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Analysis of cardiovascular and cerebral disease risk trends before and during the COVID-19 transition phase in Golestan province

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Abstract

Objective Morbidity and mortality caused by cardiovascular and cerebrovascular diseases are increasing worldwide. This study aimed to analyze the factors affecting the risk assessment of cardiovascular and cerebrovascular diseases before COVID-19 and during the COVID-19 transition phase.

Results Among 132,305 individuals (mean age: 50.11 ± 12.21 years), 65.84% were women. Regression analysis indicated that age, overweight, smoking, diabetes, hypertension, and high cholesterol significantly increased 10-year cardiovascular disease risk ($p < 0.001$). No significant trend in risk levels was found between pre-COVID-19 and COVID-19 transition periods ($p = 0.063$). Given the impact of these factors, national-level planning, appropriate policies, and intersectoral coordination are essential to reduce cardiovascular and cerebrovascular risk.

Keywords Risk assessment, Cardiovascular diseases, Non-infectious, Patients

Introduction

The twentieth century marked an epidemiological shift from communicable to non-communicable diseases [1, 2]. Today, non-communicable diseases are a major cause of global mortality [3]. accounting for approximately 71% of all deaths worldwide—over 41 million annually. Cardiovascular diseases, cancers, hypertension, and diabetes, along with key risk factors such as poor diet, physical inactivity, smoking, and alcohol use, are leading contributors to this burden [4]. Their prevalence is linked to modernization, urbanization, lifestyle changes, and unhealthy dietary habits [5]. In a 10-year CVD risk study in Malaysia using the GLOBORISK model, Nawi et al. found the northern region had the highest risk due to elevated rates of diabetes, hypertension, hypercholesterolemia, and smoking [6].

In a 10-year CVD risk study in Malaysia using the GLOBORISK model, Nawi et al. found the northern region had the highest risk due to elevated rates of diabetes, hypertension, hypercholesterolemia, and smoking [7, 8]. n Iran, disease patterns have shifted from infectious to non-infectious diseases, influenced by improved health conditions, socio-economic changes, and unplanned urbanization [9], Meanwhile, the emergence

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of COVID-19 in late 2019 quickly spread worldwide [10]. In response, healthcare resources were redirected to control transmission, resulting in a halt in follow-up care for stable patients with diabetes and hypertension [11].

Several studies have addressed NCD surveillance during COVID-19. Akrami et al. highlighted service disruptions and recommended revising COVID-19 guidelines to prioritize NCD prevention. Similarly, Afkar et al. showed the pandemic significantly impacted NCD management in Iran's primary care system [12]. Wattanapisit et al. also reported changes in patients' self-care practices [13]. Many patients lost access to routine care, and healthcare worker surveys confirmed a decline in clinic visits for NCDs [14–16]. Dehghani et al. found a significant drop in hypertension and diabetes patient visits during the year following the outbreak [17]. Al-Qudimat et al. emphasized the pandemic's role in advancing telemedicine and virtual care to improve education and reduce exposure risk [18].

Risk assessment is a practical solution for preventing and controlling cardiovascular and cerebrovascular risk factors. It estimates the 10-year probability of such events [19]; sing models like Framingham, ACC, SCORE, ASSIGN, Q RISK, and GLOBORISK [20]. In Iran, the WHO/ISH risk chart for the Eastern Mediterranean Region B is applied [21]. Given the emergence of COVID-19, the growing burden of NCDs, and the limited data in this field, this study aimed to analyze cardiovascular and cerebrovascular disease risk assessment before and after COVID-19 in Golestan province.

Materials and methods

This study is a cross-sectional (descriptive-analytical) study approved by the Ethics Committee of Azad University, Sari Branch, under no. IR.IAU.SARI.REC.1401.123. After obtaining the required permissions, we introduced the researchers to Gorgan University of Medical Sciences. The study population included 132,305 individuals from five cities in Golestan Province (Aqqala, Ramiyan, Gorgan, Gomishan, and Gonbad-e Kavus) whose risk assessment data were recorded in the NAB health information system between 2019 and 2023.

