

## ORIGINAL

# Frequency and risk factors for the development of ventricular arrhythmias after acute myocardial infarction –cross-sectional study

*Frecuencia y factores de riesgo para el desarrollo de arritmias ventriculares después del infarto agudo de miocardio – estudio transversal*

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**Abstract**

**Objectives:** Ventricular arrhythmias (VA) are the most common cause of sudden cardiac death in the period after an acute myocardial infarction (AMI), i.e. due to myocardial ischemia. The aim of this study was to analyze the frequency of ventricular tachycardia (VT) and ventricular fibrillation (VF) in patients treated for AMI, as well as to determine which factors increase the risk of these arrhythmias.

**Methods:** This is a retrospective of cross-sectional study. The data used here are from the database of the Clinical Information System from Clinic for Cardiology, University Clinical Centre of the Republic of Srpska, from 2020. Patients with a diagnosis of AMI were taken into account, and data on the occurrence of ventricular arrhythmias, percentage of ejection fraction, Killip class, comorbidities, socio-epidemiological data, and complications within the one year that the patients were under observation were taken from the medical records.

**Results:** During hospitalization, VT was significantly more common in overweight patients, in patients with a low ejection fraction (EF%) and a Killip class higher than 1. The results were similar during the one-year observation of the patients, with the exception that in the period of observation it was found that both older patients and those with multivessel heart disease are statistically significantly more prone to developing ventricular arrhythmias. AMI of the posterior wall showed a higher risk for developing complications.

**Conclusions:** The results showed that the frequency of VA after AMI is 11.26% and age, posterior localization of infarction, obesity, left ventricular function and Killip class significantly determine the tendency for patients to develop malignant arrhythmias immediately after AMI and during one year of observation.

**Key words:** Ventricular arrhythmias, ventricular tachycardia, acute myocardial infarction, risk factors, ventricular fibrillation.

**Resumen**

**Objetivos:** Las arritmias ventriculares (AV) son la causa más común de muerte súbita cardíaca en el período posterior a un infarto agudo de miocardio (IAM), es decir, debido a isquemia miocárdica. El objetivo de este estudio fue analizar la frecuencia de taquicardia ventricular (TV) y fibrilación ventricular (FV) en pacientes tratados por IAM, así como determinar qué factores aumentan el riesgo de estas arritmias.

**Métodos:** Se trata de un estudio retrospectivo de corte transversal. Los datos utilizados aquí provienen de la base de datos del Sistema de Información Clínica de la Clínica de Cardiología, Centro Clínico Universitario de la República de Srpska, de 2020. Se tuvieron en cuenta los pacientes con diagnóstico de IAM y los datos sobre la aparición de arritmias ventriculares. De las historias clínicas se extrajeron porcentaje de fracción de eyección, clase Killip, comorbilidades, datos socioepidemiológicos y complicaciones dentro del año que los pacientes estuvieron en observación.

**Resultados:** Durante la hospitalización, la TV fue significativamente más común en pacientes con sobrepeso, en pacientes con una fracción de eyección (FE%) baja y una clase Killip superior a 1. Los resultados fueron similares durante el año de observación de los pacientes, con la excepción que durante el período de observación se encontró que tanto los pacientes de mayor edad como aquellos con enfermedad cardíaca multivaso son estadísticamente significativamente más propensos a desarrollar arritmias ventriculares. El IAM de la pared posterior mostró un mayor riesgo de desarrollar complicaciones.

**Conclusiones:** Los resultados mostraron que la frecuencia de AV después del IAM es del 11,26% y la edad, la localización posterior del infarto, la obesidad, la función ventricular izquierda y la clase Killip determinan significativamente la tendencia de los pacientes a desarrollar arritmias malignas inmediatamente después del IAM y durante un año de observación.

**Palabras clave:** Arritmias ventriculares, taquicardia ventricular, infarto agudo de miocardio, factores de riesgo, fibrilación ventricular.

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## Introduction

One of the biggest risks that medical employees face when it comes to working with patients who have had a heart attack is the possibility of developing malignant arrhythmias. The most common cause of cardiac arrest in this population is ventricular arrhythmias - ventricular tachycardia (VT) and ventricular fibrillation (VF).

Myocardial infarction represents necrosis of the heart muscle in the field of ischemia caused by changes and narrowing of the coronary blood vessels, which lead to reduced oxygenation and nutrition of the myocardium. Myocardial ischemia represents the single greatest risk for the development of malignant arrhythmias<sup>1</sup>.

