

New-Onset Hypertension Following COVID-19 Among Aseer Residents, Kingdom of Saudi Arabia; Community-Based Screening

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Background: The coronavirus disease 2019 (COVID-19) pandemic has raised concerns about its long-term health impacts, including its potential association with new-onset hypertension. This study aimed to investigate the association between COVID-19 and the development of new-onset hypertension among residents of the Aseer region, Kingdom of Saudi Arabia, using a community-based approach.

Methods: A cross-sectional study was carried out involving participants aged 18 and older who did not have any communication issues. Data were collected using structured questionnaires that included demographic, health-related, and COVID-19-specific data. Blood pressure and body mass index (BMI) measurements were also taken. Hypertension was defined based on either a documented history or new findings during the survey. Statistical analysis was performed using Statistical Package for Social Science (SPSS) version 27, with a p-value < 0.05 considered significant.

Results: We included 333 participants, 39.6% aged 18–34 years, 55.0% were males, 63.7% were married, 76.0% held a university/postgraduate degree, 84.7% were non-healthcare workers, 77.8% were permanent residents of Aseer, 98.8% were Saudi nationals, and 60.7% got infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Among the surveyed population, 185 individuals reported SARS-CoV-2 infection without a prior history of hypertension. Of these, 8.1% developed new-onset hypertension following infection. Age was a significant sociodemographic factor associated with new-onset hypertension following COVID-19 ($p = 0.015$), with prevalence increasing among older age groups. Additionally, dyslipidemia showed a significant association with new-onset hypertension ($p = 0.031$).

Conclusion: The findings suggest that COVID-19 infection may increase the risk of new-onset hypertension. This highlights the importance of post-COVID-19 monitoring and management of blood pressure in individuals affected by the disease. The study underscores the need for additional research to comprehend the long-term cardiovascular effects of COVID-19 in the general population.

Keywords: COVID-19, hypertension, new-onset hypertension, Aseer region, Saudi Arabia, post-COVID-19 complications

Introduction

The coronavirus disease 2019 (COVID-19) was declared by the World Health Organization (WHO) as a pandemic on March 11, 2020. It poses a serious threat to human health and remains a major public health challenge worldwide.¹ COVID-19 is caused by a novel coronavirus: severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2).² COVID-

19 infection can cause a wide range of symptoms, from mild to severe, including fever, cough, shortness of breath, and loss of smell or taste. It causes dysregulation of immune, thrombotic, and renin-angiotensin-aldosterone balance, which results in vascular endothelial injury and dysfunction. Hence, the other name for the COVID-19 disease is a vascular disease.^{3,4}

The number of confirmed COVID-19 cases in the Kingdom of Saudi Arabia (KSA) reached about 842, 000 with nearly 9500 deaths.⁵ Although those figures are considered high, they might be underestimated as many people who catch the infection show mild or no symptoms. Those people most probably did not seek confirmation of their diagnosis and passed uncounted.⁶ The WHO declared the end of the COVID-19 pandemic as a public health emergency of international concern on May 5, 2023.⁷ This declaration shifted the concern to the long-term sequelae of the COVID-19 disease. Understanding the pathophysiology of this disease and its effect on multiple systems and various comorbidities remains under investigation.⁴ Studying the post-COVID-19 period is important to detect the short-, mid-, and long-term consequences of the infection. It helps in understanding the pathophysiology of the disease. Investigating the post-COVID-19 period allows to identify the new onset comorbidities that may develop and could be associated with the COVID-19 disease.

Hypertension is one of the comorbidities associated with an increased risk of severe SARS-CoV-2 infection and increases patients' risk of mortality.^{4,8} However, few studies examined the effect of COVID-19 on blood pressure^{2,9} and found that COVID-19 is associated with an increased risk of new-onset of hypertension and worsening of symptoms of existing hypertension. However, those studies were few hospital-based and relied on relatively small samples. Moreover, findings from hospital-based studies are of limited generalizability. Data is restricted to hospitalized patients with severe conditions/infections and other comorbidities. On the other hand, community-based participatory research (CBPR) involves collaborative studies conducted within local communities, where residents work directly with trained academic researchers. Unlike traditional research approaches tied to specific fields, CBPR is a flexible methodology applied across various disciplines, including public health, social sciences, community development, humanities, and urban planning.^{10–12}

This study hypothesized that COVID-19 is associated with an increased risk of new-onset hypertension in the general population. Therefore, the present study aimed to investigate the association between COVID-19 infection and new-onset hypertension among the general population.

Materials and Methods

Study Setting

This cross-sectional study was conducted in the Aseer region of KSA from November 27, 2023, to January 15, 2025. Aseer is one of the thirteen administrative regions of the country, located in the southwestern part. Abha, the capital of the region, also serves as the seat of the emirate. As of 2020, Aseer has a population of approximately 2,354,320, making it the fifth most populous region in the Kingdom. The population of Aseer accounts for about 6.3% of the Kingdom's total population, highlighting its significance as a key region in the country.

Study Subjects and Sample Size

Based on previous studies that reported a prevalence of hypertension following COVID-19 infection was 12%,¹³ supposing an effect size of 0.1%, an alpha error of 0.05, and a power of 95%, the minimum required sample size for this study was 188. The final sample size was 333 to compensate for non-response, incomplete, and inconsistent data. The study included healthy male and female participants aged 18 years and older from diverse social backgrounds residing in the Aseer region of KSA. Pregnant and those with communication impairments (e.g., deaf or mute) were excluded.

