

# Ambient temperature and ruptured abdominal aortic aneurism: a retrospective study from Bosnia and Herzegovina

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## ABSTRACT

**Aim** Ruptured abdominal aortic aneurysm (RAAA) is a life-threatening emergency with high mortality. While conventional risk factors are well recognized, emerging evidence suggests environmental temperature may also influence rupture risk. This relationship has not been studied in Bosnia and Herzegovina. The aim of this study is to investigate the association between ambient temperature and RAAA prevalence.

**Methods** A retrospective observational study was conducted at the Clinical Center of the University of Sarajevo between January 2021 and February 2025. Data from 105 RAAA patients were analyzed using demographic, clinical, and temperature data, with time series analysis assessing patterns around rupture events.

**Results** The mean patient age was 71.5±7.6 years; 91 (86.7%) were male. The average aneurysm diameter was 85.1±17.7 mm. Hypertension (68.6%), smoking (55.2%), and diabetes (37.7%) were the most prevalent comorbidities. The mortality rate was 38.7% (40 patients). Most ruptures occurred during colder months, with a peak in January (16.1%) and a low in August, March, and February (each 4.7%). The mean ambient temperature during the 10 days before rupture was 11.41± 6.16 °C, not significantly different from the temperature on the rupture day ( $p=0.991$ ). However, minimum daily temperature was significantly lower than the mean daily temperature on rupture days (6.48±5.92 °C vs. 11.42±17.61 °C;  $p < 0.001$ ).

**Conclusion** A seasonal RAAA pattern with winter clustering was observed, but no consistent short-term link to ambient temperature was found, warranting further study with advanced models.

**Keywords:** abdominal aortic aneurysm, aortic rupture, cardiovascular diseases, temperature, seasons

## INTRODUCTION

Abdominal aortic aneurysm rupture (RAAA) represents a life-threatening vascular emergency with high mortality rates, often ranging between 80% and 90% (1). While established risk factors such as age, male gender, smoking, hypertension, and aneurysm diameter are well-documented, emerging evidence suggests that environmental factors, particularly ambient temperature, may also influence the risk of rupture (2). Studies from various geographic regions have indicated seasonal and temperature-related variations in the prevalence of AAA rupture, with peaks observed during colder months or periods of sudden temperature fluctuations (3-5).

The underlying mechanisms by which temperature may influence aneurysmal rupture remain poorly understood but are

hypothesized to involve blood pressure variability, vasoconstriction, increased sympathetic activity, and inflammatory responses triggered by thermal stress (5-7). In colder temperatures, the combination of elevated systemic vascular resistance and increased arterial wall stress may contribute to a higher risk of aneurysm rupture, particularly in vulnerable patients (6,7).

Despite growing interest in the role of environmental factors in cardiovascular emergencies, the association between ambient temperature and RAAA remains insufficiently explored in many regions. No comprehensive studies to date have addressed this relationship within Bosnia and Herzegovina. Improved understanding of temperature-related influences on rupture risk may enhance clinical risk stratification and support more effective allocation of healthcare resources—particularly in settings with limited access to specialized vascular care and emergency surgical services.

The aim of this study was to investigate the relationship between ambient temperature and the prevalence of RAAA in Bosnia and Herzegovina, using retrospective clinical data and meteorological records. By identifying temperature-related

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patterns, we seek to contribute to the broader understanding of environmental determinants in cardiovascular emergencies and offer insights for improved patient care and seasonal preparedness.

## PATIENTS AND METHODS

### Patients and study design

This retrospective, observational study conducted to evaluate the association between ambient temperature and the prevalence of RAAA in Bosnia and Herzegovina at the Department for Cardiovascular surgery of the Clinical Center of the University of Sarajevo between January 2021 and February 2025. Inclusion criteria were: patients aged 18 years or older, and patients with a confirmed diagnosis of RAAA established through computed tomography. Exclusion criteria included traumatic aortic injury, thoracic aortic aneurysms, and incomplete clinical or admission data.

### Methods

Patient data were retrospectively extracted from hospital medical records and included demographic information (age, gender), relevant cardiovascular risk factors and comorbidities such as arterial hypertension, coronary artery disease, diabetes mellitus, chronic kidney disease, and active or former smoking status. In addition, data on the clinical presentation, hemodynamic status on admission, date and time of hospital admission, CT imaging findings, surgical intervention (if applicable), and in-hospital outcome (including mortality) were collected.

The date of RAAA was defined as the documented date of acute symptom onset or the date of emergency medical presentation, depending on the available clinical documentation. Meteorological data were obtained from the official records of the Federal Hydrometeorological Institute of Bosnia and Herzegovina. For the duration of the study period, daily meteorological variables including mean, minimum, and maximum ambient temperatures were recorded for each calendar day. For every included patient, the corresponding temperature values on the date of rupture were extracted. To assess potential delayed or cumulative effects of ambient temperature on aneurysm rupture risk, lagged temperature exposures from 1 to 10 days prior to the event were also analyzed. Temperature data were matched by geographic location of the hospital or patient residence, where available, to ensure regional accuracy.