Ventricular arrhythmias are related to myocardial ischemia, and therefore, patients with coronary heart disease (CHD) and/or low ejection fraction are the most common substrate for these rhythm disorders. They are divided into sustained and non-sustained ventricular arrhythmias, depending on the duration and nature of the arrhythmia. Nowadays, when medication or mechanical revascularization of the myocardium is performed even earlier, their lethal impact in the period of hospitalization decreases, but they still remain the most common cause of post-infarction death before and during transport to the coronary unit. These rhythm disturbances often occur in the first few minutes after the development of myocardial necrosis, often even before the patient has a contact with the medical staff. The onset of VF is sudden and unpredictable, and there are only a limited number of studies that attempt to explain the nature of the onset of these arrhythmias<sup>2-4</sup>.

A greater number of studies on acute myocardial infarction (AMI) were conducted on the topic of ischemia and correction of the effect of ischemia on the myocardium, while an insufficient number of studies looked at its arrhythmogenic effect. In practice, there is a need to monitor patients with myocardial ischemia and predict the occurrence of malignant arrhythmias, as well as how to introduce the adequate antiarrhythmics in time<sup>2,3,5</sup>.

A larger number of studies were conducted with patients who underwent primary percutaneous coronary intervention with reperfusion of artery affected by stenosis (PPCI). These studies have shown unclear conclusions<sup>6-8</sup>.

It is considered that the main trigger for VA is the appearance of autonomy in borderline zones of ischemia, where there is an overload of the intracellular milieu with calcium ions and hyperkalemia extracellularly. Further maintenance of VA takes place according to the type of re-entry arrhythmias around the focus of ischemia and later around the scar tissue<sup>7,8</sup>.

The aim of this study was to determine the frequency of VT/VF in patients who were treated at the University Clinical Centre of the Republic of Srpska (UCC RS) in 2020 for AMI, as well as to investigate which factors increase the risk of these arrhythmias.

## Methods

A retrospective cross-sectional study was performed. Data were collected from all patients who were hospitalized at the Coronary Unit of the Clinic of Cardiology, UCC RS in 2020. The study was approved by the Local Ethics Committee (decision No: 01-17367-2/21). Data were collected from electronic database – Clinical Informational System. Patients with incomplete documentation were not included in the analysis.

Basic sociodemographic data (sex, age) were collected, as well as the presence of comorbidities and risk factors: tobacco smoking, obesity, diabetes mellitus, hypertension, dyslipidemia. The clinical picture and tests performed were also recorded: how much time passed from the onset of pain to first contact with the doctor, whether the symptoms were typical for ACS, maximal troponin values, lipid and electrocardiogram (ECG) on admission. The ECG recorded whether it was STEMI / NSTEMI, as well as the localization of the infarction. Complications during hospitalization were recorded and analyzed: arrhythmias, VT (as well as whether it was sustained /unsustained), VF, AF, necessity for reanimation, death. Complications were observed and recorded for one year after the onset of ACS: reinfarction, angina, episodes of VT, VF, cardiac decompensation, death.

Data were analyzed using IBM SPSS for Windows v. 16.0 software. The normality of data distribution was determined using the Kolmogorov-Smirnov test and appropriate parametric / nonparametric statistic tests were applied. Descriptive statistics consisted of expressing the data as a mean with its standard deviation (SD) and a 95% confidence interval (CI). Categorical variables were compared using the Chi-square test (Fisher exact test if one of the categories had less than 5 variables). Comparison of continual variables was performed using Student's t-test for two categories and One-way analysis of variance for several categories for parametric data, and Man-Whitney U-test, or Kruskal-Wallis test for non-parametric data. Two continuous variables were analyzed using correlations – Pearson's for parametric and Spearman's for nonparametric variables. Statistical significance was set at  $p < 0.05$ .

## Results

The mean age of the patients was  $64.45 \pm 10.50$  years (range: 28-90). Of the 222 patients, 154 (69.37%) were men and 68 (30.63%) were women (**Table I**). Women were slightly older than men (66.31: 63.63, respectively), but without significant difference ( $F: 0.114, p = 0.736$ ). The presence of comorbidities are shown in **table I**.

There were equal distribution of risk factors and comorbidities related to age and sex. There were slightly more smokers among men, but not significantly ( $p = 0.286$ ). Symptoms, clinical picture and performed test results of patients with ACS are shown in **table II**.

