ORIGINAL ARTICLE

Annals of Agricultural and Environmental Medicine
www.aaem.pl

Prevalence of ECG-detected cardiac rhythm abnormalities among participants in a screening programme in the Lublin region of eastern Poland, taking into account risk factors and demographic differences

Mariusz Sutryk[1,A-D,F] ✉, **Paweł Kalinowski**[2,C,E-F], **Barbara Siedlecka**[1,B-C]

[1] *Faculty of Health Sciences, University of Economics and Innovation, Lublin, Poland*
[2] *Department of Hygiene and Epidemiology, Medical University, Lublin, Poland*
A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

Sutryk M, Kalinowski P, Siedlecka B. Prevalence of ECG-detected cardiac rhythm abnormalities among participants in a screening programme in the Lublin region, eastern Poland, taking into account risk factors and demographic differences. Ann Agric Environ Med. doi:10.26444/aaem/242861

Abstract

Introduction and Objective. Cardiac rhythm abnormalities and cardiovascular diseases are important problems for public health Community screening may help identify ECG abnormalities that warrant further clinical assessment. The aim of the study is to assess the prevalence of predefined ECG abnormalities among participants in a cardiovascular and metabolic screening programme in the Lublin region of eastern Poland, and to examine their associations with selected demographic variables and reported cardiovascular risk factors.

Materials and Method. A cross-sectional secondary analysis included 503 participants (age range 6.5–95 years) who underwent a resting 12-lead ECG during voluntary community-based cardiovascular and metabolic screening conducted between April – October 2023 in Lublin and Lublin County. Screening included blood pressure, heart rate, oxygen saturation, blood glucose, body measurements, a structured questionnaire and resting 12-lead ECG. ECG recordings were assessed in two stages by two researchers. The primary outcome was the presence of any predefined ECG abnormality (ST-segment abnormality, conduction disturbance, ventricular or supraventricular arrhythmia, T-wave abnormality, or atrial fibrillation). Associations were assessed using chi-square or exact procedures as appropriate, and an exploratory multivariable logistic regression model was fitted for the binary primary outcome.

Results. Among 503 participants, 378 (75.1%) had sinus rhythm and 86 (17.1%) had bradycardia; tachycardia was recorded in 29 participants (5.8%). The primary outcome – any predefined ECG abnormality – was identified in 74 participants (14.7%; 95% CI 11.9–18.1 (Wilson method)). The most frequent abnormality categories were ST-segment abnormalities (25; 5.0%) and conduction disturbances (22; 4.4%). In exploratory multivariable logistic regression (n=492 complete cases), urban residence was associated with higher odds of the primary ECG outcome (adjusted OR 2.89; 95% CI 1.01–8.27; p=0.048); age, gender, hypertension, diabetes and BMI were not statistically significant. The overall model likelihood-ratio test was not statistically significant (p=0.338).

Conclusions. In the studied group of 503 screening participants, predefined ECG abnormalities were identified in 74 individuals (14.7%). The most frequent categories were ST-segment abnormalities and conduction disturbances. The findings relate to a voluntary regional screening sample and should not be generalised to the entire population of the Lublin Province. Further studies in representative populations are warranted.

Key words

screening, cardiac arrhythmias, atrial fibrillation, cardiovascular diseases

INTRODUCTION

Cardiovascular diseases remain a major public-health burden, and population ageing increases the importance of prevention and early identification of cardiovascular risk. Regional screening programmes can provide useful descriptive information about participants, but findings from voluntary screening samples should not be interpreted as population prevalence estimates [1].

The cardiac conduction system coordinates myocardial electrical activation. Sinus rhythm originates in the sinoatrial node, while atrioventricular conduction and the His–Purkinje system transmit impulses to the ventricles [2, 3]. Established modifiable cardiovascular risk factors include hypertension, diabetes, obesity, smoking, physical inactivity and dyslipidaemia [4–6]. Contemporary cardiovascular prevention guidelines emphasize identification and management of modifiable risk factors and appropriate cardiovascular assessment according to individual clinical risk [5, 6].