### Statistical analysis

Descriptive statistics were used to summarize patient demographics and clinical characteristics. Categorical variables were expressed as frequencies and percentages, and continuous variables as mean  $\pm$  standard deviation (SD) or median with interquartile range, depending on distribution. Normality of the data was evaluated using Kolmogorov-Smirnov tests, and the t-tests were applied only when the assumption of normal distribution was satisfied. The association between ambient temperature and RAAA prevalence was evaluated using time-series analysis and Poisson regression models, adjusted for day of the week, seasonality, and long-term trends. Additional subgroup analyses were performed based on age, gender, and comorbidities. A  $p < 0.05$  was considered statistically significant.

## RESULTS

A total of 105 patients were included in the study. The cohort was predominantly male, 91 (86.7%), and the majority were residents of Sarajevo, 62 (59.0%). Arterial hypertension was the most common comorbidity, present in 72 (68.6%), followed by diabetes mellitus in 40 (37.7%) and chronic kidney disease in 23 (21.9%) patients. The mean age of patients was  $71.5 \pm 7.6$  years, with an age range of 54 to 88 years. The mean maximum diameter of the abdominal aortic aneurysms was  $85.1 \pm 17.7$  mm, ranging from 50 mm to 137 mm (Table 1).

**Table 1. Demographic, clinical characteristics, postoperative complications and surgery outcome of patients with ruptured abdominal aorta (RAAA) in the period 2022-2024**

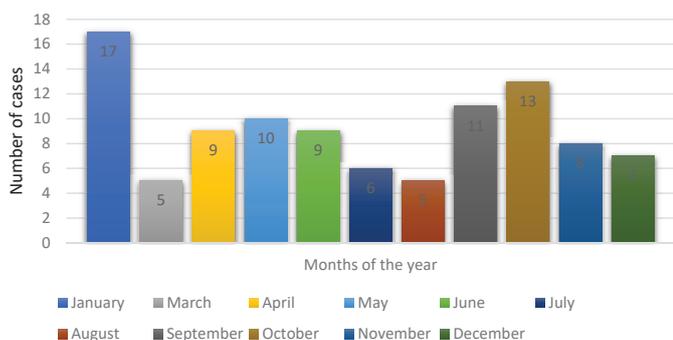
Variable	Mean $\pm$ SD	
Age (years)	71.5 $\pm$ 7.6	
	<b>No (%) of patients</b>	
Gender	Male	91 (86.7)
	Female	14 (13.3)
Place of residence	Sarajevo	62 (59.0)
	Zenica	19 (18.1)
	Mostar	2 (1.9)
	Travnik	23 (21.0)
Comorbidities	Hypertension	72 (68.6)
	DM	40 (37.7)
	CKD	23 (21.9)
	Smoking	58 (55.2)
	Dyslipidemia	33 (31.4)
Onset of symptoms of RAAA	< 6 hours	50 (47.6)
	>6 hours	55 (52.4)
Postoperative complications	47 (44.3)	
Surgery outcome	Recovered	65 (61.3)
	Death	40 (38.7)
	<b>Mean <math>\pm</math> SD</b>	
Abdominal aneurysm diameter (mm)	85.1 $\pm$ 17.7	

DM, diabetes mellitus; CKD, chronic kidney disease; CAD, coronary artery disease;

At the time of presentation, 50 (47.6%) patients reported symptom onset within less than six hours, while 55 (52.4%) presented more than six hours after the onset of symptoms. Postoperative complications were documented in 47 (44.3%), whereas 58 (55.7%) patients had no reported complications. Regarding surgical outcome, 65 (61.3%) patients survived and were discharged in stable condition, while 40 (38.7%) experienced death.

The highest rate of ruptures was in January, 17 (16.1%) and the lowest in February, March and August, 5 (4.7%). The rate was highest in autumn and winter and (September-February), and lowest in summer (June-August) (Figure 1).

According to the data obtained from the national meteorological registry, the mean ambient temperature during the overall observation period was  $11.42 \pm 8.08$  °C, with recorded values ranging from  $-0.3$  °C to  $29.8$  °C. The mean temperature during the 10 days preceding aneurysm rupture was  $11.41 \pm 6.16$  °C (range:  $1.76$ – $25.8$  °C). No statistically significant difference



