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ORIGINAL ARTICLE

Factors Associated With Paroxysmal Arrhythmias in Ambulatory ECG Monitored Patients

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Abstract

Background/Aim: Arrhythmia is a heart rhythm disorder that can appear suddenly without any symptoms and has the risk of causing other diseases and even death. This study aimed to determine predicting factors for the incidence of paroxysmal arrhythmias.

Methods: This retrospective observational cohort study used patients' medical records in the Cardiovascular Outpatient Service Unit at RSUD Budhi Asih, Jakarta, Indonesia, from 2017-2021. Based on inclusion and exclusion criteria, 406 patients were analysed. The occurrence of paroxysmal arrhythmias based on the doctor's diagnosis in medical record data was divided into paroxysmal atrial, supraventricular, ventricular and atrioventricular block (AV block) arrhythmias. Data analysis used the Chi-square test.

Results: A total of 39.4 % of patients had paroxysmal atrial arrhythmias. Factors associated with the occurrence of paroxysmal atrial arrhythmias were age, gender, smoking behaviour, comorbidities and heart-pumping ability. On the other hand, body mass index, hypertension and diabetes mellitus were shown to be significantly associated with paroxysmal supraventricular arrhythmias. Gender, smoking behaviour, diabetes mellitus, coronary heart disease, thyroid disease and heart pumping ability were predicting factors for paroxysmal ventricular arrhythmias. Meanwhile, only gender and heart disease were factors associated with paroxysmal AV block arrhythmias.

Conclusion: Sociodemographic and individual clinical conditions were associated with paroxysmal arrhythmias. However, these factors vary according to the outbreak of the arrhythmia.

Key words: Arrhythmias, cardiac; Hypertension; Diabetes mellitus; Risk factors; Comorbidity.

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Introduction

Arrhythmia, often called dysrhythmia, is a heart rhythm disorder that suddenly appears and disappears, often without the person realising it. Paroxysmal arrhythmia is a condition of abnormal heart rhythm, where the process of forming abnormal impulse conduction occurs. These conditions can be divided based on the source of the electrical impulse that causes the abnormality.[1] The American Heart Association stated that the incidence of atrial arrhythmia per 100,000 people aged 15-44 years is 20.6 and the chance increases to 1077.4 if the age is > 85 years.[2] In ad-

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dition, ventricular arrhythmias were reported in 800/100,000 residents in the United States.[3] Another study states that arrhythmias are increasing in low- and middle-income countries.[4]

Arrhythmia is one of the cardiovascular diseases that can put individuals at risk of other diseases. Arrhythmias can cause embolism, stroke, impaired contractility and sudden cardiac death.[5] Paroxysmal arrhythmias can result in impaired left ventricular function, resulting in heart failure, but the opposite condition can also result in left ventricular dysfunction.[6] A review study states that arrhythmias positively induce cardiomyopathy.[7] Arrhythmias are becoming real comorbidity in adults with congenital heart disease, impacting the use of health services and affecting survival.[1] These risks increase due to delays in diagnosis.[5] Prevention can be done with ambulatory electrocardiogram (ECG) monitoring; this action has proven to be very helpful in determining paroxysmal arrhythmias to reduce delays in diagnosis.[8]

Previous studies explain several factors that can cause paroxysmal arrhythmias, such as individual characteristics, age and gender. The incidence occurs more often in men under 40 years,[9, 10] but women are at a higher risk of experiencing recurrent episodes of arrhythmia.[11] Lifestyle also determines an individual's health condition; smoking behaviour and obesity are associated with the incidence of arrhythmias.[12, 13] On the other hand, a person's clinical condition also plays a role in causing arrhythmias, including hypertension.[14] Individuals with diabetes mellitus (DM) experience 1.5-2 times more arrhythmias compared to non-DMs.[15, 16] Decreased cardiac contractility also shows the same consequences.[17] However, previous studies examined the relationship between these factors and the occurrence of one type of paroxysmal arrhythmia.

Studies have never been carried out to determine risk factors for paroxysmal atrial, supraventricular, ventricular and atrioventricular (AV) block arrhythmias. For this reason, the main aim of this study was to determine the relationship between the patient's disease and decreased cardiac contractility and the incidence of paroxysmal atrial, supraventricular, ventricular and AV block arrhythmias. Meanwhile, the secondary objective was to analyse the relationship between respondent characteristics and lifestyle with the incidence of specific arrhythmias.