Geographical differences in access to cardiovascular care may be relevant to regional prevention and diagnostic

✉ Address for correspondence: Mariusz Sutryk, Faculty of Health Sciences, University of Economics and Innovation, Projektowa 4, 20-209, Lublin, Poland
E-mail: Mariusz.Sutryk@wsei.lublin.pl

Received: 31.07.2026; accepted: 09.11.2026; first published: 24.11.2026

planning. However, healthcare access was not directly measured in the present study and therefore cannot be used to explain differences observed between urban and rural screening participants.

Cardiac rhythm and conduction abnormalities comprise heterogeneous disturbances of impulse formation and propagation. Their clinical significance depends on the type of abnormality, its duration, the underlying cardiovascular condition and the clinical context [2, 3]. Normal sinus rhythm is generated by the sinoatrial node. Tachyarrhythmias may arise through abnormal automaticity, triggered activity or re-entry mechanisms, and their symptoms and clinical consequences vary considerably [2, 3]. Evaluation of suspected rhythm disorders commonly includes a resting 12-lead ECG and, when clinically indicated, ambulatory ECG monitoring and other cardiovascular investigations [7–10]. Prolonged and wearable rhythm-monitoring technologies have expanded opportunities to identify intermittent atrial fibrillation, although abnormal findings require appropriate clinical confirmation and interpretation [7–9, 11–18].

OBJECTIVE

The aim of the study is to assess the prevalence of predefined ECG abnormalities among participants in a cardiovascular and metabolic screening programme in the Lublin region of eastern Poland, and to examine their associations with selected demographic variables and reported cardiovascular risk factors.

MATERIALS AND METHOD

Study design and participants. A cross-sectional analysis of a voluntary community screening programme conducted between April – October 2023 in the Municipality of Lublin and Lublin Province. A total of 899 individuals participated in the broader cardiovascular and metabolic screening programme. The present analysis was restricted to the 503 participants for whom a resting 12-lead ECG was available and who had the demographic data required for the analysis. The remaining 396 programme participants did not contribute an ECG for analysis. The ECG cohort comprised participants aged 6.5 – 95 years.

This cross-sectional secondary analysis was based on anonymised data obtained during community-based preventive health screening activities conducted in the Lublin Province in 2023. The original screening programme had a preventive and health-promotion purpose. Participation was voluntary, and of the individuals participating in the screening activities, 503 underwent ECG examination and had data sufficient for inclusion in the analysis. The analysed group included 38 participants aged ≤18 years. For minors, parents or legal guardians were informed about the screening procedures and provided written consent for their child's participation.

Screening procedures. Cardiovascular and metabolic screening included blood pressure, oxygen saturation, heart rate, blood glucose, body weight and a resting 12-lead ECG. A proprietary interviewer-administered questionnaire collected gender, age, place of residence, educational attainment, medication use, cardiovascular symptoms and selected medical history. Reported symptoms included chest pain, shortness of breath, fatigue and palpitations/irregular heartbeat. Medical history included hypertension, ischaemic heart disease, heart failure, previous myocardial infarction and stroke. ECG recordings underwent a two-stage assessment: the first researcher evaluated the recording and a second researcher independently verified the interpretation.

Primary outcome. The primary outcome was the presence of any predefined ECG abnormality on the resting 12-lead ECG. For the binary outcome, ECG findings were classified as no predefined abnormality versus at least one of the following categories: ST-segment abnormality, conduction disturbance, ventricular or supraventricular arrhythmia, T-wave abnormality, or atrial fibrillation. Sinus bradycardia and sinus tachycardia were described separately as heart-rate/rhythm findings and were not, by themselves, counted as the binary primary outcome. This distinction was made because ST-segment and T-wave abnormalities are ECG abnormalities but are not, by definition, cardiac arrhythmias.

Statistical analysis. Descriptive statistics were reported as n (%), mean ± standard deviation, median and range, as appropriate. Associations between categorical variables were assessed using Pearson's chi-square test when assumptions were met; for sparse contingency tables, exact procedures (including the Fisher–Freeman–Halton test) were used. A multivariable binary logistic regression model was additionally fitted for the primary ECG outcome. Pre-specified covariates available in the individual-level database were age (per year), gender, place of residence (urban vs rural), hypertension, diabetes and BMI (kg/m^2). The regression used complete cases (n=492). Adjusted odds ratios (aORs), 95% confidence intervals (CIs) and p-values were recorded. The 95% CI for the primary-outcome proportion was calculated using the Wilson score method. The overall logistic-regression model was assessed with a likelihood-ratio test; individual coefficient estimates were interpreted in light of this global test. Statistical significance was set at $p<0.05$.