**Figure 1. Monthly number of ruptured abdominal aorta (RAAA) (N=105)**

between the mean temperature during the 10-day pre-rupture period ( $p=0.991$ ) compared to the rupture day. However, when evaluating the temperature characteristics specifically on the day of rupture, a statistically significant difference was observed between the minimum daily temperature ( $6.48\pm 5.92$  °C) and the corresponding daily mean temperature ( $11.42\pm 17.61$  °C) ( $p<0.0019$ ). In contrast, no significant difference was found between the mean monthly temperature ( $10.91\pm 7.20$  °C) and the daily mean temperature on the day of rupture ( $11.42\pm 17.61$  °C;  $p = 0.342$ ). (Table 2)

**Table 2. Ambient temperature parameters and comparative analysis related to aneurysm rupture timing**

Temperature parameter	Mean±SD (°C)	Range (°C)	Comparison	p
Overall observation period	11.42±8.08	-0.3 - 29.8		-
10 days preceding aneurysm rupture	11.41±6.16	1.76 - 25.8	Day of rupture vs. 10-day pre-rupture mean	0.991
Day of rupture – minimum daily temperature on the day of rupture	6.48±5.92	-0.1 - 19.3	Minimum daily vs. daily mean temperature	<0.001
Day of rupture – daily mean	11.42±8.08	0.5 - 27.6	Daily mean vs. mean monthly temperature	0.342

**DISCUSSION**

This study examined the clinical characteristics, seasonal distribution, and potential environmental influences on RAAA in a patient cohort from Bosnia and Herzegovina. The findings confirm well-established demographic and clinical patterns, while also contributing region-specific insights to the ongoing debate regarding the impact of ambient temperature on vascular emergencies.

Consistent with global data, the majority of patients in this study were older males, reflecting the recognized demographic profile for AAA development and rupture (8,9). The predominance of arterial hypertension and smoking as comorbidities aligns with international research, which consistently identifies these factors as key contributors to aneurysmal disease (10,11). Although diabetes mellitus was also present in a substantial proportion of patients, its role in aneurysm pathophysiology remains complex, with some studies suggesting a protective effect against rupture (12).

The mortality rate associated with RAAA in this cohort remained high, echoing outcomes reported in emergency vascu-

lar surgery worldwide (9,10). The challenge of timely diagnosis and surgical intervention, particularly in regions with limited vascular surgery infrastructure, may partly explain the observed outcome. Similar trends have been observed in other low- and middle-income countries, where delayed presentation and transfer times remain significant barriers to survival (13-15).

Seasonal variation in RAAA prevalence was evident, with clustering of cases in colder months, particularly during winter. This pattern has been reported in several international studies, including those from Europe and Asia, which have hypothesized that colder temperatures may act as a physiological stressor by increasing sympathetic tone and arterial pressure, thereby precipitating rupture in vulnerable aneurysms (16-19). While some researchers have suggested a clear winter peak, others have observed more variable patterns, possibly influenced by regional climate and healthcare access (19).

With respect to ambient temperature, this study did not identify a statistically significant relationship between the mean temperature on the day of rupture and in the days preceding the event. This finding is in contrast to studies (3-5) from countries with more pronounced seasonal shifts, where associations between cold weather and increased RAAA prevalence have been reported. Our findings are in line with those from Germany (20), where no significant association between ambient temperature or atmospheric pressure and the incidence of RAAA in a Mid-European population was reported. Similarly, we found no statistically significant differences between the mean temperature on the day of rupture and the preceding days. This convergence of findings across different European settings suggests that, in certain temperate regions, short-term fluctuations in temperature may not exert a strong or direct effect on aneurysm rupture risk (18-20). Some studies may reflect shared methodological constraints, particularly the limited sample size and reliance on basic statistical comparisons, such as t-tests, which may lack the sensitivity to detect subtle or delayed environmental effects (19,20). Also it was found that environmental variables such as temperature and pressure do not significantly influence RAAA prevalence in Germany, supporting the idea that local climate characteristics or patient profiles might mediate environmental impacts (20). While other international studies (3-5) utilizing time-series and distributed lag non-linear models have demonstrated associations between cold weather and increased rupture risk, especially in regions with more extreme seasonal variation, our results and those from Mid-European Region (20) emphasize the need for region-specific analyses and advanced modeling techniques. Future research incorporating larger multicenter cohorts and sophisticated temporal models may help clarify whether the lack of association in our and a study from Mid-European Region (20) reflects true absence of effect or insufficient analytical power.

A limitation of the study was that it examined only temperature as a factor. Future research should also consider other environmental elements, such as noise level and access to green spaces, which may affect heart and blood vessel health.

In conclusion, while this study supports known demographic and clinical characteristics of RAAA and suggests a possible seasonal trend, it does not provide conclusive evidence of temperature as a short-term trigger. Nonetheless, it offers valuable baseline data for Bosnia and Herzegovina and underscores the need for larger, multi-center studies utilizing advanced epidemiological methods to better understand environmental influ-

ences on vascular emergencies. These findings could inform future risk prediction models and support seasonal planning in vascular surgery services.

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## TRANSPARENCY DECLARATION

Conflicts of interest: None to declare.