Methods

This was retrospective observational cohort study. Secondary data were used namely patient medical records for 2017-2021. The data collection process was carried out from March to April 2022.

Participants

Participants in this study were patients who underwent ambulatory ECG monitoring at the Cardiovascular Outpatient Service Unit at RSUD Budhi Asih, Jakarta, Indonesia. Sample calculations used *G*Power 3.1* with two-tails calculation criteria, odds ratio (OR) 2.25, α error probability 0.05 and power 95 %, obtained a minimum sample size of 325 people. In this study, 406 participants met the inclusion criteria of age > 8 years, underwent an ambulatory ECG monitoring examination for at least 24 hours and had complete medical record documentation including age, gender, history of disease (DM, hypertension, coronary heart disease (CHD) or hyperthyroidism), blood pressure, body weight, lifestyle (smoking and obesity) and echocardiogram. Patients who had a pacemaker installed were the study exclusion criteria. Of 677 respondents who monitored ambulatory ECG, 271 did not meet the requirements. Namely, four people were < 8 years old, 178 had no ejection fraction results, 147 had no electrolyte results and 157 had no weight or height measurements.

Variables and operational definitions

The outcome of this study was to determine the incidence of paroxysmal arrhythmias determined based on medical record data. Paroxysmal arrhythmia events consisted of atrial arrhythmias if the source of the impulse was a change in heart rhythm from the atrial characterised by > 1 P wave and followed by one QRS wave. Paroxysmal supraventricular arrhythmia was a change in heart rhythm that originated from the supraventricular source and was characterised by the premature appearance of QRS waves. Paroxysmal ventricular arrhythmia was when the source of the impulse for changes in heart rhythm originated from the ventricles, characterised by the appearance of QRS waves > 0.12 s. Paroxysmal AV block arrhythmia was when a change in heart rhythm was due to a block in the Purkinje section with a PR wave interval > 0.20 s. Independent variables included age, gender, smoking

behaviour, body mass index (BMI), history of the disease and heart-pumping ability. Age was categorised into < 40 years and ≥ 41 years, while smoking behaviour was divided into "yes" and "no." Nutritional status was grouped based on BMI calculation into normal/overweight (< 25.0 kg/m^2) and obese (≥ 25.0 kg/m^2). Disease history is determined by a doctor's diagnosis of the presence or absence of hypertension, DM and CHD. The heart's pumping ability is seen from echocardiogram examination data in the medical record with categories based on ejection fraction (EF), namely < 46 % and ≥ 46 %.

Data analysis

The data provided by the hospital was in the form of a soft file in the Microsoft Excel program; then, a review process and extract of the data was caried according to the specified variables. Data were analysed using the SPSS v.25 programme. Univariate data were presented in a frequency distribution. The relationship between variables and outcomes was analysed using the Chi-square test. Significance was determined if the p-value was < 0.05.

Results

The findings showed that the characteristics of the participants were: over 41 years of age were 85.7 % of participants, 50.7 % were women, 60.8 % were smokers, 44.6 % were obese, 46.1 % had hypertension, 39.9 % had DM, 35.2 % had coronary heart disease, 12.3 % thyroid disease and 66.3 % heart pumping ability < 46 %. The majority of participants had paroxysmal atrial arrhythmia (39.4 %). Detailed details of the data are presented in Table 1.

Table 2 provide information that age (OR = 5.200, p = 0.023), gender (OR = 34.272, p < 0.001), smoking behaviour (OR = 22.231, p < 0.001), coronary heart disease (OR = 9.316, p = 0.002), thyroid disease (OR = 39.346, p < 0.001) and heart pumping ability (OR = 5.593, p = 0.018) were predictors of paroxysmal atrial arrhythmias. BMI was the only factor associated with paroxysmal supraventricular arrhythmias (OR = 8.693, p = 0.003). On the other hand, gender (OR = 7.991, p = 0.005), smoking behaviour (OR = 9.399, p = 0.002), coronary heart disease (OR = 22.634, p < 0.001), thyroid disease (OR = 10.083, p = 0.001) and heart pumping ability (OR = 6.573, p = 0.010) were predictor factors for the occurrence of paroxysmal ventricular arrhythmias. Meanwhile, gender (OR = 11.464, p = 0.001) and coronary heart disease (OR = 6.971, p = 0.008) were related factors with paroxysmal AV block arrhythmia.

