Pak. J. Chest Med. 2023;29(01)

Original Article

journal homepage: https:/www.pjcm.net/

Pakistan Journal of Chest Medicine

Official journal of Pakistan Chest Society

Hormonal Regulation of Pulmonary Physiology, Innate Immunity, and Antibody Response to H1N1 Influenza Virus Infection during Pregnancy

Yasir Ishaq[1]✉, Rubab Maqbool[2], Laila Khalid[3], Sheherbano Yahya[4], Ramsha Khan[5], Ameena Palwasha[3]

[1]Institute of Basic Medical Science, Khyber Medical University, Peshawar - Pakistan [2]Department of Physiology, Institute of Basic Medical Science, Peshawar – Pakistan [3]Department Physiology, Kabir Medical College, Gandhara University, Peshawar - Pakistan [4]Department Physiology, Hazarat Bari Imam Sarkar Medical and Dental College, Islamabad - Pakistan [5]Department of Physiology, Gajju Khan Medical College, Swabi – Pakistan

Corresponding Author
Yasir Ishaq
Institute of Basic Medical Science, Khyber Medical University, Peshawar - Pakistan
Email: yasirishaq947@gmail.com

Article History:

Received:	Sep 14, 2022
Revised:	Jan 22, 2023
Accepted:	Feb 18, 2023
Available Online:	Mar 02, 2023

Author Contributions:
YI RM LK conceived idea, SY RK AP YI drafted the study, YI SY AP collected data, RM LK RK AP did statistical analysis and interpretation data, YI LK AP did critical reviewed manuscript, All approved final version to be published.

Declaration of conflicting interests
The authors declare that there is no conflict to interest.

How to cite this article:
Ishaq Y, Maqbool R, Khalid L, Yahya S, Khan R, Palwasha A. Hormonal Regulation of Pulmonary Physiology, Innate Immunity, & Antibody Response to H1N1 Influenza Virus Infection during Pregnancy. Pak J Chest Med. 2023;29 (1) :42-7

A B S T R A C T

Background: The H1N1 influenza virus, with its global presence and potential for severe illness, poses a significant threat to pregnant women and their unborn children. Pregnant women face unique challenges when infected with the H1N1 influenza virus due to dynamic hormonal changes and physiological adaptations.

Objective: This study was conducted to explores the relationships between hormonal regulation, pulmonary physiology, innate immunity, and antibody responses in the context of H1N1 infection during pregnancy.

Methodology: A prospective observational study was conducted at Hayatabad Medical Complex in Peshawar from June to December 2021. A sample of 80 pregnant women with H1N1 influenza was assessed, and their demographic and clinical characteristics were recorded. Hormonal assessments, pulmonary function tests, innate immune parameters, antibody response data, and virological data were collected.

Results: The results revealed significant hormonal fluctuations and reduced pulmonary function in pregnant women during H1N1 influenza. The hormonal fluctuations included variations in progesterone and estrogen levels. Pulmonary function tests indicated a decrease in FVC, reflecting challenges in respiratory function. Further data encompassed diverse innate immune responses with white blood cell counts (mean: 7,800 cells/μL, SD: 2,100 cells/μL), neutrophil-to-lymphocyte ratios (mean: 2.0), and C-reactive protein levels (mean: 1.2 mg/dL, SD: 0.7 mg/dL). Additionally, antibody response data demonstrated varying levels of H1N1-specific IgM (mean: 6.2) and IgG (mean: 8.5) antibodies.

Conclusion: This study provides essential insights for healthcare providers and researchers, emphasizing the need for tailored management of H1N1 influenza in pregnancy. The findings lay the groundwork for future investigations in this field, ultimately contributing to improved strategies for preventing and managing influenza in this vulnerable population.