(**Table II** near here)

In-hospital complications were not significantly related to localization of the infarction. Frequency of arrhythmias occurrence, AF, reanimation and death, were not related to localization of the infarction ( $\chi^2 = 6.153, p = 0.725$ ;  $\chi^2 = 4.324, p = 0.889$ ;  $\chi^2 = 8.364, p = 0.498$ ; and  $\chi^2 = 11.967, p = 0.215$ , respectively). VT and VF occurred in 11.26% of patients treated for AMI. Occurrence of VT was influenced with localization of the infarction ( $\chi^2 = 33.027, p = 0.017$ ), VT was somewhat more common in patients with posterior AIM ( $\chi^2 = 5.259, p = 0.072$ ) (Data not shown).

Complications during one-year follow-up in relation to the localization of the infarction are shown in **Figure 1**.

Posterior wall myocardial infarction was associated with more frequent complications within one year after infarction. Ventricular arrhythmias ( $\chi^2 = 8.089, p = 0.010$ ), angina ( $\chi^2 = 11.983, p = 0.001$ ) and heart failure ( $\chi^2 = 6.656, p = 0.015$ ) were more common in

these patients. On the other hand, anterior wall infarction was associated with rarer complications. Within a year, ventricular arrhythmias ( $\chi^2 = 10.646, p = 0.001$ ), angina ( $\chi^2 = 6.405, p = 0.017$ ) and heart failure ( $\chi^2 = 7.836, p = 0.006$ ) were less common. Reinfarction and death within a year after infarction were not related to localization of the infarction (data not shown).

The frequency of VT / VF in relation to relevant risk factors, symptoms and clinical parameters during hospitalization and during one-year follow-up are shown in **Figures 2 and 3**.

**Table II:** Symptoms, clinical picture and results of tests performed in patients with acute myocardial infarction.

Parameter	N	%
<b>Onset time</b>		
Up to 1 h	70	31.53
1-2 h	28	12.61
2-3 h	15	6.76
3-4 h	10	4.50
More than 4 h	89	40.09
Missing	10	4.50
<b>Symptoms</b>		
Typical	196	88.29
Atypical	26	11.71
<b>ECG</b>		
STEMI	186	83.78
NSTEMI	35	15.77
<b>Infarction localization</b>		
Inferior	56	25.23
Inferoposterior	34	15.32
Inferolateral	5	2.25
Right-inferior	2	0.90
Posterior	7	3.15
Posterolateral	6	2.70
Anterior	69	31.08
Anterolateral	31	13.96
Lateral	4	1.80
Extended	4	1.80
Missing	4	1.80
<b>hsTnT</b>		
Mean $\pm$ SD	3078.04 $\pm$ 5052.45	
Range	0-37574	
Interquartile Range	3417.5	
<b>LDL</b>		
Mean $\pm$ SD	1.76 $\pm$ 1.89	
Range	0-7.10	
Interquartile Range	3.6	
<b>Coronography</b>		
No stenosis	10	4.50
One vessel	101	45.50
Two vessels	73	32.88
Three vessels	38	17.12
<b>ECHO – EF (%)</b>		
Mean $\pm$ SD	41.85 $\pm$ 10.99	
Range	5-65	
Interquartile Range	15	
<b>Killip class</b>		
1	169	76.13
2	29	13.06
3	18	8.11
4	1	0.45
Missing	5	2.25