Table 1: Sociodemographic and clinical characteristic of respondents (N = 406)

Variable	n (%)
Age (years)	
< 40	58 (14.3)
≥ 41	348 (85.7)
Gender	
Male	200 (49.3)
Female	206 (50.7)
Smoking behaviour	
Yes	247 (60.8)
No	159 (39.2)
BMI (kg/m^2)	
Normal/overweight	225 (55.4)
Obese	181 (44.6)
Hypertension	
Yes	187 (46.1)
No	219 (53.9)
Diabetes mellitus	
Yes	162 (39.9)
No	263 (64.8)
Coronary heart disease	
Yes	143 (35.2)
No	244 (60.1)
Thyroid disease	
Yes	50 (12.3)
No	356 (87.7)
Heart pumping ability	
< 46 %	269 (66.3)
≥ 46 %	137 (33.7)
Ambulatory ECG monitoring	
Normal ECG	121 (29.8)
Atrial	160 (39.4)
Supraventricular	28 (6.9)
Ventricular	86 (21.2)
AV block	11 (2.7)

AV = Atrioventricular; BMI = Body mass index; ECG = Electrocardiography; N = number;

Table 2: Determinants factors of paroxysmal arrhythmias in patients with ambulatory ECG monitoring (N = 406)

Variables	Type of paroxysmal arrhythmia											
	Atrial			Supraventricular			Ventricular			AV block		
	Yes	No	OR (p)†	Yes	No	OR (p)†	Yes	No	OR (p)†	Yes	No	OR (p)†
Age (years)												
< 40	15 (3.7)	43 (10.6)	**5.200 (0.023)**	7 (1.7)	51 (12.6)	2.819 (0.093)	9 (2.2)	49 (12.1)	1.301 (0.254)	1 (0.2)	57 (14.0)	0.249 (0.618)
≥ 41	145 (35.7)	203 (50.5)		21 (5.2)	327 (80.5)		77 (19.0)	271 (66.7)		10 (2.5)	338 (83.3)	
Gender												
Male	50 (12.3)	150 (36.9)	**34.272 (< 0.001)**	13 (3.2)	187 (46.1)	0.970 (0.756)	54 (13.3)	146 (36.0)	**7.991 (0.005)**	11 (2.7)	189 (46.6)	**11.464 (< 0.001)**
Female	110 (39.4)	96 (23.6)		15 (3.7)	191 (47.0)		32 (7.9)	174 (42.9)		0 (0.0)	206 (50.7)	
Smoking												
Yes	40 (9.9)	119 (29.3)	**22.231 (< 0.001)**	15 (3.7)	144 (35.5)	2.621 (0.105)	46 (11.3)	113 (27.8)	**9.399 (0.002)**	6 (1.5)	153 (37.7)	**1.123 (0.289)**
No	120 (29.6)	127 (31.3)		13 (3.2)	127 (57.6)		40 (9.9)	207 (51.0)		5 (1.2)	242 (59.6)	
BMI (kg/m²)												
Normal	87 (21.4)	138 (34.0)	0.116 (0.733)	23 (5.7)	202 (49.8)	**8.693 (0.003)**	44 (10.8)	181 (44.6)	0.800 (0.371)	4 (1.0)	221 (54.4)	1.662 (0.197)
Obesity	73 (18.0)	108 (26.6)		5 (1.2)	176 (43.3)		42 (10.3)	139 (34.2)		7 (1.7)	174 (42.9)	
Hypertension												
Yes	76 (18.7)	111 (27.3)	0.221 (0.639)	76 (18.7)	111 (27.3)	**5.368 (0.021)**	41 (10.1)	146 (36.0)	0.115 (0.735)	3 (0.7)	184 (45.3)	1.606 (0.205)
No	84 (20.7)	135 (33.3)		84 (20.7)	135 (33.3)		45 (11.1)	174 (42.9)		8 (2.0)	211 (52.0)	
Diabetes mellitus												
Yes	113 (27.8)	49 (12.1)	**89.994 (< 0.001)**	3 (0.7)	159 (39.2)	**10.684 (0.001)**	15 (3.7)	147 (36.2)	**22.952 (< 0.001)**	4 (1.0)	158 (38.9)	0.059 (0.808)
No	47 (11.6)	197 (48.5)		25 (6.2)	219 (53.9)		71 (17.5)	173 (42.6)		7 (1.7)	237 (58.4)	
CHD												
Yes	42 (10.3)	101 (24.9)	**9.316 (0.002)**	12 (3.0)	131 (32.3)	0.768 (0.381)	49 (12.1)	94 (23.2)	**22.634 (< 0.001)**	8 (2.0)	135 (33.3)	**6.971 (0.008)**
No	118 (29.1)	145 (35.7)		16 (3.9)	247 (60.8)		37 (9.1)	226 (55.7)		3 (0.7)	260 (64.0)	
Thyroid disease												
Yes	40 (9.9)	10 (2.5)	**39.346 (< 0.001)**	3 (0.7)	47 (11.6)	0.071 (0.789)	2 (0.5)	48 (11.8)	**10.083 (0.001)**	0 (0.0)	50 (12.3)	1.588 (0.208)
No	120 (29.6)	236 (58.1)		25 (6.2)	331 (81.5)		84 (20.7)	272 (67.0)		11 (2.7)	345 (85.0)	
Ambulatory ECG monitoring												
< 46 %	65 (16.0)	72 (20.4)	**5.593 (0.018)**	5 (1.2)	132 (32.5)	3.395 (0.065)	39 (9.6)	98 (24.1)	**6.573 (0.010)**	4 (1.0)	133 (32.8)	**0.035 (0.852)**
≥ 46 %	95 (23.4)	174 (42.9)		23 (5.7)	246 (60.6)		47 (11.6)	222 (54.7)		7 (1.7)	262 (64.5)	