Sampling Technique

The Aseer region is divided into sixteen governorates, as per the 2010 Census: Abha, Muhayil, An-Namas, Billasmar, Billahmar, Balqarn, Bareq, Bishah, Khamis Mushayt, Rijal Almaa, Tanomah, Dhahran Al Janub, Tathlith, Sarat Ubaida,

Ahad Rafidah, Al Majaridah, and Al Harajah. For the screening program, two public settings were randomly selected from Khamis Mushayt, Abha, and Muhayl, including locations such as coffee shops, markets, and gardens. Using a convenience sampling technique, participants were recruited from each setting. From each setting, 40–60 participants were recruited.

Data Collection Methods, Instruments Used, and Measurements

Through a structured questionnaire, we collected the following data: a demographic section that collected information on age, sex, marital status, educational level, occupation, residence (whether in Aseer or not), and nationality (Saudi or non-Saudi). The health-related section focused on chronic conditions and cortisone therapy usage. Chronic conditions were assessed through a checklist of diseases, including dyslipidemia, diabetes mellitus, thyroid diseases, and others. The questionnaire then inquired about COVID-19-specific questions, asking about diagnosis methods (eg, Polymerase chain reaction (PCR), rapid diagnostic tests (RDT), symptoms without confirmation), the timing of infection (eg, less than a year ago, one year or more), and the number of infections (eg, once, twice, three times). Additionally, participants were asked about their mental health post-infection, with options ranging from no depression to mild symptoms or significant depression.

In this study, body mass index (BMI) was measured using the standard formula: $BMI = \text{weight in kilograms} / \text{height in meters squared (kg/m}^2\text{)}$. Participants were then classified into four categories based on their BMI values: underweight ($BMI < 18.5$), normal weight ($BMI 18.5\text{--}24.9$), overweight ($BMI 25.0\text{--}29.9$), and obese ($BMI \geq 30.0$).

Blood pressure measurement: Blood pressure was measured using a calibrated sphygmomanometer with proper technique to ensure reliability. Before measurement, participants rested for 5–10 minutes in a seated position to obtain stable readings. An appropriately sized cuff was placed on the upper arm at heart level for accurate assessment. Based on standard clinical guidelines, blood pressure readings were categorized as follows: normal (SBP <120 mmHg and DBP <80 mmHg), elevated (SBP $120\text{--}129$ mmHg and DBP <80 mmHg), stage 1 hypertension (SBP $130\text{--}139$ mmHg or DBP $80\text{--}89$ mmHg), stage 2 hypertension (SBP ≥ 140 mmHg or DBP ≥ 90 mmHg), and hypertensive crisis (SBP >180 mmHg and/or DBP >120 mmHg, requiring urgent medical intervention).¹⁴

Participants were classified as hypertensive based on either a documented history of hypertension or new findings during the survey. Specifically, individuals who reported being previously diagnosed with hypertension and undergoing treatment (eg, medication, lifestyle changes) were immediately categorized as hypertensive. For those without prior history, blood pressure measurements were taken during the survey to screen potential cases of hypertension. If cases of new-onset hypertension were identified, participants were advised to remeasure their blood pressure within one week and report the results to confirm the diagnosis. Additionally, all identified hypertensive participants, whether previously diagnosed or newly detected—were referred to appropriate healthcare providers for further evaluation and management to ensure proper follow-up and care.

Case Definitions for Hypertension Outcomes

- **No Hypertension:** Participants with no documented history of hypertension or elevated blood pressure at the time of the study.
- **Hypertension unrelated to COVID-19:** Participants with hypertension and no evidence of COVID-19 infection that may affect their blood pressure status.
- **Pre-COVID-19 hypertension:** Participants diagnosed with hypertension before contracting COVID-19, with no indication that the infection caused their condition.
- **Post-COVID-19 hypertension:** Participants with new-onset hypertension (diagnosed for the first time) after confirmed COVID-19 infection, with no prior history of high blood pressure.

Study Groups

This study categorized SARS-CoV-2-infected participants without history of hypertension into two groups based on hypertension status:

- Post-COVID-19 hypertensive group: Individuals who developed new-onset hypertension following SARS-CoV-2 infection
- Non-hypertensive COVID-19 group: SARS-CoV-2-positive individuals without hypertension after infection.

Study Outcomes

- The primary outcome of this study was to implement a community-based survey to diagnose hypertension following SARS-CoV-2 infection.
- The secondary outcome aimed to examine associations between hypertension development and various socio-demographic characteristics (age, gender, education level), medication (corticosteroid), and lifestyle factors (physical activity, smoking status, BMI).

Data Management and Analysis Plan

We used the Statistical Package for Social Sciences (SPSS) V.27 to analyze the data derived from the questionnaires. Categorical variables were presented as frequencies and percentages. Quantitative variables were presented as mean and standard deviation. The chi-square test of independence was employed to examine potential associations between categorical variables. Expected frequencies were reviewed to ensure the test's validity; where cell counts were <5, Fisher's exact test was used as a supplementary analysis. A p-value of less than 0.05 was considered significant.

Ethical Considerations

The privacy, anonymity, and confidentiality of the participants were ensured. The questionnaires did not involve the participants' identities, and informed consent for participation was obtained from them after they were informed about the study objectives, its benefits, and possible risks. Participants were assured of voluntary participation and the right to withdraw at any time. This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) of King Khalid University (Approval No: ECM#2023-3215; Date: 15 November 2023).