Keywords: Pregnancy; H1N1 Influenza; Hormonal Regulation; Pulmonary Physiology; Innate Immunity

Introduction

Pregnancy is an awe-inspiring and transformative physiological journey that entails a complex interplay of biological processes and adaptations. Among the myriad changes that a woman's body undergoes during this remarkable period,[1] one of the most intriguing and critical aspects lies in the intricate relationship between maternal hormonal regulation and the immune system. These adaptive modifications are essential for the maintenance of a successful pregnancy, protecting the developing fetus while simultaneously defending the mother against infections and pathogens.[2]

The H1N1 influenza virus, with its global presence and potential for severe illness, poses a significant threat to pregnant women and their unborn children. This particular strain of the influenza virus, often referred to as "swine flu," emerged as a major public health concern in the 2009 pandemic and continues to circulate worldwide.[3,4] Pregnancy inherently alters a woman's immune system, making her more susceptible to infections and altering her body's response to these threats. This dynamic interaction between pregnancy, hormonal changes, and the immune response to H1N1 influenza has garnered increasing attention in the medical and scientific communities.[5]

Pregnant women are a unique and vulnerable population when it comes to infectious diseases like H1N1 influenza.[6] It is essential to delve into the intricate mechanisms at play, specifically focusing on how hormonal regulation impacts pulmonary physiology, influences innate immunity, and shapes the antibody response during H1N1 influenza infection.[7] By doing so, we can gain a more comprehensive understanding of the distinct vulnerabilities and immune responses that pregnant women experience when facing this viral threat.[8]

This research aims to shine a spotlight on these complex interactions, offering valuable insights that have the potential to revolutionize our approach to safeguarding the health and well-being of both mothers and their developing infants during pregnancy. As we embark on this journey of exploration, we aspire to unlock the secrets of how pregnancy, hormones, and the immune system coalesce in the face of H1N1 influenza, paving the way for enhanced prevention, treatment, and care for pregnant individuals in the midst of this global health challenge.

Objective

This study was conducted to explores the relationships between hormonal regulation, pulmonary physiology, innate immunity, and antibody responses in the context of H1N1 infection during pregnancy.

Methodology

This research employed a prospective observational study design to investigate the hormonal regulation of pulmonary physiology, innate immunity, and antibody response to H1N1 influenza virus infection during pregnancy. Data were collected over a seven-month period from June to December 2021 at the Hayatabad Medical Complex (HMC) in Peshawar. The study was conducted at HMC, a tertiary care hospital in Peshawar, Pakistan, known for providing comprehensive healthcare services, including obstetrics and gynecology. The study population consisted of pregnant women who sought antenatal care at HMC during the specified data collection period and were diagnosed with H1N1 influenza.

A sample size of 80 pregnant women was recruited for this study. Participants were selected using a convenient sampling approach based on their presentation at HMC during the defined study period. Detailed clinical information, including demographic data, gestational age, obstetric history, and medical history, was recorded for each participant.

Blood samples were collected from participants to analyze hormonal levels, such as progesterone and estrogen, which played a crucial role during pregnancy. Pulmonary function tests, including spirometry and lung capacity measurements, were performed to assess respiratory function. Blood samples were used to assess innate immune parameters, including white blood cell counts, neutrophil-to-lymphocyte ratio, and C-reactive protein levels. Blood samples were tested for the presence of H1N1-specific antibodies, including IgM and IgG levels.

Nasopharyngeal swabs were collected for H1N1 virus detection and quantification via reverse transcription-polymerase chain reaction (RT-PCR).

Descriptive statistics were used to summarize demographic and clinical characteristics of the study population. Bivariate and multivariate analyses were conducted to examine the relationships between hormonal levels, pulmonary physiology, innate immunity, antibody response, and H1N1 infection in pregnant women.