† Chi-square; AV = Atrioventricular; BMI = Body mass index; ECG = Electrocardiography; CHD: Coronary hearth disease; OR: odds ratio;

Discussion

Research findings showed that most patients experienced paroxysmal atrial arrhythmia (39.4 %), in line with global data that the most popular arrhythmic condition is atrial fibrillation (AF), which affects 60 million of the population[18] or equivalent to 0.51 % of the world population.[19] Countries considered high-income countries are estimated to experience a higher incidence of AF than others (1-4 %), while the incidence in Asia is lower at 0.49-1.9 %.[20] Different results were shown by the findings of a study in Colombia where 67 % of 500 people experienced ventricular arrhythmias,[21] a study in Egypt where 304 of 400 people also experienced premature ventricular contractions (PVC) and non-supraventricular tachycardia (N-SVT) type arrhythmias.[22]

This study found an association of hypertension with the incidence of supraventricular arrhythmias, in line with other retrospective studies.[23] Another study confirmed that SVT in hypertensive patients increases morbidity and mortality.[24] The results differ from previous studies, which found a significant relationship between hypertension and atrial arrhythmia.[25, 26] Hypertension causes myocardial electro-pathological remod-

elling, primarily by activating the renin-angiotensin-aldosterone and sympathetic nervous systems. Aldosterone can alter calcium and potassium currents, cause calcium overload and increase after depolarisation delays, thereby increasing the substrate for arrhythmias. In addition, myocardial ischaemia caused by hypertension also contributes to arrhythmogenesis.[14]

Other findings show a significant relationship between DM and atrial, supraventricular and ventricular arrhythmias. The results strengthen previous findings, which stated that the presence of DM increases the incidence of atrial fibrillation and ventricular arrhythmias, thus affecting cardiovascular morbidity and mortality.[27] This parallel with the Framingham Offspring Study showed an incremental and predictive relationship between diabetes, heart rate recovery and new-onset atrial fibrillation. Type 1 and type 2 diabetes patients show cardiac autonomic neuropathy, which results in cardiovascular disorders, one of which is arrhythmia without symptoms.[28] Cross-sectional studies found the incidence of different arrhythmias in people with type 2 DM.[29] The relationship between diabetes and arrhythmias is complex and multifactorial, including autonomic dysfunction, atrial and ventricular remodelling and molecular changes. Patients with hypoglycaemia or hyperglycaemia who have type 2 DM can experience long-term damage to the heart, which can cause arrhythmia disorders.[27, 29]