Results

The age distribution shows that 39.6% of the participants were between 18–34 years, 55.0% were males, more than three-fifths participants were married (63.7%), 76.0% held a university or postgraduate degree, 15.3% were healthcare workers, 77.8% were permanent residents in Aseer, 9.8% were Saudi nationals, 44.7% had monthly income above 10000 SAR, 18.9% were smokers, and 21.3% were not on physical activity. [Table 1](#)

The BMI distribution among participants shows that 1.5% were underweight, while 27.6% had a normal BMI. However, a significant proportion fell into higher BMI categories, with 37.5% classified as overweight and 33.3% as obese. [Figure 1](#)

The distribution of chronic conditions among participants highlights dyslipidemia as the most prevalent condition (21.9%), followed by diabetes mellitus (8.4%) and thyroid diseases (7.5%) were also notable, allergic diseases (6%) while cardiac diseases (2.1%) and autoimmune diseases (1.5%) had lower prevalence rates. [Figure 2](#)

Most participants (92.8%) were not on corticosteroids. Regarding COVID-19 history, 60.7% reported a SARS-CoV-2 infection, with confirmation methods as follows: 26.7% via PCR testing, 21.3% through RDT, 11.1% based on symptomatic presentation, and 0.9% diagnosed via radiology. Regarding the number of infections, 39.6% had it once, 16.5% twice, and only 2.1% experienced it three times. A small percentage (1.8%) could not recall how many times they were infected. Post-infection depression was experienced by 7.8% of those infected, with 13.8% reporting mild symptoms. Nearly two-fifths, 38.7% of those who had COVID-19 did not experience depression. [Table 2](#)

Most participants (85.0%) did not have hypertension. Among those with hypertension, 5.4% had hypertension without any association with COVID-19, while a smaller proportion (5.1%) had hypertension before contracting COVID-19. Among the participants studied, 4.5% were diagnosed with hypertension after being infected with COVID-19. [Figure 3](#)

Table 1 Sociodemographic Characteristics of the Study Population (N=333)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–34	132	39.6
	35–44	72	21.6
	45–54	102	30.6
	≥ 55–59	27	8.1
Sex	Male	183	55.0
	Female	150	45.0
Marital status	Married	212	63.7
	Not married	121	36.3
Educational level	Secondary school or less	80	24.0
	University	253	76.0
Occupation	Healthcare worker	51	15.3
	Non-healthcare worker	282	84.7
Permanent Aseer resident #	Yes	259	77.8
	No	74	22.2
Nationality	Saudi	329	98.8
	Non-Saudi	4	1.2
Monthly income	< 5000 SAR	107	32.1
	5000- 9999 SAR	77	23.1
	≥ 10000 SAR	149	44.7
Smoking	No	270	81.1
	Yes	63	18.9
On physical activity	No	71	21.3
	Sometimes	171	51.4
	Yes	91	27.3

Note: SAR: Saudi Riyal (3.75 SAR = 1 USD), # Non-permanent residents include expatriates and Saudis from other Saudi regions working in the Aseer region.

In the surveyed population, 185 individuals reported SARS-CoV-2 infection without pre-existing hypertension. Among these cases, 8.1% (15/185) developed new-onset hypertension post-infection. Most notably, age demonstrated a strong association, with the 45–54 age group showing the highest proportion of new-onset hypertension cases at 16.2%, compared to just 3.2% in 18–34-year-olds and 2.2% in 35–44-year-olds ($p = 0.015$). A significant association was observed between dyslipidemia and the development of hypertension, with affected individuals exhibiting nearly three times the prevalence compared to those without dyslipidemia (13.3% vs 4.7%, $p = 0.031$). Several factors showed notable trends that approached statistical significance. The recent COVID-19 infection (<1 year) was associated with a higher hypertension rate (40.0% vs 7.2% for earlier infections, $p = 0.053$). Multiple infections showed a dose-response pattern, with twice-infected individuals having higher hypertension rates (11.5%) than single-infection cases (7.4%), though this did not reach significance. No significant differences were found for several demographic and socioeconomic factors, including sex, marital status, occupation type, corticosteroid therapy, physical activity level, smoking, income levels, and post-COVID depression. [Table 3](#)

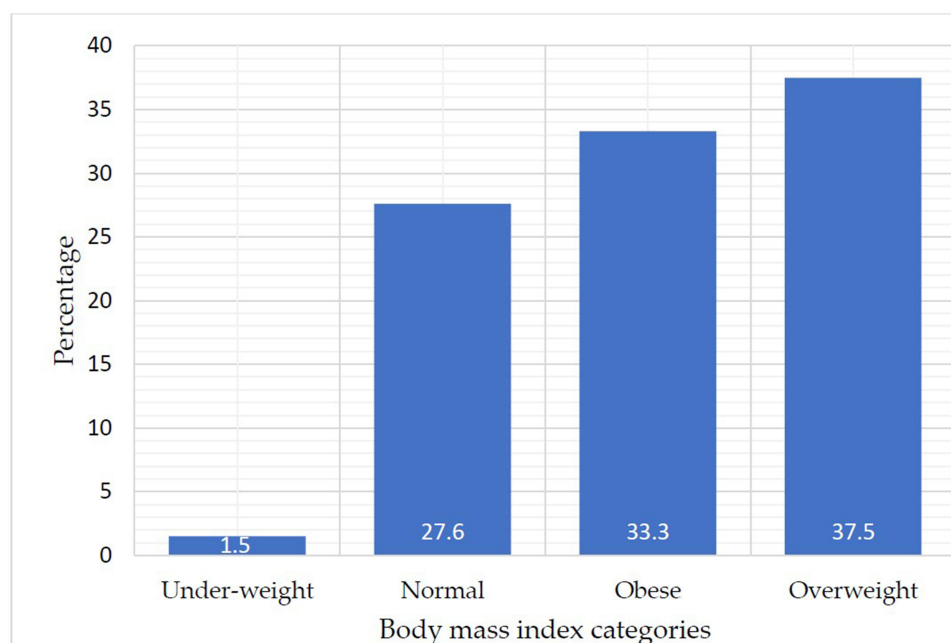


Figure 1 Distribution of the participants across their body mass index.

