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Original Research

Pregnancy-Induced Hypertension and Association With Future Autoimmune Diseases

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OBJECTIVE: To explore the associations between hypertensive disorders of pregnancy and the subsequent development of autoimmune diseases.

METHODS: This retrospective cohort study used TriNetX, a federated network of real-world data. Using the Global Collaborative Network data, we collected electronic medical records from 102 health care organizations with 131 million patient records from 2006 to 2020. The study assessed the risk of autoimmune diseases in women aged 16–45 years. Two cohorts were compared: the pregnancy-induced hypertension cohort, which included women with gestational hypertension, preeclampsia, or eclampsia, and the normotensive pregnancy cohort. Women with preexisting autoimmune diseases or hypertension and those with complications occurring before 20 weeks of gestation were excluded. Propensity score matching was used to ensure balanced cohorts. The primary outcome was the long-term risk of autoimmune diseases during a follow-up period of up to 18 years. The secondary outcome evaluated the association between the risk of autoimmune diseases and both the patient's age and the severity of pregnancy-induced hypertension.

RESULTS: The prevalence of pregnancy-induced hypertension was found to be 13.4%. After propensity score matching, among 289,564 women, those with pregnancy-induced hypertension demonstrated a significantly higher risk of developing autoimmune diseases during long-term follow-up. The risk of systemic lupus erythematosus was notably higher (hazard ratio 1.87, 95% CI, 1.60–2.18), along with elevated risks of multiple sclerosis, Addison disease, antiphospholipid syndrome, inflammatory bowel disease, mixed connective tissue disease, and rheumatoid arthritis. Subgroup analysis revealed that women of advanced maternal age with pregnancy-induced hypertension had a similar risk of developing autoimmune diseases compared with younger women. In addition, the risk of these autoimmune diseases increased with the severity of pregnancy-induced hypertension.

CONCLUSION: Women with a history of pregnancy-induced hypertension face a higher long-term risk of autoimmune diseases, emphasizing the need for ongoing monitoring and preventive care.

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The pathogenesis of hypertension may be related to immune cells. Numerous studies have implicated T lymphocytes and other hematopoietic cells in the pathogenesis of essential hypertension in humans and in experimental models of chronic hypertension.[1] It is now clear that various immune mediators such as complement proteins, cytokines, and both innate and adaptive immune cells play a role in the regulation and elevation of blood pressure.[2] However, because of the interrelated nature of oxidative stress and inflammation, which can trigger and amplify each other, it is difficult to determine which comes first. Therefore, there may

be a bidirectional relationship between hypertension and immune dysfunction.[3]

It is well known that women with pregnancy-induced hypertension are 11 times more likely to develop chronic hypertension later compared with those without pregnancy-induced hypertension.[4] Thus, it is possible that pregnancy-induced hypertension could lead to chronic hypertension, further increasing the risk of autoimmune diseases. Another possibility is that pregnancy is a period of profound immune adaptation, during which the maternal immune system undergoes significant changes to support and protect the developing fetus.[5] However, hypertensive disorders during pregnancy may disrupt this immune balance, potentially leading to immune dysregulation.[6] This dysregulation could predispose women to the development of autoimmune diseases later in life. Furthermore, endothelial dysfunction and inflammation associated with pregnancy-induced hypertension may have long-lasting effects on the immune system, further increasing the risk of autoimmune diseases.[6]

Previous studies have established an association between autoimmune diseases and hypertension. For instance, a large population-based study revealed that patients with rheumatoid arthritis (RA) had a 31% prevalence of hypertension compared with 23% in the general population.[7] Similarly, studies have shown that up to 40% of patients with systemic lupus erythematosus (SLE) younger than age 40 years are affected by hypertension.[8] These findings underscore the intricate relationship between autoimmune and cardiovascular diseases.

Despite these associations, the specific association of hypertensive disorders during pregnancy and the future risk of developing autoimmune diseases remains unclear. The long-term implications of pregnancy-induced hypertension on autoimmune disease risk have not been comprehensively studied, particularly in large, diverse populations. This study aims to fill this knowledge gap by using the extensive TriNetX database. Through a robust retrospective analysis, we seek to explore the associations between various hypertensive disorders of pregnancy and the subsequent development of autoimmune diseases. Our study focuses on a range of autoimmune conditions, including SLE, RA, multiple sclerosis, and others, and aims to identify specific risk factors that may contribute to the onset of these diseases in women with a history of pregnancy hypertension.