CHD also showed the association between atrial and ventricular arrhythmias and AV block. The results are in line with the findings of a study in 278 patients showing that 22 % had PVC arrhythmias of more than 50 contractions/hour, non-sustained ventricular tachycardia occurred in 15 % of patients and < 1 % experienced lethal arrhythmias such as pulseless ventricular tachycardia and ventricular fibrillation. This shows that CHD influences the emergence of ventricular arrhythmia.[30] CHD activates ventricular action potentials due to myocardial ischemia. This results in ATP deficiency and anaerobic glycolysis, which causes acidosis, increases extracellular K+ and causes accumulation of lysophosphatidylcholine, which disrupts the action potential process and causes arrhythmia.[31]

Other results showed a significant relationship between thyroid disease and the incidence of atrial and ventricular arrhythmias, in line with a study that found that 8.3 % of patients with hyperthyroidism experienced changes in ECG recordings in the form of AF or atrial flutter.[32] Atrial arrhythmias in patients with thyroid disease are due to a decrease in the atrial refractory period and an increase in sympathetic nerves with a reduction in heart rate variability. The hormone T3 also influences arrhythmias, which results in atrial remodelling because T3 increases the sensitivity of B1 adrenergic and reduces the sensitivity of M2 muscarinic receptors.[33]

Studies also showed a significant relationship between decreased heart pumping ability and the incidence of atrial and ventricular arrhythmias. Heart pump dysfunction also causes changes in remodelling the heart's electrical impulses. In general, it is not known how long it takes for arrhythmias to appear, but in electrophysiological studies, fibrosis or apoptosis results in remodelling of ventricular arrhythmias, disruption of action potentials and shortened clutch intervals.[17, 34] The emergence of arrhythmias can also result in heart pump dysfunction, characterised by increased heart rate and widening of the left ventricular chamber for approximately 3 to 7 days, as well as primary and minor signs of heart failure.[35]

This study found that age was significantly related to the incidence of paroxysmal atrial arrhythmias; age ≥ 41 showed a greater risk of occurrence than group < 40 years. These results align with previous studies from Western Europe, Australia and North America, which found that the incidence of AF was higher with increasing age, with 70 % of the incidence at age > 65.[20] Mortality due to AF was 1.8-2.6-fold at a higher age of > 60 years.[36] Review studies explain the degenerative process in old age causing structural disorders and atrial remodelling as the cause of the high incidence of AF, coupled with the presence of other degenerative diseases that increase the incidence of AF.[37, 38]

The findings showed a significant relationship between gender and the incidence of atrial and ventricular arrhythmias and AV block; women were more likely to be at higher risk of experiencing AF, while men are more at risk of experiencing ventricular arrhythmias and AV block. This is in line with studies in North America and Europe, which found that the incidence of AF in women was 1.5-2 times higher than in men.[39] The influence of hormones on the incidence of atri-

al arrhythmias in women has been discussed in previous research. The electrophysiological contribution of sex hormones such as progesterone and oestrogen had an active role in the shortening of the action potential and the occurrence of the QT interval during the luteal phase of the menstrual cycle.[40]

Findings may provide information on factors associated with each type of paroxysmal arrhythmia. The majority of previous studies only discussed one type of arrhythmia, so the related factors could not be compared with one another. This study shows that the same variables can cause several types of paroxysmal arrhythmia. This research provides essential information that can be used for early detection or warning if these factors are found in a person. Early engagement of patients and health workers of existing risks can prevent further risks.