Sampling grouped cities into three regions (east, west, center):

- West: Gomishan and Aqqala (selected via lottery).
- East: Ramiyan and Gonbad-e Kavus.
- Center: Gorgan.

Data for individuals aged ≥ 30 years were extracted from NAB, focusing on inclusion criteria: risk assessment during 2019–2023, age ≥ 30, and ≥ 1 risk factor (diabetes, hypertension, waist circumference ≥ 91 cm, age > 41, smoking, alcohol use, family history of diabetes/kidney disease, or early cardiovascular events). A checklist was used to gather the relevant data on these variables, which was designed by the researchers. Exclusion criteria: confirmed cardiovascular disease, prior heart attack/stroke, or incomplete data.

The 10-year risk of fatal or non-fatal heart and cerebral strokes was calculated using the cardiovascular risk chart, based on diabetes status, sex, smoking, age, systolic blood pressure (mmHg), and total cholesterol. Participants were stratified into four risk groups: <10% (low/green), 10–20% (moderate/yellow), 20–30% (high/orange), and ≥ 30% (very high/red). A risk below 10% indicates a less than 10% probability of heart attack or stroke in the next decade, while higher-risk individuals were referred for further evaluation and treatment [21].

For analysis, the four-category risk variable was dichotomized for simplicity into "no risk" (< 10%) and "at risk" (> 10%) to facilitate interpretation.

Data were analyzed in SPSS20 using descriptive statistics (mean ± SD, frequencies) and regression models (univariate/multivariate) to identify predictors of risk. The Armitage trend test assessed temporal changes in risk distribution, with significance set at $p \leq 0.05$.

Result

Out of 132,305 individuals assessed between 2019 and 2023, the highest numbers were recorded in 2022 (50,644; 38.28%) and 2023 (42,778; 32.33%). The mean age was 50.11 ± 12.21 years. In terms of risk level, 124,812 (94.33%) had < 10% risk, while 5,451 (4.12%), 1,080 (0.82%), and 962 (0.73%) had risk levels of 10–19%, 20–29%, and ≥ 30%, respectively.

Among participants, 87,103 (65.84%) were women, 87,164 (65.88%) lived in rural areas, and 114,873 (86.82%) were married. A total of 5,164 (3.9%) reported smoking (Table 1).

A history of diabetes, high blood pressure, and cardiovascular diseases was present in 16,520 (12.49%), 25,442 (19.23%), and 517 (0.39%) individuals, respectively. Based on BMI, 49,116 (37.12%) were overweight. During risk assessment, 6,241 (4.72%) had first-stage and 1,368 (1.03%) had second-stage hypertension. Mean systolic and diastolic pressures were 115.05 ± 13.23 and 69.96 ± 9.02 mm Hg, respectively. A total of 6,789 (5.13%) individuals had high blood cholesterol (Table 2).

Using univariate regression, it was found that the risk of cardiovascular and cerebrovascular diseases increased by 1.11 times per year of age, and male gender increased the risk by 1.06 times compared to females. Interestingly, overweight and obesity were associated with a lower risk (OR = 0.89) over ten years.

In multivariable regression, significant odds ratios were observed for: age (1.10), urban residence (1.39), smoking (4.42), hypertension (1.75), diabetes (4.41), and high

Table 1 Demographic information of risk-assessed people in selected cities of Golestan Province during 2019–2023

Variable	Sub-groups	Frequency	Frequency Percentage	Cumulative percentage	Mean (SD)	Min	Max
Gender	**Female**	87,103	65.84	65.84	-	-	-
	Male	45.202	34.16	100			
Age group	**30–45**	55,328	41.82	41.82	50.11 ± 12.21	30	99
	46–60	45,863	34.66	76.48			
	61–75	28,567	21.59	98.07			
	> 75	2547	1.93	100			
Residence	**Rural**	87,164	65.88	65.88	-	-	-
	Urban	45,141	34.12	100			
Marital status	**Single**	3886	2.94	2.94	-	-	-
	Married	114,873	86.82	89.76			
	Divorced/Separated	2102	1.59	91.35			
	Widowed	11,444	8.65	100			
Smoking status	**Smoker**	5164	3.90	3.90	-	-	-
	Not smoker	127,141	96.10	100			