METHODS

This study is a retrospective analysis using data from the U.S. Collaborative Network, which includes information from 102 health care organizations within the TriNetX Research Network. TriNetX gathers data primarily from structured electronic health record systems, including demographics, diagnoses, procedures, and medications, and uses natural language processing to extract information from clinical documents. The TriNetX database consists of deidentified electronic health records. The platform performs extensive data preprocessing to handle missing values and standardizes the data to a consistent clinical model, ensuring uniform querying across various data sources.[9] Our study used the TriNetX database, covering the period from January 1, 2006, to December 31, 2020.

The study complied with regulatory guidelines such as the Health Insurance Portability and Accountability Act and the General Data Protection Regulation. Approval was granted by the IRB of Taichung Veterans General Hospital (CE24489A).

Two cohorts were established for this study. The pregnancy-induced hypertension cohort included women aged 16–45 who experienced pregnancy-induced hypertension, encompassing gestational hypertension, preeclampsia (with or without severe features), and eclampsia. Women in this cohort had no history of SLE, Sjogren syndrome, multiple sclerosis, Addison disease, polymyositis, dermatomyositis, antiphospholipid syndrome, Behçet disease, inflammatory bowel disease, polyarteritis nodosa, mixed connective tissue disease, or RA. Women with preexisting hypertension, those who developed hypertension before 20 weeks of gestation, and those with complications occurring before 20 weeks, including ectopic pregnancy, abortion, cervical insufficiency, preterm premature rupture of the membranes, and intrauterine infection, were excluded. The normotensive pregnancy cohort consisted of women aged 16–45 who delivered without complications and had no history of hypertension or the aforementioned autoimmune diseases before pregnancy.

To ensure a balanced comparison between the two cohorts, propensity score matching was used. Covariates included in the matching process were age at index (age at which a woman experiences pregnancy), race, overweight and obesity, gestational diabetes mellitus, and type 1 and 2 diabetes.

Race was included in the propensity score matching because it is a relevant factor for both pregnancy-induced hypertension and autoimmune disease.[10,11] Propensity scores were calculated from a logistic regression model, and patients from the pregnancy-induced hypertension cohort were matched 1:1 with those from the normotensive cohort on the basis of their propensity scores.

Patients were followed up for up to 18 years after pregnancy to assess the long-term risk of developing

autoimmune diseases. The primary outcome of interest was the long-term risk of developing autoimmune diseases after pregnancy, assessed over a follow-up period of up to 18 years. These diseases included SLE, multiple sclerosis, Addison disease, antiphospholipid syndrome, inflammatory bowel disease, mixed connective tissue disease, RA, Sjögren syndrome, polymyositis, dermatomyositis, Behçet disease, and polyarteritis nodosa. The secondary outcome evaluated the association between the risk of autoimmune diseases and both the patient's age and the severity of pregnancy-induced hypertension. Figure 1 illustrates the study flowchart. Appendix 1, available online at http://links.lww.com/AOG/E25, lists the diseases discussed in this article, along with their corresponding codes.

Descriptive statistics were used to summarize baseline characteristics of the study population. The primary analysis involved the calculation of hazard ratios (HRs) and 95% CIs for the development of autoimmune diseases in the pregnancy-induced hypertension cohort compared with the normotensive pregnancy cohort. Cox proportional hazards models were used to estimate HRs, with adjustment for potential confounders. Subgroup analyses were conducted to assess the association of age at the time of pregnancy and the severity of the hypertensive disorder on autoimmune disease risk. $P<.05$ was considered statistically significant. All analyses were performed with R 4.0.2.