This study has several limitations, including the use of information from one centre, retrospective design and the absence of regular and systematic rhythm monitoring. The research design chosen only displays data at one time without any follow-up, so it cannot explain the influence of cause and effect in more detail. The sample size is small, so it cannot be generalised to the entire population. The following limitation is that we did not conduct a multivariate analysis, so we only examined the relationship between two variables without involving other variables. The incidence of comorbidities is grouped into only two categories. Hence, further study is needed to determine the significant increase in blood pressure and blood sugar values with the occurrence of arrhythmias. Nutritional status only uses normal and obese categories, so it cannot be generalised to other groups. Data on smoking behaviour is only in the form of two categories without further analysis regarding the severity of smoking behaviour.

Conclusion

Study findings showed that age, gender, smoking, comorbidities and heart-pumping ability are associated with the occurrence of paroxysmal atrial arrhythmias. On the other hand, only BMI, hypertension and diabetes mellitus showed significant association with paroxysmal supraventricular arrhythmias. Gender, smoking, DM, coronary heart disease, thyroid disease and heart pumping ability are predictor factors for paroxysmal ventricular arrhythmias. Meanwhile, only gender and heart disease were factors associated with paroxysmal AV block arrhythmias. The study findings motivated researchers to continue further studies, developing a "Prototype Arrhythmia Prediction," designed to detect paroxysmal arrhythmia events early. Future researchers can also research this topic with methods such as causal-effect using interventions that can reduce the incidence of paroxysmal arrhythmias.

Ethics

The study was approved by the Ethics Committee of the Universitas Muhammadiyah Jakarta, decision No 0305/F.9-UMJ/III/2022, dated 15 March 2022 and the Ethics Commission of RSUD Buhdi Asih Jakarta, decision No 320/KEP-ETIK/VII/2022, dated 7 July 2024. The data used in this study are secondary, so it does not require individual participants to sign informed consent.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

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References

1. Schamroth Pravda N, Kalter-Leibovici O, Nir A, Lorber A, Dadashev A, Hirsch R, et al. Arrhythmia burden among adult patients with congenital heart disease: A population-based study. J Am Heart Assoc. 2024;13(9):e031760. doi: 10.1161/JAHA.123.031760.
2. Association AH [Internet]. Highlights of the 2010 American Heart Association guidelines for CPR and ECC: American Heart Association; 2010. [Cited: 1-Jan-2025]. Available at: https://cpr.heart.org/-/media/cpr-files/cpr-guidelines-files/highlights/hghlghts_2020_ecc_guidelines_english.pdf
3. Al-Khatib SM, Stevenson WG, Ackerman MJ, Bryant WJ, Callans DJ, Curtis AB, et al. 2017 AHA/ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. J Am Coll Cardiology. 2018;72(14):e91-e220. doi: 10.1161/CIR.0000000000000548.