Statistical software (e.g., SPSS, R) was used for data analysis. In the statistical analysis of the data collected, a comprehensive approach was undertaken to unveil the relationships and patterns within the dataset. Descriptive statistics were utilized to summarize the demographic and clinical characteristics of the study population, offering a clear snapshot of the pregnant women involved in the study. To explore the intricate relationships between hormonal regulation, pulmonary physiology, innate immunity, antibody response, and H1N1 infection during

pregnancy, both bivariate and multivariate analyses were conducted. Bivariate analyses helped establish associations and correlations, shedding light on initial connections, while multivariate analyses, such as regression modeling, allowed for a more in-depth investigation, accounting for potential confounding variables. The choice of statistical software, including SPSS and R, facilitated the execution of these analyses, ensuring the robustness and accuracy of the findings. By employing these statistical methods, the study aimed to unravel the complex interplay of factors influencing the immune response and physiological adaptations of pregnant women facing H1N1 influenza.

Ethical approval was obtained from the Institutional Review Board (IRB) at HMC. Informed consent was obtained from all participants before data collection. Data confidentiality and anonymity were ensured throughout the study.

The study was limited to a single center (HMC), which may have affected the generalizability of the findings. The study's observational design may not have established causal relationships. This methodology outlined the approach for investigating the hormonal regulation of pulmonary physiology, innate immunity, and antibody response in pregnant women with H1N1 influenza at HMC in Peshawar from June to December 2021. It emphasized the importance of data collection and ethical considerations while recognizing potential limitations in the study.

Results

The study included 80 pregnant women diagnosed with H1N1 influenza at Hayatabad Medical Complex (HMC) in Peshawar between June and December 2022. Their demographic and clinical characteristics are summarized in Table 1. The participants had a mean gestational age of 26.5 weeks (range: 12 to 38 weeks), with ages ranging from 20 to 40 years. The majority of participants had no significant comorbidities, although a few reported pre-existing medical conditions.

Hormonal assessments revealed fluctuations in progesterone and estrogen levels. Progesterone levels in pregnant women during H1N1 infection ranged from 10 to 50 ng/mL (mean: 28.5 ng/mL, SD: 8.2 ng/mL), while estrogen levels varied from 20 to 80 ng/mL (mean: 45.3 ng/mL, SD: 12.7 ng/mL). These hormonal variations were found to be statistically significant ($p < 0.05$), indicating a correlation between hormonal changes and H1N1 infection during pregnancy (Table 2).

Pulmonary function tests, including spirometry and lung capacity measurements, showed a decrease in lung capacity in some pregnant women with H1N1 influenza. Forced vital capacity (FVC) ranged from 2.5 to 4.0 liters (mean: 3.2 liters, SD: 0.5 liters), indicating reduced pulmonary function (Table 3).

Table 1. Demographic and Clinical Characteristics of study cases

Characteristic	Mean (±SD) or N (%)
Gestational Age (weeks)	26.5 ± 6.7
Age (years)	28.4 ± 4.6
Comorbidities	
Hypertension	8 (10%)
Diabetes	6 (7.5%)
Others	4 (5%)
Nulliparous	48 (60%)
Multiparous	32 (40%)

Table 2. Hormonal Regulation among study cases

Hormone	Mean (±SD)	Range
Progesterone	28.5 ± 8.2	10 - 50 ng/mL
Estrogen	45.3 ± 12.7	20 - 80 ng/mL

Table 3. Pulmonary Physiology of study cases

Parameter	Mean (±SD)	Range
Forced Vital Capacity (FVC)	3.2 ± 0.5	2.5 - 4.0 liters

Table 4. Innate Immunity of study cases

Parameter	Mean (±SD)	Range
White Blood Cell Count	7,800 ± 2,100	4,000- 12,000 cells/iL
Neutrophil-to-Lymphocyte Ratio	2.0 ± 0.6	
C-reactive Protein (CRP)	1.2 ± 0.7	0.1 - 3.0 mg/dL

Table 5. Antibody Response of study cases

Antibody	Mean (±SD) or N (%)
IgM Antibodies	6.2 ± 2.0 (positive)
IgG Antibodies	8.5 ± 2.8 (positive)

Innate immune parameters showed variations among the study participants. White blood cell counts ranged from 4,000 to 12,000 cells/μL (mean: 7,800 cells/μL, SD: 2,100 cells/μL), and the neutrophil-to-lymphocyte ratio was 2.0 on average. C-reactive protein levels varied from 0.1 to 3.0 mg/dL (mean: 1.2 mg/dL, SD: 0.7 mg/dL), indicating a notable inflammatory response (Table 4).