RESULTS

A total of 630,013 patients met the inclusion criteria for the study, with 145,523 patients in the pregnancy-induced hypertension cohort and 484,490 patients in

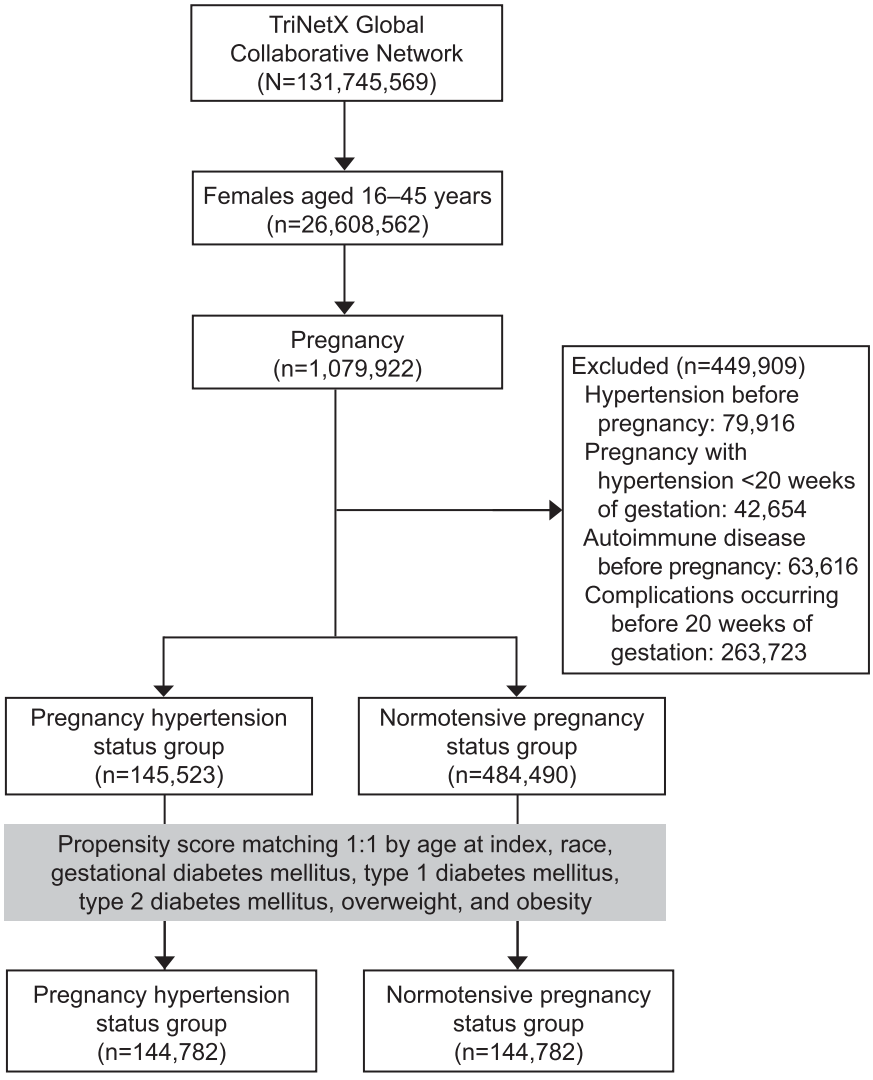

Fig. 1. Study flowchart.
Shih. Autoimmune Disease Risk After Pregnancy Hypertension. Obstet Gynecol 2025.

Table 1. Baseline Characteristics of the Study Population

Characteristic	Before PSM			After PSM		
	Pregnancy-Induced Hypertension (n=145,523)	Normotensive Pregnancy (n=484,490)	SMD	Pregnancy-Induced Hypertension (n=144,782)	Normotensive Pregnancy (n=144,782)	SMD
Age at index (y)	27.7±5.5	26.9±5.6	0.146	27.7±5.5	27.7±5.5	0.002
Race						
Asian	4,153 (2.9)	22,019 (4.5)	0.09	4,148 (2.9)	4,172 (2.9)	0.001
Black or African American	27,663 (19.0)	72,889 (15.0)	0.106	27,449 (19.0)	27,738 (19.2)	0.005
White	84,520 (58.1)	249,666 (51.5)	0.132	84,055 (58.1)	83,833 (57.9)	0.003
Comorbidities						
Overweight and obesity	33,506 (23.0)	56,329 (11.6)	0.305	32,973 (23.8)	33,354 (23.0)	0.006
Gestational diabetes	16,935 (11.6)	30,097 (6.2)	0.191	16,531 (11.4)	17,204 (11.9)	0.014
Type 1diabetes	1,987 (1.4)	1,207 (0.2)	0.125	1,596 (1.1)	1,183 (0.8)	0.029
Type 2 diabetes	5,843 (4.0)	5,495 (1.1)	0.183	5,158 (3.6)	4,905 (3.4)	0.01