Table 2 Medical and paraclinical information of risk-assessed people in selected cities of Golestan Province during 2019–2023

Variable	Sub-groups	Frequency	Frequency percentage	Mean (SD)	Min	Max
Waist circumference (Cm)	< 90	45,986	34.76	94.26 ± 11.06	71	143
	≥ 90	86,319	65.24			
BMI	Underweight < 18.5	4319	3.26			
	Normal (18.5–24.9)	34,074	25.75			
	Overweight (25-29.9)	49,116	37.12			
	Obesity I (30-34.9)	31,520	23.82			
	Obesity II (35-39.9)	10,908	8.24			
	Obesity III (≥ 40)	2368	1.79			
Diabetes	Yes	16,520	12.49	106.08 ± 40.41	52	506
	No	115,785	87.51			
Hypertension	Yes	25,442	19.23	-	-	-
	No	106,863	80.77			
Cardiovascular disease	Yes	517	0.39	-	-	-
	No	131,788	99.61			
Systolic blood pressure (mmHg)	Normal (< 120)	76,669	56.44	115.05 ± 23.13	60	250
	Pre-HTN (120–139)	50,027	37.81			
	Stage I HTN (140–159)	6241	4.72			
	Stage II HTN (≥ 160)	1368	1.03			
Diastolic blood pressure (mmHg)	Normal (< 80)	97,179	73.45	69.96 ± 9.02	35	150
	Pre-HTN (80–89)	30,433	23.00			
	Stage I HTN (90–99)	3537	2.67			
	Stage II HTN (≥ 100)	1156	0.87			
Cholesterol level	Normal (< 200)	106,854	80.76	167.91 ± 50.17	41	680
	Intermediate (200–239)	18,662	14.11			
	High (≥ 240)	6789	5.13			
History of DM in first-degree relatives	Yes	3213	2.43	-	-	
	No	129,092	97.57			
History of CVD in first-degree relatives	Yes	2951	2.23	-	-	
	No	129.354	97.77			

cholesterol (1.83) ($p < 0.001$). No significant associations were found for gender, BMI, or waist circumference.

The risk trend from 2019 to 2023 showed that the 10–19% risk group was 10.28% in 2019, then remained almost stable, fluctuating between 3.5% and 3.37%. The 20–29% risk level was 3.23% in 2019, decreasing to 0.40–0.45% by 2023. Similarly, the ≥ 30% risk group declined from 5.43% in 2019 to 3.37% in 2023. However, according to the Cochran-Armitage Trend Test, none of these changes were statistically significant ($p = 0.063$).

Table 3 Risk factors of ten-year cardiovascular diseases in risk-assessed people of selected cities during 2019–2023 using logistic regression

Variable	Number	Univariate analysis		Multivariate analysis	
		OR (95%CI)	*P*-value	OR (95%CI)	*P*-value
Age	132,305	1.11(1.10–1.11)	< 0.001	1.10(1.9–1.10)	< 0.001
Gender					
Female	87,103	reference			
Male	45,202	1.06(1.01–1.11)	0.011	1.00(0.95–1.06)	0.787
BMI					
Underweight and normal	4139	reference			
Overweight and obesity	128,166	0.89(0.87–0.91)	< 0.001	0.97(0.90–1.06)	0.227
Residence					
Rural	87,164	reference			
Urban	45,141	1.29(1.23–1.36)	< 0.001	1.39(1.32–1.46)	< 0.001
Smoking					
No	127,141	reference			
Yes	5164	3.00(2.77–3.26)	< 0.001	4.42(4.20–4.86)	< 0.001
Hypertension					
No	106,863	reference			
Yes	25,442	5.60(5.34–5.87)	< 0.001	1.75(1.65–1.85)	< 0.001
Diabetes					
No	115,785	reference			
Yes	16,520	7.80(7.43–8.19)	< 0.001	4.41(4.17–4.66)	< 0.001
High cholesterol					
Normal	106,854	reference			
Intermediate/high	25,451	1.86(1.80–1.93)	0.001	1.83(1.76–1.90)	< 0.001
Waist Circumference					
Less than 90 cm	45,986	reference			
90 cm and higher	86,319	0.92(0.87–0.96)	0.001	0.95(0.89-1.00)	0.100