Ethical considerations. The data analysed in this study were originally collected in 2023 during community-based preventive health screening activities conducted in the Lublin Province. These activities were undertaken for preventive and health-promotion purposes and were not originally initiated as a prospective research study. Participation in the screening was voluntary. Before participation, individuals were informed about the screening procedures and provided consent to participate. For participants under 18 years of age, parents or legal guardians provided written consent for the childrens' participation.

For the purposes of the scientific analysis, the dataset was anonymised prior to analysis, and only anonymised data without direct personal identifiers were used. The subsequent scientific use and analysis of the collected data formed part of the project entitled 'Personal correlates of the occurrence of cardiovascular, respiratory and thyroid diseases among the rural and urban population of the Lublin Province', which received a positive opinion from the Research Ethics Committee involving Human Participants at the University of Economics and Innovation in Lublin (Opinion No. 2/KEBN/2025, 3 November 2025). The opinion was issued

after the preventive screening activities conducted in 2023, and is reported according to the actual chronology, and not presented as prospective ethical approval for the 2023 screening activities.

RESULTS

The final ECG analysis included 503 participants: 306 women (60.8%) and 197 men (39.2%). Mean age was 52.7 ± 19.1 years (median 56; range 6.5–95). Thirty-eight participants (7.6%) were aged ≤18 years, 77 (15.3%) were aged 19–39 years, 206 (41.0%) were aged 40–64 years, and 182 (36.2%) were aged ≥65 years. Most participants lived in urban areas (438; 87.1%). Educational attainment was recorded as primary in 32 participants (6.4%), vocational in 68 (13.5%), secondary in 220 (43.7%) and higher in 178 (35.4%); education data were missing for 5 participants (1.0%). Rural residence was reported by 65 participants (12.9%). Mean BMI was 25.0 ± 3.2 kg/m² (median 25.2; range 13.6–40.3). BMI categories were underweight in 10 participants (2.0%), normal weight in 223 (44.3%), overweight in 251 (49.9%) and obesity in 19 (3.8%). Fatigue was reported by 172 participants (34.2%), palpitations by 147 (29.2%), shortness of breath by 105 (20.9%), and chest pain by 99 (19.7%). At least one of these symptoms was reported by 252 participants (50.1%). Symptoms reported by participants are summarised in Table 1.

Table 1. Symptoms reported by participants (N=503)

Symptom	n	%
Chest pain	99	19.7
Shortness of breath	105	20.9
Palpitations / irregular heartbeat	147	29.2
Fatigue	172	34.2
At least one of the above symptoms	252	50.1
None of the above symptoms	251	49.9

Among the 503 ECG recordings, sinus rhythm was reported in 378 participants (75.1%) and bradycardia in 86 (17.1%). Tachycardia was recorded in 29 participants (5.8%). ECG rhythm classifications and the primary ECG outcome are presented in Table 2.

Table 2. ECG rhythm classification and primary ECG outcome among study participants (N=503)

Variable	Category	n	%	95% CI
ECG rhythm classification	Sinus rhythm	378	75.1	71.2–78.7
	Bradycardia	86	17.1	14.1–20.6
	Tachycardia	29	5.8	4.0–8.2
	Other arrhythmia	10	2.0	1.1–3.6
Primary ECG outcome	No predefined ECG abnormality	429	85.3	81.9–88.1
	At least one predefined ECG abnormality	74	14.7	11.9–18.1

Symptoms were treated as multiple responses; therefore, percentages for individual symptoms do not sum to 100%

The primary outcome, defined as any predefined ECG abnormality, was present in 74 participants (14.7%; 95% CI 11.9–18.1). The most frequently classified abnormalities were ST-segment abnormalities (25; 5.0%) and conduction disturbances (22; 4.4%), followed by ventricular or supraventricular arrhythmias (10; 2.0%), T-wave abnormalities (9; 1.8%), and atrial fibrillation (8; 1.6%).