PSM, propensity score matching; SMD, standardized mean difference (age at index, age at which a woman experiences pregnancy). Data are mean±SD or n (%) unless otherwise specified.

the normotensive pregnancy cohort. The prevalence of pregnancy-induced hypertension was found to be 13.4%. After propensity score matching was applied, 144,782 patients were included in each cohort, resulting in a well-balanced study population for comparison. The average age at the index was 27.5 years, with a diverse representation of ethnicity: 58.1% White, 19.0% Black or African American, and 2.9% Asian (Table 1). The remaining 20.0% in TriNetX are listed as unknown race and other race. To avoid potential interference with statistical analysis because of the inclusion of small racial groups, this study did not include individuals categorized as unknown race and other race.

The longest follow-up period for cases in this study was 18 years, during which a significant increase in the incidence of autoimmune diseases was observed in the pregnancy-induced hypertension cohort compared with the normotensive pregnancy cohort. The risk of developing SLE was notably higher in the pregnancy-induced hypertension cohort, with an HR of 1.87 (95% CI, 1.60–2.18). Similar trends were observed for multiple sclerosis (HR 1.66, 95% CI, 1.08–2.57), Addison disease (HR 1.45, 95% CI, 1.10–1.92), antiphospholipid syndrome (HR 1.97, 95% CI, 1.64–2.37), inflammatory bowel disease (HR 1.21, 95% CI, 1.16–1.26), mixed connective tissue disease (HR 1.35, 95% CI, 1.120–1.52), and RA (HR 1.37, 95% CI, 1.23–1.52). However, the risks of other autoimmune diseases such as Sjogren syndrome, polymyositis, dermatomyositis, Behçet disease, and polyarteritis nodosa were not significantly elevated (Table 2).

Subgroup analysis revealed that among women who became pregnant between the ages of 16 and 34, there was a significant increase in the risk of several autoimmune diseases, including SLE (HR 1.82, 95% CI, 1.44–2.32), Addison disease (HR 1.96, 95% CI, 1.22–3.13), antiphospholipid syndrome (HR 1.48, 95% CI, 1.08–2.02), inflammatory bowel disease (HR 1.26, 95% CI, 1.19–1.33), and mixed connective tissue disease (HR 1.79, 95% CI, 1.43–2.25). However, no significant differences were found for other autoimmune diseases in this age group.

In the 35–45 age group (advanced maternal age), pregnancy-induced hypertension was significantly associated with an increased incidence of SLE, antiphospholipid syndrome, inflammatory bowel disease, and mixed connective tissue disease compared with the normotensive pregnancy group. In addition, RA demonstrated a statistically significant increase in women with pregnancy-induced hypertension within this age range (Table 3).

Further subgroup analyses were conducted on the basis of the severity of the hypertensive disorder. Women with gestational hypertension were found to have an elevated risk of SLE, multiple sclerosis,

Table 2. Risk of Autoimmune Disease According to Pregnancy-Induced Hypertension Status (n=144,782)

Autoimmune Disease	Patients With Outcome (n)		HR (95% CI)
	Pregnancy-Induced Hypertension	Normotensive Pregnancy	
Systemic lupus erythematosus	477	243	1.87 (1.60–2.18)
Sjogren syndrome	159	130	1.15 (0.92–1.46)
Multiple sclerosis	56	32	1.66 (1.08–2.57)
Addison disease	125	82	1.45 (1.10–1.92)
Polymyositis	10	10	0.19 (0.02–1.60)
Dermatomyositis	25	26	0.91 (0.53–1.58)
Antiphospholipid syndrome	344	166	1.97 (1.64–2.37)
Behçet disease	10	11	0.69 (0.28–1.73)
Inflammatory bowel disease	6,041	4,782	1.21 (1.16–1.26)
Polyarteritis nodosa	19	10	1.80 (0.84–3.88)
Mixed connective tissue disease	661	463	1.35 (1.20–1.52)
Rheumatoid arthritis	796	555	1.37 (1.23–1.52)

HR, hazard ratio.