Discussion

The study identified age, urbanization, smoking, hypertension, diabetes, and high cholesterol as significant predictors of 10-year cardiovascular/cerebrovascular risk. Conversely, gender, BMI, and waist circumference showed no significant association. No temporal trend in risk levels was observed between 2019 and 2023 (pre- and post-COVID-19 transition period).

Concerning determining the risk level based on the age of the risk-assessed people, the results of the study showed that for every one year of age increase, the chance of cardiovascular and cerebrovascular diseases increases 1.10 times, in a study that Kjeldsen and colleagues [22] have done, age above 55 years for men and above 65 years for women is associated with a higher risk of cardiovascular diseases, and in the study of Wang et al. [23] it was also shown that the risk of cardiovascular diseases increase with increasing age in people with high blood pressure. It was also shown in the study of Elmiladi et al. [24] that increasing age in diabetic patients is associated with an increase in the occurrence of cardiovascular diseases. In line with the results of the present study, it was shown in the study of Jahani et al. [21] that age is a predictor of the risk level of cardiovascular diseases. After adjusting the effect of other variables, for every one year of age increase, the risk of cardiovascular and cerebrovascular diseases increases 1.15 times. Although aging is one of the unmodifiable factors of cardiovascular and cerebrovascular diseases, primary healthcare providers can postpone and decrease these events by necessary interventions such as education on healthy diet, smoking cessation, and adequate physical activity.

The results of the study showed that there was no significant relationship between gender and risk of cardiovascular and cerebrovascular diseases. In the study by Booth et al. [25], it was shown that the risk of cardiovascular diseases in men with diabetes (HR = 1.22) is higher than in women; in the study by Aalst et al. [26], men compared with women were at a higher risk level for cardiovascular disease. Kjeldsen et al. [22] observed that the male gender is one of the important factors in the occurrence of cardiovascular diseases. The disparity with the present study may be due to the difference between the two studied populations. In Kjeldsen's study, it was shown that the average age of the participants in the study was much lower than the average in the present study. However, the study of Elmiladi et al. [24] showed that gender is not a determining factor for the occurrence of cardiovascular diseases. In another study conducted by Nakhaie et al. [27], it was shown that the male gender had been associated with a higher risk of cardiovascular events in the next 10 years, while Darabi et al.'s study [28] showed that 38.3% of men and 61.72% of women were at a risk level of 10–20% and 34.8% of men and 65.2% of women were at a risk level of 20–30%, 28.9% of men and 71.1% of women were at a risk level above 30%, showing that women are at a higher risk level than men. It seems that these contradictions are due to the region's lifestyle and the culture of the studied population.