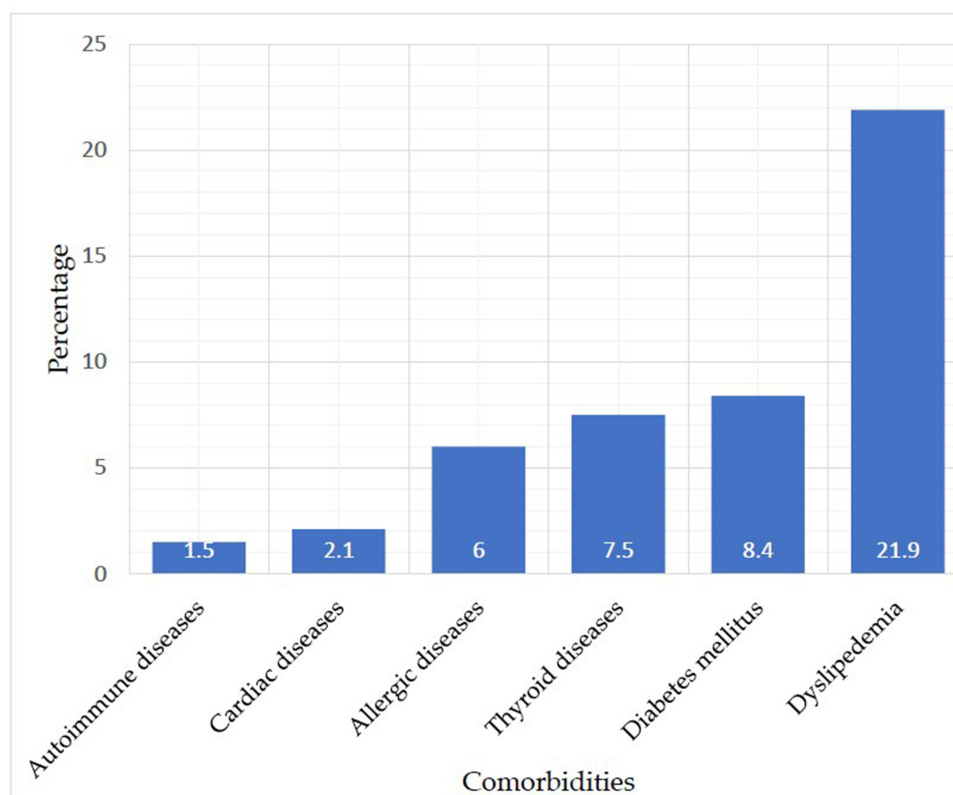


Figure 2 Prevalence of chronic diseases among study participants.

Discussion

Cardiovascular diseases are closely associated with SARS-CoV-2 infection, with approximately 15% of patients developing cardiovascular complications.¹⁵ A meta-analysis based on a large population of over 19 million individuals

Table 2 Health Outcomes and COVID-19 Impact Among Participants: a Summary of Cortisone Therapy, Infection Rates, and Post-Infection Depression (N = 333)

Variable	Level	Frequency	Percent
On corticosteroid	No	309	92.8
	Yes	24	7.2
Diagnosed COVID-19	Did not get the infection	131	39.3
	Positive PCR	91	27.33
	Positive radiology	3	0.90
	Positive RDT	71	21.32
	Positive signs-symptoms	37	11.11
When got COVID-19	Did not get the infection	131	39.3
	Less than a year	5	1.5
	One year or more	197	59.2
How many times have you gotten COVID-19	Did not get the infection	131	39.3
	Once	133	39.9
	Twice	56	16.8
	Three times	7	2.1
	Can not determine	6	1.8
Diagnosed with post-infection depression	Did not get the infection	131	39.4
	No	129	38.7
	To some extent	46	13.8
	Yes	27	8.1

revealed that subjects recovering from COVID-19 faced an additional 70% risk of developing new-onset heart failure within 7 months following the acute infection.¹⁶ Hypertension stands out as one of the most frequently reported comorbidities among patients with COVID-19.¹⁷ This study examined the prevalence of new-onset hypertension following SARS-CoV-2 infection among Aseer region residents in KSA.

The Study's Main Findings

Among the surveyed population, 60.7% reported a prior SARS-CoV-2 infection. Regardless of SARS-CoV-2 infection, 15.0% were diagnosed with hypertension. Among individuals without pre-existing hypertension who contracted the virus, 8.1% developed new-onset hypertension following infection. The development of hypertension was associated with increasing age and dyslipidemia.