Addison disease, antiphospholipid syndrome, inflammatory bowel disease, mixed connective tissue disease, and RA. When women with preeclampsia, with or without severe features, were analyzed, the risk of these autoimmune diseases increased further, except for multiple sclerosis, which did not reach statistical significance. Among women who experienced eclampsia, the risk was even higher, with SLE and antiphospholipid syndrome showing an up to fourfold increased risk (Table 4).

DISCUSSION

This study, which included 289,564 patients after propensity score matching and followed them up for up to 18 years, found that women with pregnancy-induced hypertension had a significantly higher risk of developing autoimmune diseases compared with women with normotensive pregnancies. The risk was notably elevated for conditions such as SLE and antiphospholipid syndrome. Subgroup analysis showed that women of advanced maternal age with

Table 3. Risk of Autoimmune Disease According to Pregnancy-Induced Hypertension Status by Age

Autoimmune Disease	Patients With Outcome at Pregnancy Age 16–34 y (n=54,750) (n)			Patients With Outcome at Pregnancy Age 35–45 y (n=90,300) (n)		
	Pregnancy-Induced Hypertension	Normotensive Pregnancy	HR (95% CI)	Pregnancy-Induced Hypertension	Normotensive Pregnancy	HR (95% CI)
Systemic lupus erythematosus	166	120	1.82 (1.44–2.32)	353	174	1.60 (1.33–1.92)
Sjogren syndrome	34	31	1.56 (0.95–2.58)	143	97	1.08 (0.83–1.40)
Multiple sclerosis	19	17	1.54 (0.78–3.03)	40	19	1.66 (0.96, 2.88)
Addison disease	45	31	1.96 (1.22–3.13)	93	58	1.26 (0.91–1.75)
Polymyositis	10	10	1.20 (0.08–19.42)	10	10	1.64 (0.11–12.90)
Dermatomyositis	10	10	2.48 (0.62–9.96)	22	11	1.54 (0.74–3.18)
Antiphospholipid syndrome	91	73	1.48 (1.08–2.02)	287	111	2.19 (1.76–2.73)
Behçet disease	10	10	0.57 (0.11–3.02)	10	10	0.88 (0.31–2.50)
Inflammatory bowel disease	2,426	2,282	1.26 (1.19–1.33)	4,032	2,738	1.23 (1.17–1.29)
Polyarteritis nodosa	10	10	3.91 (0.81–18.86)	12	10	1.99 (0.70–5.66)
Mixed connective tissue disease	183	136	1.79 (1.43–2.25)	526	318	1.26 (1.10–1.45)
Rheumatoid arthritis	171	184	1.18 (0.95–1.46)	663	441	1.32 (1.33–1.75)

HR, hazard ratio.

Table 4. Risk of Autoimmune Disease According to Pregnancy-Induced Hypertension Status by Severity

Autoimmune Disease	Patients With Outcome (n=130,966) (n)			Patients With Outcome (n=26,542) (n)	
	Gestational Hypertension	Normotensive Pregnancy	HR (95% CI)	Preeclampsia	Normotensive Pregnancy
Systemic lupus erythematosus	381	245	1.48 (1.26–1.74)	143	52
Sjogren syndrome	134	118	1.07 (0.84–1.37)	41	29
Multiple sclerosis	53	27	1.86 (1.17–2.96)	14	10
Addison disease	97	68	1.36 (1.00–1.86)	37	16
Polymyositis	10	10	0.31 (0.03–2.93)	0	0
Dermatomyositis	24	18	1.25 (0.68–2.31)	10	10
Antiphospholipid syndrome	272	161	1.61 (1.32–1.95)	126	41
Behçet disease	10	10	1.95 (0.59–6.49)	0	0
Inflammatory bowel disease	5,426	4,250	1.22 (1.18–1.27)	1,396	931
Polyarteritis nodosa	16	10	2.17 (0.89–5.28)	10	10
Mixed connective tissue disease	593	415	1.35 (1.19–1.53)	146	95
Rheumatoid arthritis	725	522	1.32 (1.18–1.48)	167	113