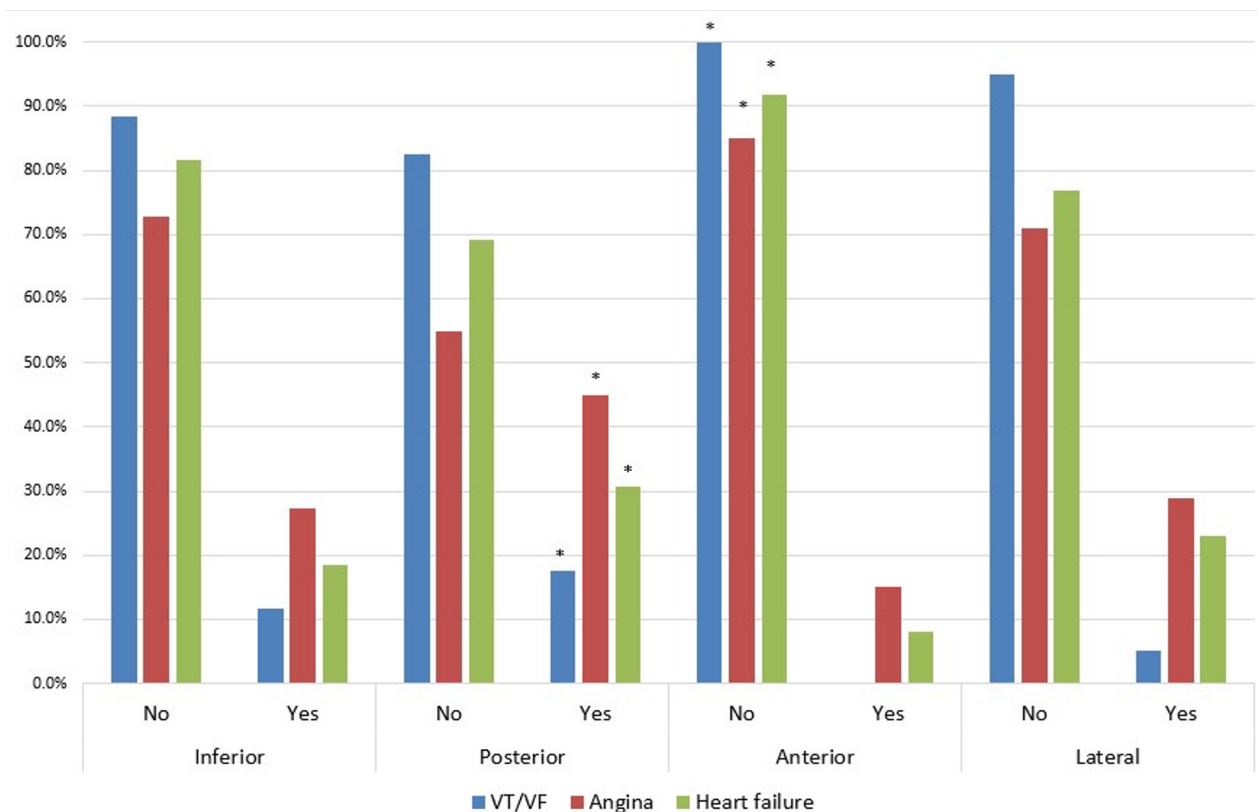
Onset time: period from first manifestation of symptoms until first contact with doctors; hsTnT: high-sensitive troponin T, normal value: < 15 pg/mL; LDL: low-density lipoprotein, normal value: 2.6 - 3.3 mmol/L; EF: ejection fraction.

**Table I:** Sociodemographic parameters and comorbidities in patients with acute myocardial infarction.

Parameter	Total	
	N	%
<b>Sex</b>		
Male	154	69.37
Female	68	30.63
<b>Age</b>		
Mean $\pm$ SD	64.45 $\pm$ 10.50	
<b>Hypertension</b>		
Yes	174	78.38
No	48	21.62
<b>Diabetes mellitus</b>		
Yes	63	28.38
No	159	71.62
<b>Obesity</b>		
Yes	21	10.40
No	181	89.60
<b>Tobacco smoking</b>		
Yes	81	36.49
No	88	39.64
Missing	53	23.87
<b>Total</b>	222	100.00

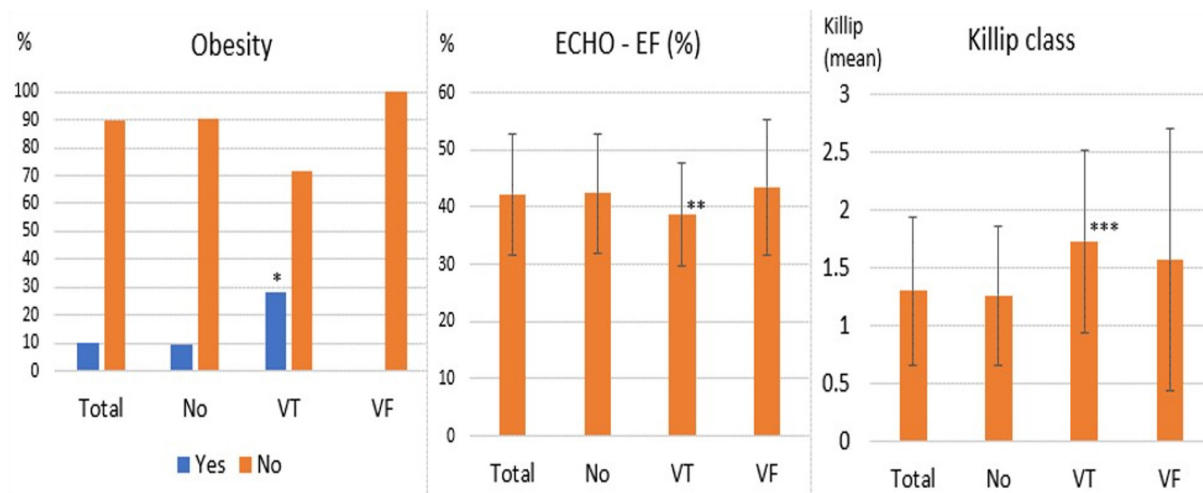
\*Obesity: body mass index more than 30 kg/m<sup>2</sup>;

