

ORIGINAL RESEARCH ARTICLE

Catheter ablation in paroxysmal atrial fibrillation: Sex, BMI, and real-world procedural patterns

Jay Nemade¹, Teimurazi Tchikhoria^{2*}, Gulnoza Dussekeyeva^{3,5}, Nino Javakhidze⁴, and Roin Rekvava^{4,6}

¹Faculty of Medicine, Georgian National University SEU, Tbilisi, Georgia

²Faculty of Medicine, Tbilisi State Medical University, Tbilisi, Georgia

³NEI Kazakh-Russian Medical University, Almaty, Kazakhstan

⁴David Tvildiani Medical University, Tbilisi, Georgia

⁵National Hospital of the Medical Center of the Presidential Administration of the Republic of Kazakhstan, Almaty, Kazakhstan

⁶Department of Cardiac Electrophysiology, American Hospital Tbilisi, Tbilisi, Georgia

Abstract

Paroxysmal atrial fibrillation represents an early and potentially modifiable stage of atrial fibrillation due to its self-terminating nature. Age, body mass index, and sex influence procedural planning and outcomes of catheter ablation. As electrophysiology globally transitions toward low- and zero-fluoroscopy approaches, understanding procedural variability across demographic groups and populations is essential for guiding the adoption of these techniques. This retrospective study evaluated regional and sex-specific differences in demographic characteristics and ablation strategies among 84 patients with paroxysmal atrial fibrillation treated at centers in Georgia ($n = 43$) and Kazakhstan ($n = 41$). Female patients were significantly older than male patients (Cohen's $d = 0.55$, $p = 0.014$), with the largest age difference observed in the Kazakh cohort (Cohen's $d = 0.70$, $p = 0.031$). Across the combined Kazakh and Georgian cohort, no significant sex-related heterogeneity was identified (all $p > 0.05$). Cryoballoon ablation accounted for the majority of procedures (58.3%). In Kazakhstan, cryoablation was more frequently performed in males, whereas in Georgia, a modest preference for radiofrequency ablation among females was observed. Furthermore, fluoroscopy-related metrics highlighted real-world heterogeneity in electrophysiology practice and provided insight into how patient-level factors may influence procedural planning and the implementation of contemporary low- and zero-fluoroscopy ablation techniques.

Keywords: Atrial fibrillation; Paroxysmal atrial fibrillation; Catheter ablation; Cryoballoon ablation; Radiofrequency ablation; Fluoroscopy

*Corresponding author:

Teimurazi Tchikhoria
(t.chikhoriamd@gmail.com)

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1. Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia encountered in clinical practice and is characterized by rapid and disorganized electrical activation of the atria, resulting in ineffective atrial contraction and an irregular ventricular response. The condition represents a growing global health burden, with its prevalence

increasing substantially due to population aging and the rising incidence of cardiovascular risk factors, including hypertension, obesity, diabetes mellitus, and structural heart disease. Beyond its cardiovascular effects, AF is associated with significant adverse clinical outcomes, including ischemic stroke, systemic thromboembolism, heart failure, cognitive decline, dementia, reduced quality of life, and increased all-cause mortality. Notably, patients with AF have an approximately five-fold increased risk of stroke, with AF-related strokes often resulting in greater disability and mortality compared with strokes from other causes. The pathophysiology of AF is complex and involves electrical and structural remodeling of the atrial myocardium, which promotes both the initiation and maintenance of the arrhythmia. Given its substantial contribution to cardiovascular morbidity, healthcare utilization, and economic burden, early identification and effective management of AF remain critical components of contemporary cardiovascular care.¹

Paroxysmal atrial fibrillation (PAF), defined by episodes that terminate spontaneously within seven days, represents an early and potentially modifiable stage within the AF continuum. Early rhythm control strategies in PAF are increasingly emphasized, particularly through catheter ablation, which has demonstrated efficacy in maintaining sinus rhythm and reducing arrhythmia burden.²