Interpretation of the Main Study Findings

In this study, 4.5% (15/333) of the sample were diagnosed with hypertension following SARS-CoV-2 infection. Among individuals without pre-existing hypertension who contracted SARS-CoV-2, 8.1% (15/185) developed new-onset hypertension post-infection. Consistent with our findings, multiple studies have reported a statistically significant association between SARS-CoV-2 infection and new-onset hypertension.^{13,17,18} Zhang et al,¹⁷ reported that among patients without pre-existing hypertension, new-onset hypertension occurred in 0.6% of hospitalized COVID-19 cases compared to

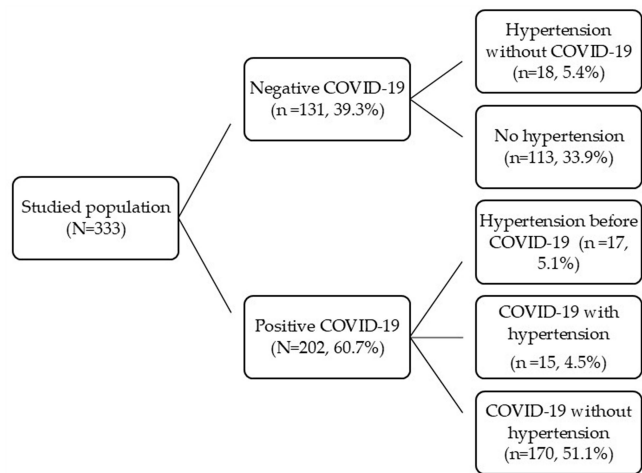


Figure 3 Prevalence of hypertension among the study participants across COVID-19 status.

10.85% of non-hospitalized cases. Furthermore, Delalić et al,¹³ found that during the one-year follow-up period, 16.1% (32/199) of patients infected with SARS-CoV-2 exhibited clinically significant hypertensive changes, comprising new-onset hypertension in 7.5% and worsening of pre-existing hypertension in 8.5%. On the other hand, in a large,

Table 3 Association Between Demographic, Socioeconomic, and Lifestyle Variables and Hypertension Among Individuals with a History of COVID-19 (N = 185)

Variable	Level	Hypertension after COVID-19 (n=15)		No hypertension after COVID-19 (n=170)		P-value
		N	%	N	%	
Age group	18–34	2	3.2	61	96.8	0.015
	35–44	1	2.2	44	97.8	
	45–54	11	16.2	57	83.8	
	≥ 55–59	1	11.1	8	88.9	
Sex	Male	7	7.8	83	92.2	0.873
	Female	8	8.4	87	91.6	
Marital status	Married	4	7.3	51	92.7	1.00
	Not married	11	8.5	119	91.5	
Monthly income	< 5000 SAR	4	7.4	50	92.6	0.214
	5000- 9999 SAR	1	2.4	41	97.6	
	≥ 10000 SAR	10	11.2	79	88.8	
Educational level	Secondary school or less	5	10.6	42	89.4	0.541
	University/postgraduate degree	10	7.2	128	92.8	
Occupation	Non-healthcare worker	13	8.1	147	91.9	0.983
	Healthcare worker	2	8.0	23	92.0	

(Continued)

Table 3 (Continued).

Variable	Level	Hypertension after COVID-19 (n=15)		No hypertension after COVID-19 (n=170)		P-value
		N	%	N	%	
Work-related stress	No	4	12.5	28	87.5	0.397
	Maybe	3	4.8	60	95.2	
	Yes	8	8.9	82	91.1	
Dyslipidemia (n = 152)	No	5	4.7	102	95.3	0.031
	Yes	6	13.3	39	86.7	
When got COVID-19	Less than a year	2	40.0	3	60.0	0.053
	One year or more	13	7.2	167	92.8	
How many times have you gotten COVID-19	Do not remember	0	0.0	6	100.0	0.523
	Once	9	7.4	112	92.6	
	Twice	6	11.5	46	88.5	
	Three times	0	0.0	6	100.0	
Post-infection depression	No	8	6.8	109	93.2	0.408
	Yes	7	10.3	61	89.7	
Smoking	No	12	7.8	141	92.8	0.083
	Yes	3	9.4	29	90.6	
Physical activity	No	4	9.5	38	90.5	0.667
	Sometimes	9	9.2	89	91.8	
	Yes	2	4.5	43	9.5	

population-based cohort study from Sweden and Norway, SARS-CoV-2 infection during pregnancy was not associated with a higher risk of developing gestational hypertension or pre-eclampsia, and this finding remained consistent across all trimesters and different periods of variant dominance.¹⁹ However, this contradiction can be explained by fundamental differences in the patient population and underlying physiology.

We observed an increase in cases of newly diagnosed hypertension with prolonged duration following SARS-CoV-2 infection, though this association did not reach statistical significance, likely due to limited sample size. These findings align with broader epidemiological trends demonstrating a marked rise in hypertension incidence during the pandemic era. In the pre-pandemic period (2017–2019), the baseline incidence was 2.11 cases per 100 person-years. This rate surged to 5.20 during 2020–2022—a 2.46-fold increase (relative risk = 2.46) compared to pre-pandemic levels. By 2023, incidence further rose to 6.76 cases per 100 person-years, reflecting a 3.20-fold elevation from baseline and a 30% increase over early pandemic rates.¹⁸ This progressive upward trajectory suggests both acute and sustained effects of the pandemic on hypertension risk. Clinically, this requires a shift in approach towards long-term, proactive monitoring of cardiovascular health for the hundreds of millions of COVID-19 survivors around the globe. For public health officials, this indicates an impending surge of hypertension-related diseases, highlighting the need for strategic planning regarding healthcare resource allocation and the implementation of targeted screening programs.