4. Mkoko P, Bahiru E, Ajijola OA, Bonny A, Chin A. Cardiac arrhythmias in low- and middle-income countries. Cardiovasc Diagn Ther. 2020 Apr;10(2):350-60. doi: 10.21037/cdt.2019.09.21.
5. Srinivasan NT, Schilling RJ. Sudden cardiac death and arrhythmias. Arrh Electrophysiol Rev. 2018;7(2):111. doi: 10.15420/aer.2018:15:2.
6. Armstrong PW. Left ventricular dysfunction: causes, natural history, and hopes for reversal. Heart. 2000;84(suppl 1):i15-i7. doi: 10.1136/heart.84.suppl_1.i15.
7. Huizar JF, Ellenbogen KA, Tan AY, Kaszala K. Arrhythmia-induced cardiomyopathy. J Am Coll Cardiol. 2019;73(18):2328-44. doi: 10.1016/j.jacc.2019.02.045.
8. Kohno R, Abe H, Benditt DG. Ambulatory electrocardiogram monitoring devices for evaluating transient loss of consciousness or other related symptoms. J Arrhythmia. 2017;33(6):583-9. doi: 10.1016/j.joa.2017.04.012.
9. Bernal O, Moro C. Cardiac arrhythmias in women. Revista Española de Cardiología (English Edition). 2006;59(6):609-18. doi: 10.1016/S1885-5857(07)60011-5.
10. Roger VL, Go AS, Lloyd-Jones DM, Benjamin EJ, Berry JD, Borden WB, et al. Heart disease and stroke statistics—2012 update: a report from the American Heart Association. Circulation. 2012;125(1):e2. doi: 10.1161/CIR.0b013e31823ac046.
11. Wong GR, Nalliah CJ, Lee G, Voskoboinik A, Chieng D, Prabhu S, et al. Sex-related differences in atrial remodeling in patients with atrial fibrillation: relationship to ablation outcomes. Circulation: Arrh Electrophysiol. 2022;15(1):e009925. doi: 10.1161/CIRCEP.121.009925.
12. Patel KHK, Reddy RK, Sau A, Sivanandarajah P, Ardissino M, Ng FS. Obesity as a risk factor for cardiac arrhythmias. BMJ Medicine. 2022;1(1):e000308. doi: 10.1136/bmjmed-2022-000308.
13. Wang TJ, Parise H, Levy D, D'Agostino RB, Wolf PA, Vasan RS, et al. Obesity and the risk of new-onset atrial fibrillation. JAMA. 2004;292(20):2471-7. doi: 10.1001/jama.292.20.2471.
14. Marazzato J, Blasi F, Golino M, Verdecchia P, Angeli F, De Ponti R. Hypertension and arrhythmias: a clinical overview of the pathophysiology-driven management of cardiac arrhythmias in hypertensive patients. J Cardiovasc Development Disease. 2022;9(4):110. doi: 10.3390/jcdd9040110.
15. Ph DL. Association of atrial fibrillation with diabetes mellitus, high risk comorbidities. Maedica (Bucur). 2022;17(1):143-52. doi: 10.26574/maedica.2022.17.1.143.
16. Lorenzo-Almorós A, Casado Cerrada J, Álvarez-Sala Walther L-A, Méndez Bailón M, Lorenzo González Ó. Atrial fibrillation and diabetes mellitus: dangerous liaisons or innocent bystanders? J Clinical Medicine. 2023;12(8):2868. doi: 10.3390/jcm12082868.
17. Fauchier L, Bisson A, Bodin A. Heart failure with preserved ejection fraction and atrial fibrillation: recent advances and open questions. BMC medicine. 2023;21(1):54. doi: 10.1186/s12916-023-02764-3.
18. Elliott AD, Middeldorp ME, Van Gelder IC, Albert CM, Sanders P. Epidemiology and modifiable risk factors for atrial fibrillation. Nature Rev Cardiol. 2023;20(6):404-17. doi: 10.1038/s41569-022-00820-8.
19. Lippi G, Sanchis-Gomar F, Cervellin G. Global epidemiology of atrial fibrillation: An increasing epidemic and public health challenge. Int J Stroke. 2021;16(2):217-21. doi: 10.1177/1747493019897870.