Figure 1: Complications during one-year follow-up period in patients with acute coronary syndrome in relation to the localization of the infarction.



\*Statistical significance: Ventricular arrhythmias ( $\chi^2 = 8.089, p = 0.010$ ), angina ( $\chi^2 = 11.983, p = 0.001$ ) and heart failure ( $\chi^2 = 6.656, p = 0.015$ ) were more common in patients with posterior wall infarction, and less common in patients with anterior wall infarction ( $\chi^2 = 10.646, p = 0.001$ ), ( $\chi^2 = 6.405, p = 0.017$ ) and ( $\chi^2 = 7.836, p = 0.006$ ), respectively.

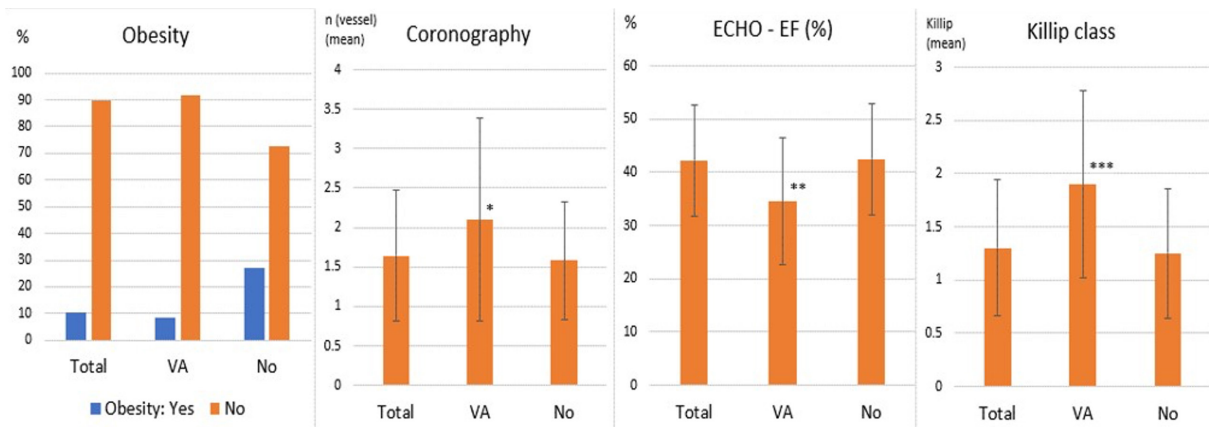
Figure 2: The frequency of VT / VF in relation to obesity, EF and Killip class during hospitalization.



\* Obese patients were significantly more likely to have VT ( $\chi^2 = 6.068, p = 0.048$ ). \*\*VT was more common in individuals who had lower EF on ultrasonography. \*\*\* VT was more common in patients with higher Killip class score.

Although VT was slightly more common in men and older and VF in women and older, the difference was not statistically significant. Obese patients were significantly more likely to have VT ( $\chi^2 = 6.068, p = 0.048$ ). Other risk factors (hypertension, diabetes mellitus, smokers) did not influence frequency of VT.

VT was more common in individuals who had lower ejection fraction (EF%) on ultrasonography (Kruskal-Wallis test:  $\chi^2 = 7.751, p = 0.021$ ) as well as higher Killip class score ( $\chi^2 = 15.880, p < 0.001$ ). Symptoms, onset time, ECG and hsTnT were not related to frequency of VT occurrence.

**Figure 3:** The frequency of VT / VF in relation to obesity, coronary angiography findings, EF and Killip class during one-year follow-up.

\*VT / VF were more common in subjects with lower EF values on ultrasonography (Man-Whitney U = 408.000, p = 0.029), higher Killip scores (U = 606.000, p = 0.005) and the presence of occlusion of multiple blood vessels on coronary angiography (U = 572.500, p = 0.017).