The observed association between COVID-19 and subsequent hypertension may be mediated through endothelial damage. While SARS-CoV-2 primarily targets the respiratory system, growing evidence shows that it also causes

widespread vascular injury through direct viral effects and indirect immune-mediated pathways. The infection induces multiple forms of endothelial dysfunction—such as impaired nitric oxide bioavailability, oxidative stress, barrier disruption, inflammation, and hypercoagulability—leading to multi-organ damage.²⁰ Another mechanism may be through dysregulation of the renin-angiotensin-aldosterone system (RAAS). As a key regulator of blood pressure and fluid balance, RAAS activity appears to be significantly altered by SARS-CoV-2 infection.²¹ Other mechanisms of development of hypertension include the severe manifestations of COVID-19, such as systemic hypoxia, acute respiratory distress, hypercoagulation, sepsis, inflammation, metabolic stress, and cytokine storms, which can place significant strain on the cardiovascular system, potentially leading to blood pressure dysregulation.²² Furthermore, there is evidence that SARS-CoV-2 may directly infect cardiac cells through angiotensin converting enzyme 2 (ACE2) receptors, which could contribute to cardiac dysfunction and further disrupt blood pressure regulation.²³ Other proposed mechanisms contributing to hypertension following COVID-19 infection include acute kidney injury,²⁴ psychological stress,²⁵ social isolation, reduced physical activity due to lockdown measures, and the adoption of unhealthy dietary habits.²⁶ These factors may exacerbate blood pressure dysregulation and further compound the cardiovascular burden in individuals recovering from the infection.

Age is an established risk factor for both incident hypertension and COVID-19 severity.²⁷ This study found that older age was significantly associated with hypertension following COVID-19, with advancing age strongly associated with an increased likelihood of diagnosis. These findings highlight the critical role of aging in blood pressure dysregulation and the progression of hypertensive disorders. Supporting this, prior research has also identified age as one of the most important predictors of persistent hypertension after SARS-CoV-2 infection.^{18,28} Other sociodemographic factors were not associated with the diagnosis of hypertension. On the other hand, several studies found an association between female sex and hypertension. Female sex influences the risk of new-onset hypertension and cardiovascular sequelae after SARS-CoV-2 infection, potentially due to differences in immune system function between sexes.²⁹ Females typically mount stronger innate and adaptive immune responses, which can protect against initial infection and severity. However, Wang et al³⁰ found that female COVID-19 survivors had a higher risk of long-term cardiovascular events, including myocarditis, ischemic cardiomyopathy, and atrial fibrillation, compared to sex-matched controls.

This study did not find a significant association between comorbidities and hypertension, except for dyslipidemia. One possible explanation for the relationship between hypertension and dyslipidemia is that they share common pathophysiological mechanisms, such as obesity and the associated dysregulation of adipocytokine release from adipose tissue.³¹ Additionally, dyslipidemia negatively impacts functional and structural arterial properties, promoting atherosclerosis, which further exacerbates cardiovascular risks.^{32,33}

Implications of This Study

The findings of this study underscore the pivotal role of age and dyslipidemia in the development of post-COVID-19 cardiometabolic complications, specifically hypertension. This demands a coordinated public health and clinical response to mitigate long-term morbidity. A key recommendation is the establishment of formal post-COVID-19 surveillance protocols that mandate regular cardiovascular screening, including blood pressure checks and lipid panels, particularly for older adult survivors. For those identified as high-risk, prompt initiation of lifestyle modification or pharmacotherapy is imperative. Concurrently, healthcare systems must develop structured long-term follow-up pathways that not only manage hypertension and dyslipidemia but also address often-overlooked aspects such as mental health and the management of other pre-existing conditions. Critically, these initiatives must be designed to bridge, rather than widen, existing gaps in healthcare access. Finally, while managing sequelae is crucial, primary prevention remains paramount; thus, vaccination against SARS-CoV-2 should be vigorously promoted as a foundational strategy to prevent the initial infection and its associated cardiovascular complications. COVID-19 vaccines have demonstrated strong immunogenicity, a favorable safety profile, and high efficacy in preventing SARS-CoV-2 infection.^{34,35} Moreover, COVID-19 vaccination was associated with a significantly reduced risk of new-onset hypertension following SARS-CoV-2 infection. At 90 days post-diagnosis, the relative risk of developing hypertension was 0.33 (95% CI, 0.26–0.42) in vaccinated individuals compared with those unvaccinated, indicating a strong protective effect.³⁶

Strengths and Limitations

This study's robust methodology, using structured questionnaires to assess sociodemographics, comorbidities, COVID-19 history, and mental health, provides valuable insights into post-COVID-19 hypertension, an understudied but critical long-term effect. Its focus on cardiovascular sequelae (new-onset hypertension) advances our understanding of the pandemic's lasting health impacts. Despite these strengths, this study has certain limitations. Its cross-sectional design restricts the ability to establish causal relationships, meaning that while associations between COVID-19 and hypertension were identified, causation cannot be definitively proven. The use of convenience sampling may introduce selection bias and limits generalization of the findings. Additionally, much of the data relied on self-reporting, which is susceptible to recall bias and inaccuracies, particularly regarding chronic conditions, lifestyle habits, and COVID-19 history. However, numerous studies have demonstrated the high accuracy of self-reported COVID-19 data, including symptom reporting and vaccination details (such as number of doses, vaccine brand, and timing), which can inform and guide future research.^{37–39} While dyslipidemia was significantly associated with hypertension, the study did not explore other potential comorbidities or risk factors, such as genetic predispositions or environmental influences, in sufficient depth.⁴⁰ Geographically, the study's exclusive focus on the Aseer region limits the generalizability of findings to other parts of KSA or globally, as regional variations in lifestyle, healthcare access, and disease prevalence may influence outcomes. Finally, the lack of objective biomarkers, such as inflammatory markers or lipid profiles, to corroborate self-reported data or provide deeper insights into biological mechanisms linking COVID-19 to hypertension represents another limitation that future research should address.