Catheter ablation, including cryoballoon and radiofrequency ablation (RFA), uses pulmonary vein isolation (PVI) as the cornerstone strategy for eliminating pulmonary vein-derived triggers. It is increasingly utilized in symptomatic patients or those with antiarrhythmic drug-refractory AF to improve rhythm control and quality of life.³ RFA and cryoballoon ablation remain the most widely used and extensively validated techniques for achieving PVI. However, in recent years, pulsed field ablation (PFA) has emerged as an innovative non-thermal ablation strategy that utilizes irreversible electroporation to preferentially target myocardial tissue. Compared with conventional thermal energy sources, PFA has the potential to reduce collateral injury to adjacent structures, including the esophagus and phrenic nerve, while enabling rapid and effective lesion formation. Evidence from early multicenter clinical studies has demonstrated favorable procedural efficacy, a favorable safety profile, and encouraging durability of PVI, supporting the increasing adoption of PFA in contemporary electrophysiology practice.⁴

1.1. Body mass index as a determinant of procedural complexity

Body mass index (BMI) represents a critical risk determinant due to its direct impact on clinical outcomes

and its alterability with lifestyle interventions.⁵

Obesity is associated with comorbidities such as arterial hypertension, diabetes mellitus, and ischemic heart disease.⁶ These comorbidities contribute to atrial remodeling and fibrosis. Thus, they create a synergistic environment that increases the risk of AF onset and progression.⁷ Maintaining a balanced BMI is essential, because being underweight is also associated with higher all-cause and cardiovascular mortality in AF patients.⁸

Additionally, BMI has been shown to influence both AF pathophysiology and procedural outcomes.⁹ Elevated BMI is associated with atrial structural remodeling, increased epicardial adipose tissue accumulation, prolonged ablation procedures, and greater technical complexity, including vascular access challenges and an increased risk of periprocedural complications.¹⁰ These factors may influence procedural planning and technical complexity during catheter ablation.

Lower BMI may facilitate vascular access and catheter navigation; however, among patients with lower body mass, an increased risk of cardiac perforation and procedural complications has been reported, highlighting a potential non-linear relationship between body habitus and procedural risk.¹¹

1.2. Sex-based differences in procedural characteristics

Sex-based differences further contribute to variability in AF presentation, procedural characteristics, and ablation outcomes. Female patients are more likely to present with AF at an older age and exhibit smaller body size and vascular dimensions, factors that may influence vascular access complexity and procedural planning.¹²

Several studies have reported higher complication rates and recurrence rates in women, potentially reflecting later referral and more advanced substrate at the time of intervention. In contrast, male patients demonstrate a higher overall burden of AF and are often referred earlier for invasive management, with larger atrial dimensions influencing procedural strategy.^{13,14}

These patient-level factors may contribute to variability in catheter ablation characteristics and procedural decision-making in routine clinical practice. Procedural decision-making is therefore increasingly individualized rather than protocol-driven.

1.3. Knowledge gap

While prior studies have explored associations between BMI, sex, and AF incidence^{12–16}, fewer studies have examined how these factors relate to catheter ablation patterns in

PAF across different geographic regions.^{17–21} In addition, the interaction between patient-level characteristics and procedural selection in real-world electrophysiology practice remains incompletely characterized.

Recent advances in cardiac electrophysiology have led to substantial changes in the management of AF, particularly through the increasing use of three-dimensional mapping systems, intracardiac imaging, and low- and zero-fluoroscopy ablation approaches. These developments have improved procedural safety and efficiency; however, patient characteristics remain important factors associated with procedural planning and treatment selection. Factors such as age, sex, and BMI may influence atrial anatomy, disease progression, procedural complexity, and the selection of ablation modality.

Several studies have demonstrated important sex-related differences in AF presentation and management. Women are often diagnosed at an older age, frequently report a higher symptom burden, and may undergo catheter ablation later in the disease course. Similarly, increased BMI has been associated with structural and electrical atrial remodeling, contributing to both the development and persistence of AF. These observations suggest that demographic and anthropometric characteristics may influence not only disease presentation but also clinical management and procedural decision-making.