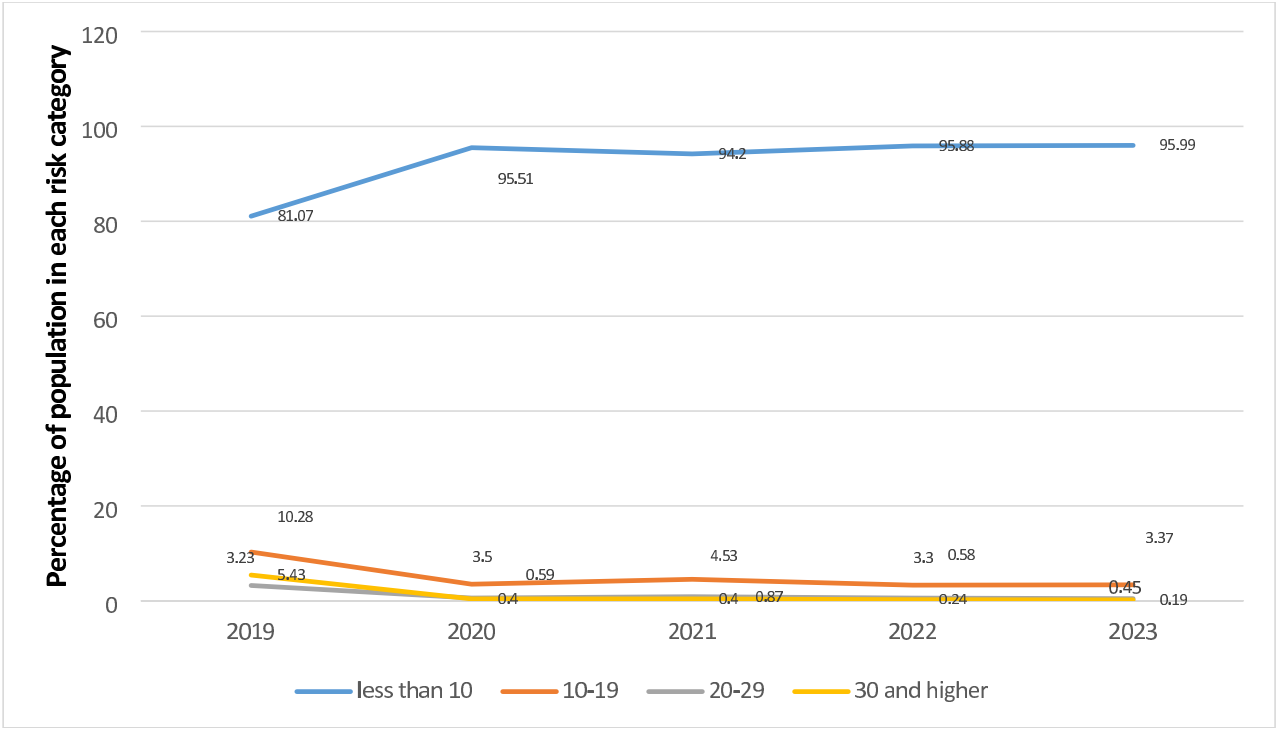

Chart 1 The trend chart of the risk levels of cardiovascular diseases in the next ten years in risk-assessed people during the years 2019–2023

In terms of determining the level of risk in risk-assessed people based on body mass index, the findings of the study showed that body mass index did not affect the occurrence of cardiovascular and cerebrovascular diseases. In Wang's study [29], it was shown that people with high blood pressure, overweight, and obesity have 1.3 and 1.51 times the risk of cardiovascular disease, respectively; The differences may arise from variations in sample population characteristics, study settings, and methodologies. For instance, our study population predominantly consisted of individuals from rural areas with limited healthcare access, potentially influencing outcomes. The inverse association between BMI and cardiovascular/cerebrovascular disease risk observed in univariate analysis may be explained by the phenomenon known as the 'obesity paradox' [30, 31]. While elevated BMI is a well-known risk factor for cardiovascular disease, several studies have reported that overweight or mildly obese individuals may exhibit lower mortality or morbidity under certain clinical conditions. This paradox has been attributed to factors such as reverse causation, measurement limitations of BMI, and unmeasured confounding.