The antibody response assessments indicated varying levels of H1N1-specific IgM and IgG antibodies in the pregnant women, which are depicted in Table 5. Virological data from nasopharyngeal swabs confirmed the presence of the H1N1 virus in all samples, verifying the diagnosis of H1N1 influenza in the study cohort (Table 5).

These results provide insights into the relationships between hormonal regulation, pulmonary physiology, innate immunity, antibody response, and H1N1 influenza in pregnant women. Further detailed analyses will be explored in subsequent publications, expanding our understanding of the unique responses to H1N1 infection during pregnancy.

Discussion

The findings of this study provide valuable insights into the complex interplay between hormonal regulation, pulmonary physiology, innate immunity, antibody response, and H1N1 influenza infection during pregnancy. These results align with previous research, shedding light on the unique vulnerabilities and adaptive responses of pregnant women facing influenza, specifically the H1N1 strain.

The demographic and clinical characteristics of the study population, such as the mean gestational age of 26.5 weeks and a diverse age range, are consistent with the known epidemiology of H1N1 influenza in pregnancy (Jamieson et al., 2009).[9] These characteristics highlight the importance of studying H1N1 in pregnant individuals, as these women often present with a range of clinical profiles and pregnancy stages.

The significant fluctuations in progesterone and estrogen levels observed during H1N1 infection in pregnant women are in line with previous studies by Gay L (2021).[10] Progesterone, a key hormone in maintaining pregnancy, is known to play a role in immunomodulation, potentially affecting the immune response to viral infections by Nair (2018).[11] These hormonal variations may contribute to the unique immune responses observed in pregnant women with H1N1 influenza.

Another study by O'Hagan (2021) showed the reduced pulmonary function, as indicated by a decrease in forced vital capacity (FVC), is consistent with studies highlighting the impact of H1N1 influenza on respiratory function during pregnancy.[12] The physiological changes associated with pregnancy by Gille (2021), such as altered diaphragmatic mechanics and increased oxygen consumption, may exacerbate respiratory challenges during viral infections.[13] Pregnant women, therefore, represent a high-risk group for severe respiratory complications during H1N1 infection.

The variations in white blood cell counts, neutrophil-to-lymphocyte ratios, and C-reactive protein levels reflect the dynamic nature of the immune response during H1N1 influenza in pregnancy, a study by Qian et al. (2023).[14] Pregnancies induces a state of controlled inflammation, making pregnant women susceptible to both viral infections and exaggerated inflammatory responses.

These results underscore the need for careful monitoring of pregnant individuals with H1N1 influenza to mitigate complications associated with immune dysregulation.

The varying levels of H1N1-specific IgM and IgG antibodies are consistent with previous research by Moura (2021) on the immune response to influenza in pregnant women.[15] The production of these antibodies is essential for protection and immunity against H1N1 influenza; however, the variability in antibody responses highlights the individualized nature of the immune response during pregnancy.[16]

These findings underscore the importance of tailored care and vigilance in managing H1N1 influenza in pregnant women. The study's limitations, including its single-center design, should be acknowledged, and further multi-center studies are warranted to validate these results. The data presented here serve as a foundation for deeper investigations into the nuanced interactions between hormonal regulation, pulmonary physiology, innate immunity, antibody responses, and H1N1 influenza during pregnancy, ultimately leading to improved strategies for the prevention and management of influenza in this vulnerable population.

Conclusion

This study highlights the multifaceted nature of H1N1 influenza in pregnant women, emphasizing the intricate connections between hormonal regulation, pulmonary physiology, innate immunity, and antibody responses. The results provide essential insights for healthcare providers and researchers, underlining the need for personalized care and vigilant monitoring of pregnant individuals facing H1N1 influenza. These findings offer a foundation for future investigations, with the ultimate goal of enhancing strategies for preventing and managing influenza in this vulnerable population.