Autoimmune Disease	HR (95% CI)	Patients With Outcome (n=7,828) (n)		HR (95% CI)
		Eclampsia	Normotensive Pregnancy	
Systemic lupus erythematosus	2.45 (1.78–3.37)	50	11	4.20 (2.18–8.06)
Sjogren syndrome	1.24 (0.77–2.00)	16	10	2.39 (0.93–3.11)
Multiple sclerosis	2.08 (0.80–5.42)	10	0	—
Addison disease	2.04 (1.14–3.68)	10	10	3.08 (0.85–11.20)
Polymyositis	—	0	0	—
Dermatomyositis	1.07 (0.29–3.99)	10	10	0.29 (0.03–2.76)
Antiphospholipid syndrome	2.80 (1.97–3.99)	54	11	4.66 (2.43–8.91)
Behçet disease	—	0	0	—
Inflammatory bowel disease	1.36 (1.25–1.48)	436	264	1.59 (1.37–1.86)
Polyarteritis nodosa	0.82 (0.12–5.79)	10	0	—
Mixed connective tissue disease	1.35 (1.04–1.75)	51	26	1.8 (1.12–2.89)
Rheumatoid arthritis	1.33 (1.05–1.69)	47	35	1.2 (0.79–1.90)

HR, hazard ratio.

pregnancy-induced hypertension had a similar risk of developing autoimmune diseases compared with younger women. However, the risk was higher in those with more severe hypertensive disorders such as preeclampsia and eclampsia.

Compelling evidence suggests that the prevalence of hypertension is significantly higher in patients with systemic autoimmune diseases. Hypertension is a major cardiovascular risk factor in patients with SLE, who exhibit a markedly higher prevalence of hypertension compared with healthy individuals. Similarly, most case–control studies, including several large cohort studies, report a significant increase in the prevalence of hypertension (30–38%) among patients with primary Sjögren syndrome. For patients with RA, large community-based studies have shown that their prevalence of hypertension is notably higher than that of the general population, even in the 12 months preceding diagnosis.[12] The complex interplay of genetic, environmental, hormonal, and metabolic factors contributes to the heightened risk of autoimmune diseases and chronic inflammation, which in turn disrupts blood pressure regulation.[13]

In addition, growing experimental and clinical evidence underscores the inflammatory and autoimmune components of essential hypertension. Oxidative stress and inflammatory infiltration in both the renal interstitium and vascular wall can lead to mechanistic changes that ultimately result in elevated blood pressure.[3] Although previous research has focused primarily on the risk of developing hypertension in individuals with autoimmune diseases, there are

currently no studies demonstrating the association of hypertension pregnancy-induced hypertension and the subsequent risk of developing autoimmune diseases. From the aforementioned findings, it can be hypothesized that the presence of hypertension may potentially exacerbate the risk of developing autoimmune diseases, or contribute to their progression, by intensifying the underlying mechanisms of inflammation, immune system dysfunction, and oxidative stress.

Pregnancy-induced hypertension, encompassing gestational hypertension, preeclampsia, and eclampsia, presents with a more complex cause and pathophysiology compared with hypertension in the general adult population and may involve more intricate immune mechanisms. Central to its pathophysiology is inadequate placentation, which arises from insufficient trophoblastic invasion of the uterine spiral arteries, leading to placental hypoxia. This, in turn, triggers the release of proinflammatory cytokines, angiogenic and antiangiogenic factors, and microRNAs into the maternal circulation. Both innate and adaptive immune cells–including regulatory T cells, macrophages, natural killer cells, neutrophils, and B cells–along with immune mediators such as inflammatory cytokines and anti–angiotensin II type 1 receptor autoantibodies, play crucial roles in the development of the disease by contributing to oxidative stress and systemic inflammation. Moreover, factors such as neutrophil activation and elevated vasoconstrictor levels further aggravate endothelial dysfunction, underscoring the complex interplay between immune and vascular factors in the development of preeclampsia.[14,15] In addition, T lymphocytes, which are essential for immunologic memory, may contribute to the long-term sequelae of preeclampsia, including stroke or other cardiovascular events.[16] Changes in immune factors during pregnancy may influence the risk of developing autoimmune diseases later in life. As our study has found, pregnancy-induced hypertension is associated with an increased likelihood of autoimmune diseases.