During one-year follow-up, the elderly were more likely to have ventricular arrhythmias (Student t-test t = 2.232, p = 0.027). VT / VF were more common in subjects with lower EF% values on ultrasonography (Man-Whitney U = 408.000, p = 0.029), higher Killip scores (U = 606.000, p = 0.005) and the presence of occlusion of multiple blood vessels on coronary angiography (U = 572.500, p = 0.017). Other parameters were without significant difference.

## Discussion

Among the data collected from 222 patients in 2020, from the Clinical Information System of the UCC RS, it was found that VT and VF occurred in 11.26% of patients treated for AMI, which is in accordance with the data obtained by experts from other world centres<sup>6-8</sup>.

The study indicated that VT/VF in hospital conditions, i.e. in the first 48 hours after the AMI itself, occur most often in cardiac arrest with posterior localization. The majority of world studies have shown that the greatest risk for early VT/VF is cardiac arrests affecting the posterior segment of the lower wall, especially the part of the myocardium around the annulus, which leads to circular movement of depolarization currents in unclear manner. In this study, there was no statistical significance in the number of sustained and unsustained VT<sup>9-11</sup>.

According to these data, patients with a lower EF% are more liable to AMI complications, especially ventricular arrhythmias. This has also been confirmed in international studies as the main factor in assessing the risk of ventricular arrhythmias post-infarction. The MADIT study (The multicenter automatic defibrillator implantation trial) proved a 5.6% reduction in mortality in patients who had an AMI, and who were preventively implanted with an ICD; the observation period was 27 months. However,

the MUSTT study indicated that EF% should not be the only argument for VA risk assessment. According to this study, other parameters should be included, such as age, degree of myocardial functionality, history of heart failure, conduction abnormalities, AF and others<sup>12-14</sup>.

When we observe the Killip class at admission, a Killip class higher than 1 represents an additional risk of developing VA. This makes sense, given that the Killip classification was introduced as a tool for rapid risk assessment in patients with AMI. This classification has proven to be an extremely useful tool, especially in countries with less developed methods and diagnostics when it comes to the health system<sup>15-17</sup>.

The estimated risk for VA according to gender showed no statistically significant difference, although VT was slightly more common in men, while VF was more common in women. International studies, as well, have not shown that gender plays a significant role as a risk factor in these arrhythmias after myocardial infarction.

Ventricular tachycardias, according to research data, more often affected the elderly population and obese patients. These data are consistent with the data obtained in some foreign studies. The MADIT II study linked overweight with an increased risk of myocardial arrhythmogenicity after AMI. However, some other studies strongly point to the so-called "obesity-paradox", where a higher body-mass index (BMI) is associated with a protective role when complications of certain chronic diseases come in question. This applies mostly to patients with low EF% and patients with AMI. It is not clear why in this particular case a higher BMI indicates a lower risk of VA, but some possible solutions have been suggested - inadequate sample, obesity is more common in younger people, more obese patients are more often on more rigorous therapeutic regimens, adipose metaplasia of coronary blood vessels, absence of ischemic cachexia<sup>18-20</sup>...

While observing the patients over a period of one year, it was shown that patients with AMI of the posterior wall were more liable to complications in terms of ventricular arrhythmias, angina pectoris and heart failure, while in patients with anterior localization of infarction, a lower risk of developing complications related to AMI. Not enough studies have been done worldwide to confirm or contradict the results of this study.

Research has showed that the degree of affected coronary blood vessels (multivessel coronary disease) represents a risk for the development of ventricular arrhythmias in the observation period of one year after hospitalization. These results are consistent with research results from around the world. This makes sense if it is known that the degree of affected myocardium and left ventricular dysfunction determine the risk for ventricular arrhythmias. Multivessel coronary disease leads to chronic ischemia of a large part of the myocardium, and to cardiac remodeling. This weakens the EF%, and increases the risk of VA<sup>2,13,15</sup>.

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## Conclusion

The main risk factor for VT is ischemia that occurs during myocardial infarction, or chronic ischemia in coronary disease, where ejection function of the myocardium is lowered significantly. The study confirmed these findings. This research indicated that patients with posterior wall infarction, higher Killip class, obese and older patients were more susceptible to ventricular arrhythmias. Creating clear list of risk factors for developing ventricular arrhythmias is still the subject of continuing research.

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## Competing interests

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