Conclusions

This study highlights the significant impact of COVID-19 on cardiovascular health, particularly the development of new-onset hypertension among residents of the Aseer region in KSA. The findings demonstrate that age is associated with hypertension risk, with older age groups showing a significantly higher prevalence of hypertension following infection. Notably, dyslipidemia emerged as a significant comorbidity associated with hypertension. These results underscore the importance of implementing targeted preventive measures, promoting healthy lifestyle changes, and addressing modifiable risk factors to mitigate the cardiovascular burden posed by the pandemic. Further research is warranted to explore the underlying mechanisms and develop strategies to manage post-COVID-19 cardiovascular complications effectively.

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Disclosure

The authors report no conflicts of interest in this work.

References

1. Asem N, Ramadan A, Hassany M, et al. Pattern and determinants of COVID-19 infection and mortality across countries: an ecological study. *Heliyon*. 2021;7(7):e07504. doi:10.1016/j.heliyon.2021.e07504
2. Akpek M. Does COVID-19 cause hypertension? *Angiology*. 2022;73(7):682–687. doi:10.1177/00033197211053903
3. Siddiqi HK, Libby P, Ridker PM. COVID-19 – a vascular disease. *Trend Cardiovasc Med*. 2021;31(1):1–5. doi:10.1016/j.tcm.2020.10.005
4. Mithal A, Jevalikar G, Sharma R, et al. High prevalence of diabetes and other comorbidities in hospitalized patients with COVID-19 in Delhi, India, and their association with outcomes. *Diabetes Metab Syndr*. 2021;15(1):169–175. doi:10.1016/j.dsx.2020.12.029
5. World Health Organization (WHO). WHO health emergency dashboard 2023. Available from: <https://covid19.who.int/region/emro/country/sa>. Accessed November 8, 2023.
6. Gao Z, Xu Y, Sun C, et al. A systematic review of asymptomatic infections with COVID-19. *J Microbiol Immunol Infect*. 2021;54(1):12–16. doi:10.1016/j.jmii.2020.05.001
7. World Health Organization (WHO). Coronavirus disease (COVID-19) pandemic. 2023. Available from: <https://www.who.int/europe/emergencies/situations/covid-19>. Accessed November 8, 2023.
8. Lippi G, Wong J, Henry BM. Hypertension and its severity or mortality in coronavirus disease 2019 (COVID-19): a pooled analysis. *Pol Arch Intern Med*. 2020;130(4):304–309. doi:10.20452/pamw.15272