The primary ECG outcome was observed in 70 of 438 urban participants (16.0%) and 4 of 65 rural participants (6.2%). This association was statistically significant (p=0.037) but small in magnitude (Cramer's V=0.093). The cross-sectional data do not identify the cause of this difference, and no causal explanation related to lifestyle, environment or access to care is inferred. The comparison by residence is presented in Table 3, and the distribution of specific ECG abnormality categories is shown in Table 4.

Table 3. Primary ECG outcome according to place of residence

Primary ECG outcome	Urban (n=438), n (%)	Rural (n=65), n (%)	χ^2	df	p	Cramer's V
No abnormality	368 (84.0%)	61 (93.8%)	4.36	1	0.037	0.093
Abnormality	70 (16.0%)	4 (6.2%)				

Table 4. Categories of ECG-detected abnormalities among participants who underwent ECG (N=503)

ECG category	n	%	95% CI
No abnormalities	429	85.3	81.9–88.1
ST-segment abnormalities	25	5.0	3.4–7.2
Conduction disturbances	22	4.4	2.9–6.5
Ventricular / supraventricular arrhythmias	10	2.0	1.1–3.6
T-wave abnormalities	9	1.8	0.9–3.4
Atrial fibrillation	8	1.6	0.8–3.1

No statistically significant association was found between the detailed ECG abnormality categories and age group (p=0.214; Cramer's V=0.112). Likewise, no statistically significant association was demonstrated with educational level (p=0.156; Cramer's V=0.114); because many expected cell counts were <5, these detailed cross-tabulations were interpreted cautiously and exact procedures were considered. In the multivariable logistic regression based on 492 complete cases, urban residence was associated with higher odds of the binary primary ECG outcome (aOR 2.89; 95% CI 1.01–8.27; p=0.048). Age, gender, hypertension, diabetes and BMI were not statistically significant independent predictors in this model. The overall model likelihood-ratio test was not statistically significant (p=0.338), so the adjusted residence estimate should be interpreted cautiously and regarded as exploratory, given its wide 95% CI and the non-significant overall model likelihood-ratio test. Age-stratified ECG findings are presented in Table 5; detailed ECG categories by residence are shown in Table 6. However, this comparison was not statistically significant using the Fisher–Freeman–Halton exact test (p=0.461). The multivariable regression results are presented in Table 7.

DISCUSSION

In this voluntary regional screening sample, 14.7% of participants had at least one predefined ECG abnormality. ST-segment abnormalities and conduction disturbances were the most frequent categories. Approximately half of the participants reported at least one analysed cardiovascular symptom, illustrating that symptom reporting and a single

Table 5. ECG-detected abnormalities across age groups

ECG category	≤18 y (n=38)	19–39 y (n=77)	40–64 y (n=206)	≥65 y (n=182)
No abnormalities	29 (76.3%)	64 (83.1%)	179 (86.9%)	157 (86.3%)
ST-segment abnormalities	1 (2.6%)	4 (5.2%)	10 (4.9%)	10 (5.5%)
Conduction disturbances	6 (15.8%)	5 (6.5%)	5 (2.4%)	6 (3.3%)
Ventricular/ supraventricular arrhythmias	1 (2.6%)	2 (2.6%)	3 (1.5%)	4 (2.2%)
T-wave abnormalities	0	1 (1.3%)	6 (2.9%)	2 (1.1%)
Atrial fibrillation	1 (2.6%)	1 (1.3%)	3 (1.5%)	3 (1.6%)

Overall comparison: Pearson χ^2=19.00, df=15, p=0.214, Cramer's V=0.112; Fisher–Freeman–Halton exact p=0.410. Because 67% of expected cell counts were <5, the exact result should be prioritised

Table 6. Detailed ECG abnormality categories according to place of residence

ECG category	Urban (n=438)	Rural (n=65)
No abnormalities	368 (84.0%)	61 (93.8%)
ST-segment abnormalities	24 (5.5%)	1 (1.5%)
Conduction disturbances	21 (4.8%)	1 (1.5%)
Ventricular/supraventricular arrhythmias	10 (2.3%)	0
T-wave abnormalities	8 (1.8%)	1 (1.5%)
Atrial fibrillation	7 (1.6%)	1 (1.5%)

Overall detailed-category comparison: Pearson χ^2=5.29, df=5, p=0.381, Cramer's V=0.103; Fisher–Freeman–Halton exact p=0.461. Forty-two percent of expected cell counts were <5; exact inference is therefore preferred