20. Zulkifly H, Lip GYH, Lane DA. Epidemiology of atrial fibrillation. Int J Clin Pract. 2018;72(3):e13070. doi: 10.1111/ijcp.13070.
21. Whang W, Peacock J, Soto AV, Borda T, Bhatt AB, Richardson SI, et al. Relationship between premature ventricular complexes and depressive symptoms in non-ST-elevation acute coronary syndrome. European Heart J: Acute Cardiovascular Care. 2013;2(1):61-7. doi: 10.1177/2048872613476101.
22. Sanhoury M, Mohamed F, Sadaka M, Abdel-Hay MA, Sobhy M, Elwany M. The impact of asymptomatic ventricular arrhythmias on the outcome of heart failure patients with reduced ejection fraction. Egypt Heart J. 2022;74(1):11. doi: 10.1186/s43044-022-00247-z.
23. Fingrova Z, Ambroz D, Jansa P, Kuchar J, Lindner J, Kunstyr J, et al. The prevalence and clinical outcome of supraventricular tachycardia in different etiologies of pulmonary hypertension. Plos One. 2021;16(1):e0245752. doi: 10.1371/journal.pone.0245752.
24. Wen L, Sun M-L, An P, Jiang X, Sun K, Zheng L, et al. Frequency of supraventricular arrhythmias in patients with idiopathic pulmonary arterial hypertension. Am J Cardiol. 2014;114(9):1420-5. doi: 10.1016/j.amjcard.2014.07.079.
25. Dzeshka MS, Shantsila A, Shantsila E, Lip GYH. Atrial fibrillation and hypertension. Hypertension. 2017;70(5):854-61. doi: 10.1161/HYPERTENSIONAHA.117.08934.
26. Verdecchia P, Angeli F, Reboldi G. Hypertension and atrial fibrillation. Circulation Res. 2018;122(2):352-68. doi: 10.1161/CIRCRESAHA.117.311402.
27. Grisanti LA. Diabetes and arrhythmias: pathophysiology, mechanisms and therapeutic outcomes. Frontiers Physiol. 2018;9:1669. doi: 10.3389/fphys.2018.01669.
28. Negishi K, Seicean S, Negishi T, Yingchoncharoen T, Aljaroudi W, Marwick TH. Relation of heart-rate recovery to new onset heart failure and atrial fibrillation in patients with diabetes mellitus and preserved ejection fraction. Am J Cardiology. 2013;111(5):748-53. doi: 10.1016/j.amjcard.2012.11.028.
29. Agarwal G, Singh SK. Arrhythmias in type 2 diabetes mellitus. Indian J Endocrinol Metabolism. 2017;21(5):715-8. doi: 10.4103/ijem.IJEM_448_16.
30. Chua S-K, Chen L-C, Lien L-M, Lo H-M, Liao Z-Y, Chao S-P, et al. Comparison of arrhythmia detection by 24-hour Holter and 14-day continuous electrocardiography patch monitoring. Acta Cardiologica Sinica. 2020;36(3):251. doi: 10.6515/ACS.202005_36(3).20190903A.
31. Gorenek B, Blomström Lundqvist C, Brugada Terradellas J, Camm AJ, Hindricks G, Huber K, et al. Cardiac arrhythmias in acute coronary syndromes: position paper from the joint EHRA, ACCA, and EAPCI task force. EP Europace. 2014;16(11):1655-73. doi: 10.1093/europace/euu208.
32. Jayaprasad N, Francis J. Atrial fibrillation and hyperthyroidism. Indian pacing and electrophysiology journal. 2005;5(4):305. PMID: 16943880.
33. Reddy V, Taha W, Kundumadam S, Khan M. Atrial fibrillation and hyperthyroidism: a literature review. Indian Heart J. 2017;69(4):545-50. doi: 10.1016/j.ihj.2017.07.004.
34. Ariyaratnam JP, Elliott AD, Mishima RS, Gallagher C, Lau DH, Sanders P. Heart failure with preserved ejection fraction: An alternative paradigm to explain the clinical implications of atrial fibrillation. Heart Rhythm O2. 2021;2(6Part B):771-83. doi: 10.1016/j.hroo.2021.09.015.
35. Martin CA, Lambiase PD. Pathophysiology, diagnosis and treatment of tachycardiomyopathy. Heart. 2017;103(19):1543-52 doi: 10.1136/heartjnl-2016-310391.
36. Morseth B, Geelhoed B, Linneberg A, Johansson L, Kuulasmaa K, Salomaa V, et al. Age-specific atrial fibrillation incidence, attributable risk factors and risk of stroke and mortality: results from the MORGAM Consortium. Open Heart. 2021;8(2). doi: 10.1136/openhrt-2021-001624.
37. Laredo M, Waldmann V, Khairy P, Nattel S. Age as a critical determinant of atrial fibrillation: a two-sided relationship. Cana J Cardiol. 2018;34(11):1396-406. doi: 10.1016/j.cjca.2018.08.007.
38. Sankaranarayanan R, Kirkwood G, Dibb K, Garratt CJ. Comparison of atrial fibrillation in the young versus that in the elderly: a review. Cardiol Res Practice. 2013;2013(1):976976. doi: 10.1155/2013/976976.
39. Ko D, Rahman F, Schnabel RB, Yin X, Benjamin EJ, Christophersen IE. Atrial fibrillation in women: epidemiology, pathophysiology, presentation, and prognosis. Nature Rev Cardiol. 2016;13(6):321-32. doi: 10.1038/nrcardio.2016.45.
40. Zeitler EP, Poole JE, Albert CM, Al-Khatib SM, Ali-Ahmed F, Birgersdotter-Green U, et al. Arrhythmias in female patients: incidence, presentation and management. Circul Res. 2022;130(4):474-95. doi: 10.1161/CIRCRESAHA.121.319893.