About the effect of the cholesterol level on cardiovascular and cerebral disease risk, it was observed that people with high cholesterol were 1.83 times more at risk. Abdelhafez et al. [32] showed that a higher-than-normal level of cholesterol in patients with diabetes increases the risk of death from cardiovascular diseases compared to non-diabetic people. Perhaps the apparent reason for the increased risk in Stemler's study is that the risk-assessed people had diabetes, which can increase the risk of cardiovascular disease. Franklin et al. [33] also concluded that the risk of cardiovascular diseases increases in hypertensive patients with increased cholesterol levels. Also, in the study of Jahani et al. [21], they concluded that high cholesterol increases the risk of cardiovascular and cerebrovascular diseases 7.37 times compared to healthy people in terms of cholesterol levels. Although it was in line with the results of the present study, it had a Stronger association than ours. In the study of Hansen et al. [34], high blood cholesterol had a statistically significant relationship with the increased risk of heart attack at a younger age.

In relation to the status of smoking and its effect on the incidence of cardiovascular and cerebrovascular diseases, it was shown that the odds ratio for smokers was 4.42 times. In the study of Usman et al. [35], it was also shown that the risk of heart attack increases 4 times in men and 6 times in women compared to non-smokers. Also, Qin et al. [36], in a meta-analysis study, showed that in patients with diabetes, the relative risk of smokers compared to non-smokers for death from cardiovascular diseases is 1.36. For the occurrence of events related to coronary artery diseases, it is 1.54; for the occurrence of stroke, it is 1.44; and for Myocardial infarction, it is 1.52.

The study of Derakhshan et al. [37] showed that 8.7% of smokers had a CVD risk of 10% or higher; since the

target index in this study was not an odds ratio, it cannot be judged whether this risk percentage was significant.

The COVID-19 transition period in our study refers to the phase from mid-2021 to late 2022, marked by declining case numbers and the easing of restrictions. Our analysis showed no significant trend in risk assessment levels from 2019 to 2023, with no difference between the pre-pandemic and transition periods. This contrasts with Isfahani et al. [11], who found that during the pandemic, most non-communicable disease services were suspended, and care shifted to phone consultations. The difference may be due to our study comparing pre-pandemic data with COVID-19 transition data, while Isfahani et al. focused on a specific part of that period. Similarly, Finney et al. [38] reported a 30% decrease in non-communicable disease care in England compared to the pre-pandemic period, with hypertension care dropping by 22% in the first year of the pandemic. Their study, however, only compared data from one year before and one year after the pandemic, excluding the transition years.

Study limitations

One limitation of this study is that the risk assessment program began in early 2019, so no prior data exist to evaluate earlier trends. Additionally, diet and physical activity, two key factors in preventing cardiovascular diseases, were not included in the program, thus their effects could not be assessed.

Conclusion

The study found no significant trend in the risk levels of non-communicable diseases before and during the COVID-19 transition years. It also highlighted the impact of various risk factors on cardiovascular disease risk assessment. Despite this, the risk assessment program alone has not been effective in reducing cardiovascular disease risk factors. To address this, more precise national planning and improved policies, along with better coordination among health institutions and the use of appropriate technology, are necessary to reduce the occurrence and spread of cardiovascular and cerebrovascular disease risk factors.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13104-025-07283-3.

Supplementary Material 1

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Author contributions

MA.J, S.S, Gh.M and M.Gh were the principal investigators and designed the study. M.Gh searched literature. MA.J and S.S supported the interview development. S-A.S and A-R.M collected data and prepared data for qualitative analyses. MA.J and Gh.M supervised data collection. S-N.H analyzed data. S-A.S and A-R.M drafted the manuscript and both MA.J and Gh.M supported drafting the manuscript. All authors have provided comments and critical revisions to the manuscript. All authors approved the final manuscript prior to submission.

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Data availability

The data set is available upon request from the corresponding author. Ghahraman48@yahoo.com.

Declarations

Ethical approval and consent to participate

The study was approved by the Ethics Committee of Azad University, Sari Branch, no. (IR.IAU.SARI.REC.1401.123). the researcher was introduced to Gorgan University of Medical Sciences. Informed consent was obtained from the participants. Consent to participate was written. This research followed the ethical guidelines of the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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