Table 7. Multivariable logistic regression for the primary ECG outcome (complete cases, n=492)

Covariate	Adjusted OR	95% CI	p
Age, per year	0.99	0.98–1.01	0.310
Male gender	1.04	0.60–1.82	0.892
Urban residence	2.89	1.01–8.27	0.048
Hypertension	0.95	0.50–1.80	0.873
Diabetes	0.91	0.30–2.78	0.867
BMI, per kg/m^2	0.99	0.89–1.09	0.829

Outcome: any predefined ECG abnormality (yes/no). Overall likelihood-ratio test for the model: p=0.338. Coefficient-level associations are exploratory

resting ECG capture different aspects of cardiovascular status. A single resting ECG also has limited sensitivity for intermittent rhythm disturbances, for which prolonged monitoring may be required in selected patients [7–18].

The observed association between place of residence and the primary ECG outcome was statistically significant, but weak. A higher proportion of predefined ECG abnormalities was observed among urban than rural participants (16.0% vs 6.2%; Cramer's V=0.093). Because recruitment was voluntary, the rural subgroup was relatively small, and variables such as healthcare access, environmental exposure and stress were not directly measured, the finding should therefore not be interpreted as evidence that urban residence causes ECG abnormalities or that rural residence is protective.

Age-group and educational-level comparisons did not demonstrate statistically significant associations with the detailed ECG abnormality categories. Sparse cells in several detailed cross-tabulations reduce the reliability of asymptotic chi-square inference; exact testing and cautious interpretation are therefore appropriate. These findings should be regarded as exploratory rather than confirmatory.

The individual-level database permitted an exploratory multivariable analysis of selected cardiovascular risk factors. After simultaneous adjustment for age, gender, hypertension, diabetes and BMI, urban residence was associated with the binary primary ECG outcome, whereas the other included covariates were not statistically significant. The model as a whole did not reach statistical significance, and the number of primary-outcome events was limited; therefore, these adjusted estimates should also be considered exploratory rather than confirmatory.

From a public-health perspective, the findings support the potential value of targeted cardiovascular risk assessment and ECG evaluation in appropriately selected higher-risk or symptomatic groups. Educational programmes addressing modifiable cardiovascular risk factors may complement screening [5, 6]. The urban–rural comparison also indicates a need for further research using representative sampling and direct measures of healthcare access before service inequalities are inferred from these data.

Limitations of the study. This study has several limitations. First, the sample was regional and voluntary, with recruitment from a community screening programme in Lublin and Lublin Province; selection bias is therefore possible and the sample should not be regarded as representative of the entire Lublin Province. Second, the analysis was based on a single resting 12-lead ECG, which has limited ability to detect paroxysmal rhythm disturbances. Third, there was no long-term follow-up, Holter monitoring or systematic confirmation of screening abnormalities in the dataset analysed here. Fourth, the rural subgroup was substantially smaller than the urban subgroup, limiting precision of residence-based comparisons. Fifth, several detailed contingency tables contained low expected cell counts, which limits conventional chi-square inference. Sixth, the multivariable regression was exploratory, used complete cases (n=492), included 74 primary-outcome events, and could not account for unmeasured factors, such as healthcare access, physical activity, smoking intensity or other potential confounders.

CONCLUSIONS

In the studied group of 503 screened participants, at least one predefined ECG abnormality was identified in 74 individuals (14.7%). The most frequent categories were ST-segment abnormalities and conduction disturbances. No statistically significant associations were found between the detailed ECG abnormality categories and age group or educational level. An exploratory association with urban residence was observed (aOR 2.89; 95% CI 1.01–8.27; p=0.048), but the confidence interval was wide and the overall regression model was not statistically significant (p=0.338). These findings apply to the screened sample rather than to the entire Lublin Province and require confirmation in more representative populations, preferably using longitudinal ECG monitoring and pre-specified multivariable analyses.

Practical implications. Periodic ECG assessment may be considered in appropriately selected higher-risk or symptomatic groups; cardiovascular risk-factor education should accompany screening; and access to outpatient

cardiology diagnostics, including in rural areas, should be evaluated using dedicated healthcare-access data rather than inferred from residence alone.

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