Pregnancy outcomes in women of advanced maternal age can have lasting health effects as they age, influenced by both pregnancy-induced changes and an increased likelihood of pregnancy-related complications. Data from the Women's Health Initiative indicate a higher risk of hemorrhagic stroke in women whose last pregnancy occurred at age 40 years or older compared with those who completed their pregnancies before age 40 years.[17] In addition, preeclampsia–a major risk factor for future cardiovascular disease–is significantly more prevalent in women of advanced maternal age, with an incidence of approximately 3–4% in the general obstetric population, rising to 5–10% among women more than 40 years old.[18] Currently, no literature specifically addresses the association of the age at which hypertension occurs during pregnancy and the subsequent development of autoimmune diseases. However, when we divided the study participants into younger and advanced maternal age groups, we found that in different autoimmune diseases, not all women with pregnancy-induced hypertension in the advanced maternal age group had a higher risk of developing autoimmune diseases compared with younger women. One possible explanation is that younger women with pregnancy-induced hypertension may be influenced by other immune or lifestyle factors, increasing their risk of autoimmune diseases. In addition, women of advanced maternal age often receive more monitoring and medical interventions during pregnancy, which may affect disease progression. Thus, these results suggest that autoimmune disease development is influenced by a combination of factors, not just age or pregnancy-induced hypertension.

Our analysis shows a significant association between the severity of pregnancy-induced hypertension and the risk of autoimmune diseases. Specifically, as the severity of pregnancy-induced hypertension increases, the risk of developing autoimmune diseases also significantly rises, which is consistent with previous studies indicating that pregnancy-induced hypertension may exacerbate pathologic processes related to immune function. In our subgroup analysis of preeclampsia with and without severe features, we also observed that patients with preeclampsia with severe features had a slightly higher risk of developing autoimmune diseases compared with those without severe features (Appendix 2, available online at http://links.lww.com/AOG/E25). This result suggests that severe features may challenge the immune system more, thereby promoting the development of autoimmune diseases.

The results of this study have important clinical implications for the management of women with a history of pregnancy-induced hypertension. Given the increased risk of autoimmune diseases, it is essential for health care professionals to monitor these women closely in the years after pregnancy. Early detection and intervention could potentially mitigate the association of autoimmune diseases, improving long-term health outcomes. Routine screening for autoimmune markers and early signs of disease may be warranted in women with a history of pregnancy-induced hypertension, particularly those who developed preeclampsia or eclampsia. In addition, lifestyle interventions and preventive strategies aimed at reducing

inflammation and supporting immune health may be beneficial for these women.

In our study, we included only 12 autoimmune diseases. As is well known, autoimmune diseases currently encompass at least 80 identified conditions, which can affect almost any part of the human body. Because this study references International Classification of Diseases, Tenth Revision, which does not include a single comprehensive category that covers all autoimmune diseases, this study did not analyze generalized autoimmune diseases as a whole but instead selected a few categories for analysis. In addition, preeclampsia is one of the diagnostic criteria for antiphospholipid syndrome. Therefore, when antiphospholipid syndrome is evaluated as an outcome, there may be an influence of causal relationships. As a result, the finding in this study that antiphospholipid syndrome has the highest risk among all autoimmune diseases may be attributable in part to this reason.

Although this study offers valuable insights, several limitations must be acknowledged. First, the retrospective design and reliance on electronic health record data may introduce biases related to data accuracy and completeness. The observational nature of the study also restricts the ability to establish causal relationships between hypertensive disorders of pregnancy and autoimmune diseases. Although propensity score matching was used to balance covariates, unmeasured confounding factors may still influence the findings. Factors such as smoking history and insurance status were not included in our analysis because of concerns about inconsistent documentation in clinical systems.[19] Specifically, physicians may not consistently record smoking history or insurance status, leading to potential underestimation of these variables in the TriNetX database and increasing the margin of error. Moreover, the data set lacked specific coding for detailed metrics such as the number of pregnancies, gestational age at the diagnosis of preeclampsia, week of delivery and delivery method, and the timing of autoimmune disease onset, which further limits the granularity of the findings.

In conclusion, this study demonstrates a significant association between hypertensive disorders of pregnancy and an increased risk of autoimmune diseases in the years after pregnancy. The findings highlight the importance of long-term monitoring and early intervention strategies for women with a history of hypertensive disorders of pregnancy, particularly those who experienced more severe forms of the condition. Further research is needed to elucidate the mechanisms underlying this relationship and to develop targeted preventive and therapeutic approaches to improve the long-term health outcomes for these women.

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