9. Vyas P, Joshi D, Sharma V, et al. Incidence and predictors of development of new onset hypertension post COVID-19 disease. *Indian Heart J.* 2023;75(5):347–351. doi:10.1016/j.ihj.2023.06.002
10. Duke M. *Community-Based Participatory Research*. Oxford University Press; 2020.
11. Riccardi MT, Pettinichio V, Di Pumpo M, et al. Community-based participatory research to engage disadvantaged communities: levels of engagement reached and how to increase it. A systematic review. *Health Policy.* 2023;137:104905. doi:10.1016/j.healthpol.2023.104905
12. Jull J, Giles A, Graham ID. Community-based participatory research and integrated knowledge translation: advancing the co-creation of knowledge. *Implement Sci.* 2017;12(1):150. doi:10.1186/s13012-017-0696-3
13. Delalić Đ, Jug J, Prkačin I. Arterial hypertension following covid-19: a retrospective study of patients in a central European tertiary care center. *Acta Clin Croat.* 2022;61(Suppl 1):23–27. doi:10.20471/acc.2022.61.s1.03
14. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American college of cardiology/American heart association task force on clinical practice guidelines. *J Am Coll Cardiol.* 2018;71(19):e127–e248. doi:10.1016/j.jacc.2017.11.006
15. Huang LW, Li H-M, He B, et al. Prevalence of cardiovascular symptoms in post-acute COVID-19 syndrome: a meta-analysis. *BMC Med.* 2025;23(1):70. doi:10.1186/s12916-025-03908-3
16. Zuin M, Rigatelli G, Bilato C, et al. Risk of incident new-onset arterial hypertension after COVID-19 recovery: a systematic review and meta-analysis. *High Blood Pressure Cardiovasc Prev.* 2023;30(3):227–233. doi:10.1007/s40292-023-00574-5
17. Zhang V, Fisher M, Hou W, et al. Incidence of new-onset hypertension post-COVID-19: comparison with influenza. *Hypertension.* 2023;80(10):2135–2148. doi:10.1161/HYPERTENSIONAHA.123.21174
18. Trimarco V, Izzo R, Pacella D, et al. Incidence of new-onset hypertension before, during, and after the COVID-19 pandemic: a 7-year longitudinal cohort study in a large population. *BMC Med.* 2024;22(1):127. doi:10.1186/s12916-024-03328-9
19. Örtqvist AK, Magnus MC, Dahlqvist E, et al. Association between SARS-CoV-2 infection and newly diagnosed hypertension during pregnancy: prospective, population based cohort study. *BMJ Med.* 2023;2(1):e000465. doi:10.1136/bmjmed-2022-000465
20. Xu S-W, Ilyas I, Weng J-P. Endothelial dysfunction in COVID-19: an overview of evidence, biomarkers, mechanisms and potential therapies. *Acta Pharmacol Sin.* 2023;44(4):695–709. doi:10.1038/s41401-022-00998-0
21. Ranjbar T, Oza PP, Kashfi K. The renin-angiotensin-aldosterone system, nitric oxide, and hydrogen sulfide at the crossroads of hypertension and COVID-19: racial disparities and outcomes. *Int J Mol Sci.* 2022;23(22):13895. doi:10.3390/ijms232213895
22. Guo T, Fan Y, Chen M, et al. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 2019 (COVID-19). *JAMA Cardiol.* 2020;5(7):811–818. doi:10.1001/jamacardio.2020.1017
23. Hoffmann M, Kleine-Weber H, Schroeder S, et al. SARS-CoV-2 cell entry depends on ACE2 and TMPRSS2 and is blocked by a clinically proven protease inhibitor. *Cell.* 2020;181(2):271–280.e8. doi:10.1016/j.cell.2020.02.052
24. Lu JY, Buczek A, Fleysheer R, et al. Outcomes of hospitalized patients with COVID-19 with acute kidney injury and acute cardiac injury. *Front Cardiovasc Med.* 2021;8:798897. doi:10.3389/fcvm.2021.798897
25. Abd ElHafeez S, Cruz MME, Gouda S, et al. Sleep quality and anxiety among Egyptian population during covid-19 pandemic. *Sleep Sci.* 2022;15(01):8–16. doi:10.5935/1984-0063.20210020
26. Abd ElHafeez S, Issa YA, Tharwat S, et al. Dietary habits and weight change during the second wave of the COVID-19 pandemic among the Egyptian population. *BMC Nutr.* 2025;11(1):2. doi:10.1186/s40795-024-00977-0
27. Buford TW. Hypertension and aging. *Ageing Res Rev.* 2016;26:96–111. doi:10.1016/j.arr.2016.01.007
28. Boparai MS, Gordon J, Bajrami S, et al. Incidence and risk factors of new-onset hypertension up to 3 years post SARS-CoV-2 infection. *Sci Rep.* 2025;15(1):28728. doi:10.1038/s41598-025-14617-5
29. Klein SL, Flanagan KL. Sex differences in immune responses. *Nat Rev Immunol.* 2016;16(10):626–638. doi:10.1038/nri.2016.90
30. Wang W, Wang C-Y, Wang S-I, et al. Long-term cardiovascular outcomes in COVID-19 survivors among non-vaccinated population: a retrospective cohort study from the TriNetX US collaborative networks. *EClinicalMedicine.* 2022;53:101619. doi:10.1016/j.eclinm.2022.101619
31. McGill JB, Haffner S, Rees TJ, et al. Progress and controversies: treating obesity and insulin resistance in the context of hypertension. *J Clin Hypertens.* 2009;11(1):36–41. doi:10.1111/j.1751-7176.2008.00065.x
32. Wilkinson IB, Prasad K, Hall IR, et al. Increased central pulse pressure and augmentation index in subjects with hypercholesterolemia. *J Am Coll Cardiol.* 2002;39(6):1005–1011. doi:10.1016/S0735-1097(02)01723-0
33. Otsuka T, Takada H, Nishiyama Y, et al. Dyslipidemia and the risk of developing hypertension in a working-age male population. *J Am Heart Assoc.* 2016;5(3):e003053. doi:10.1161/JAHA.115.003053
34. Ashmawy R, Hamdy NA, Elhadi YAM, et al. A meta-analysis on the safety and immunogenicity of covid-19 vaccines. *J Primary Care Community Health.* 2022;13:21501319221089255. doi:10.1177/21501319221089255
35. Ghazy RM, Ashmawy R, Hamdy NA, et al. Efficacy and effectiveness of SARS-CoV-2 vaccines: a systematic review and meta-analysis. *Vaccines.* 2022;10(3):350. doi:10.3390/vaccines10030350
36. Zisis SN, Durieux JC, Mouchati C, et al. The protective effect of coronavirus disease 2019 (COVID-19) vaccination on postacute sequelae of COVID-19: a multicenter study from a large national health research network. *Open Forum Infect Dis.* 2022;9(7). doi:10.1093/ofid/ofac228
37. Senjam SS, Goel G, Lomi N, et al. Can self-reported symptoms be relied on for COVID-19 screening in low-resource settings? *COVID.* 2025;5(2):15. doi:10.3390/covid5020015
38. Nomura S, Yoneoka D, Shi S, et al. An assessment of self-reported COVID-19 related symptoms of 227,898 users of a social networking service in Japan: has the regional risk changed after the declaration of the state of emergency? *Lancet Regional Health.* 2020;1:100011. doi:10.1016/j.lanwpc.2020.100011
39. Archambault PM, Rosychuk RJ, Audet M, et al. Accuracy of self-reported COVID-19 vaccination status compared with a public health vaccination registry in québec: observational diagnostic study. *JMIR Public Health Surveill.* 2023;9:e44465. doi:10.2196/44465
40. Tan JS, Liu -N-N, Guo -T-T, et al. Genetic predisposition to COVID-19 may increase the risk of hypertension disorders in pregnancy: a two-sample Mendelian randomization study. *Pregnancy Hypertens.* 2021;26:17–23. doi:10.1016/j.preghy.2021.08.112

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