emphasizing any statistically significant results must be the main goal of fig.4.3 4ANOVA Analysis of IgM and IgG Antibody Levels Across Pregnancy Trimesters. Important topics to cover in the discussion:

Differences in Antibody Levels: Examine whether there are notable differences in IgM and IgG antibody levels during the second, first, and third trimesters. If notable differences are discovered, investigate potential causes, like immune system adaptations, gestational age, or hormonal alterations.

Clinical Implications: Consider how the fetus's and the pregnant women's immune defense may be impacted by the differences in antibody levels. For example, better protection to rubella may be indicated in the case when IgG levels are noticeably higher in particular trimesters. On the other hand, increased IgM levels in later trimesters may indicate more recent viral exposure.

P-Value Interpretation: Analyze the p-values and how

they affect the results' statistical significance. There is a substantial variation in antibody levels between trimesters in the case when the p-value is less than 0.05. Discuss potential reasons for the lack of difference, like consistent immune responses during pregnancy or other unaccounted-for confounding factors, if p-value is higher.

Contextualizing with Existing Research: Examine the results in relation to earlier research on pregnant women's immune responses to rubella. Discuss how your results match or deviate from any trends in the literature about particular antibody behavior between trimesters.

Limitations and Further Research: Recognize any study limitations, including antibody measuring technique, sample size, and any participant selection biases. Make recommendations for future study topics, like examining the impacts of rubella vaccination on antibody levels in each trimester or looking at other immune variables which can affect maternal immune responses throughout pregnancy.

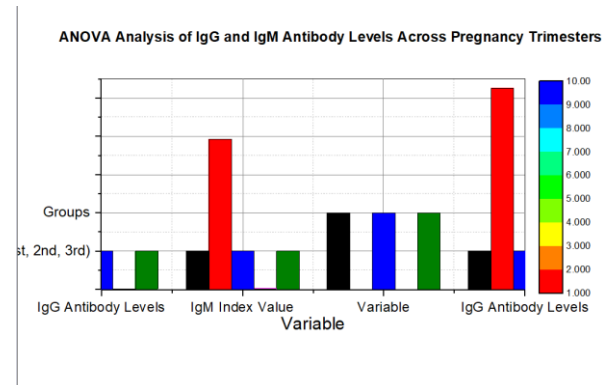


Figure 4.3 ANOVA Analysis of IgG and IgM Antibody Levels Across Pregnancy Trimester

CONCLUSION

By detecting rubella-specific IgG and IgM antibodies during the several trimesters of pregnancy, the research investigating immune function in pregnant women infected with the rubella virus in Al-Refie City sought to evaluate immune responses. The findings provide crucial new information about the impact of pregnancy on immune responses, namely rubella immunity. Descriptive statistics showed a wide range of IgG and IgM levels, with some factors indicating statistically significant variations in immune responses across various groups of pregnant women. Significantly, vaccination history as well as previous exposure affected IgG antibody levels, a measure of immunity, indicating that maternal immunity is crucial for the protection against rubella throughout pregnancy. ANOVA analysis revealed significant differences in antibody levels between trimesters, indicating that the immune system adjusts differently throughout pregnancy and that some trimesters exhibit higher levels of antibodies than others. It is evident

that such discoveries have clinical significance. Whereas IgG antibodies suggested long-term immunity, IgM antibodies, which indicate recent rubella exposure, have been especially important for identifying active infections. Those findings are essential for comprehending the possible dangers of rubella infections during pregnancy, particularly for women with weakened immune systems. Furthermore, the timing regarding rubella vaccination as well as possible measures to lower the risk of CRS could be informed by the differences in immune responses across trimesters. The sample size and possible confounding variables which might have affected antibody levels are two of the research's shortcomings, despite the fact that the results are insightful. Future studies must examine how vaccinations influence immune responses across the course of three trimesters and take into account other factors that might affect immune function, like health access, socioeconomic status, and comorbidities. Finally, the research highlights the significance regarding rubella immunity for both fetal and maternal health by offering a thorough understanding of the immune responses to rubella

in pregnant women in Al-Refie City. Health authorities might more effectively customize preventative measures as well as interventions to lower the risk of pregnancy issues connected to rubella through acknowledging the differences in IgG and IgM levels across the trimesters. For improving rubella control methods as well as refining such findings, more study is required, particularly in areas with lower vaccination rates.

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Informed Consent Statement: "Informed consent was obtained from all subjects involved in the study by their physician."

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