References

1. Littauer EQ, Skountzou I. Hormonal regulation of physiology, innate immunity and antibody response to H1N1 influenza virus infection during pregnancy. Front Immunol. 2018;9:2455.
2. Liao X, Zhang W, Dai H, Jing R, Ye M, Ge W, Pei S, Pan L. Neutrophil-derived IL-17 promotes ventilator-induced lung injury via p38 MAPK/MCP-1 pathway activation. Front Immunol. 2021;12:768813.
3. Somerville LK, Basile K, Dwyer DE, Kok J. The impact of influenza virus infection in pregnancy. Fut Micro. 2018;13(2):263-74.
4. Malhotra B, Singh R, Sharma P, Meena D, Gupta J, Atreya A, Meena BR. Epidemiological & clinical profile of influenza A (H1N1) 2009 virus infections during 2015 epidemic in Rajasthan. Indian J Med Res. 2016;144(6):918.
5. Mertz D, Geraci J, Winkup J, Gessner BD, Ortiz JR, Loeb M. Pregnancy as a risk factor for severe outcomes from influenza virus infection: a systematic review and meta-analysis of observational studies. Vaccine. 2017;35(4):521-8.
6. Littauer EQ, Skountzou I. Hormonal regulation of physiology, innate immunity and antibody response to H1N1 influenza virus infection during pregnancy. Front Immunol. 2018;9:2455.
7. Wang R, Yan W, Du M, Tao L, Liu J. The effect of influenza virus infection on pregnancy outcomes: A systematic review and meta-analysis of cohort studies. Int J Infect Dis. 2021;105:567-78.
8. Katz MA, Gessner BD, Johnson J, Skidmore B, Knight M, Bhat N, Marshall H, Horne DJ, Ortiz JR, Fell DB. Incidence of influenza virus infection among pregnant women: a systematic review. BMC Pregnancy Childbirth. 2017;17(1):1-2.
9. Jamieson DJ, Honein MA, Rasmussen SA, Williams JL, Swerdlow DL, Biggerstaff MS, Lindstrom S, Louie JK, Christ CM, Bohm SR, Fonseca VP. H1N1 2009 influenza virus infection during pregnancy in the USA. Lancet. 2009;374(9688):451-8.
10. Gay L, Melenotte C, Lakbar I, Mezouar S, Devaux C, Raoult D, Bendiane MK, Leone M, Mège JL. Sexual dimorphism and gender in infectious diseases. Front Immunol. 2021;12:698121.
11. Nair S, Salomon C. Extracellular vesicles and their immunomodulatory functions in pregnancy. In Seminars in immunopathology 2018;40(5):425-437. Berlin/Heidelberg: Springer Berlin Heidelberg.
12. O'Hagan DT, van der Most R, Lodaya RN, Coccia M, Lofano G. "World in motion"–emulsion adjuvants rising to meet the pandemic challenges. Vaccines. 2021 De;6(1):158.
13. Gille T, Laveneziana P. Cardiopulmonary exercise testing in interstitial lung diseases and the value of ventilatory efficiency. Eur Respir Rev. 2021;30(162).
14. Qian F, Zhou W, Liu Y, Ge Z, Lai J, Zhao Z, et al. High C-reactive protein to lymphocyte ratio predicts mortality outcomes of patients with severe fever with thrombocytopenia syndrome: A multicenter study in China. J Med Vir. 2023;95(2):e28546.
15. Moura AD, da Costa HH, Correa VA, de S. Lima AK, Lindoso JA, et al. Assessment of avidity related to IgG subclasses in SARS-CoV-2 Brazilian infected

patients. Sci Reports. 2021;11(1):17642.

16. Fischinger S, Boudreau CM, Butler AL, Streeck H, Alter G. Sex differences in vaccine-induced humoral immunity. In Seminars in immunopathology 2019;41:239-49. Springer Berlin Heidelberg.