Despite the growing body of evidence regarding AF, most available data originate from large studies conducted in Western Europe, North America, and selected Asian countries. Evidence from the South Caucasus and Central Asian regions remains limited. Consequently, potential regional differences in patient demographics and treatment practices within these populations remain poorly characterized. Understanding such differences is important because variations in healthcare systems, referral patterns, operator preferences, and access to ablation technologies may influence clinical decision-making and procedural strategies.

Despite the recent emergence of PFA in contemporary cardiac electrophysiology, its implementation in routine clinical practice remains variable across institutions and healthcare systems. Conventional thermal techniques, particularly RFA and cryoballoon ablation, continue to represent the predominant approaches for catheter ablation in many regions where access to PFA remains limited. Therefore, evaluating demographic and clinical factors associated with current ablation strategies is essential for understanding contemporary procedural decision-making and establishing a framework for assessing the future integration and potential clinical implications of PFA.⁴

In this context, the present study aimed to examine sex- and region-specific differences in age, BMI, and catheter ablation strategy among patients with PAF treated in Georgia and Kazakhstan. By evaluating real-world data from two geographically underrepresented populations, this study seeks to provide additional insight into contemporary ablation practice and contribute to the limited evidence available from these regions.

2. Methodology

2.1. Study population and data collection

A total of 84 patients were retrospectively included in this cross-sectional study, comprising 43 patients from Georgia and 41 patients from Kazakhstan. To examine sex-specific differences in demographic characteristics, management strategies, and BMI among patients with PAF, data on age, BMI, sex, and procedure type were collected.

The cohorts were derived from periods in which routine institutional protocols for PAF management were consistently applied at each center. The Kazakhstan cohort was enrolled between 2019 and 2022, whereas the Georgia cohort was enrolled between 2022 and 2024. Thus, this study characterizes sex- and center-specific patterns in demographic characteristics, BMI, and catheter ablation strategy among geographically understudied regions. Rather than establishing causal regional differences, this exploratory analysis aims to describe cohort variability and generate hypotheses for future comparative studies.

2.2. Data analysis

Age, BMI, and procedure type were analyzed across the study cohort. Data from each center were stratified by sex, resulting in four subgroups: (i) male and (ii) female patients from Georgia, and (iii) male and (iv) female patients from Kazakhstan.

Normality of continuous variables was assessed using the Shapiro–Wilk test. Sex-based differences in age and BMI were evaluated using independent *t*-tests, with effect sizes reported as Cohen's *d*. Differences in categorical variables (procedure type) were assessed using Cohen's *h*.

Additionally, BMI distribution characteristics and potential outliers were explored using kernel density estimation as a non-parametric density estimation method. These distributions were used to qualitatively assess variability across subgroups.

All statistical analyses were conducted using Python 3.11.1 (Python Software Foundation, United States) with the NumPy, SciPy, pandas, and scikit-learn libraries. Visualizations were generated using Bokeh. Two-tailed

p -values < 0.05 were considered statistically significant.

A sensitivity power analysis was performed to estimate the minimum detectable effect size given the achieved sample size. For the overall comparison between male and female patients ($n = 40$ and $n = 44$, respectively), assuming a two-sided α of 0.05 and 80% power, the study was capable of detecting standardized differences of approximately Cohen's $d = 0.62$, corresponding to a BMI difference of approximately 3 kg/m², given the observed pooled variance. Following stratification by center, subgroup sizes of approximately 20 participants per group reduced statistical power substantially, allowing detection primarily of large effects (Cohen's $d \approx 0.9$). Therefore, non-significant BMI comparisons should not be interpreted as evidence of equivalence, as smaller or moderate differences may not have been detectable.

2.3. Ethics

The study was conducted in accordance with the Declaration of Helsinki. All data were fully anonymized prior to analysis. The study was exempted from formal ethical review under local regulations governing retrospective observational studies involving de-identified data (by the Personal Data Protection Service of Georgia) for both centers. Consent documentation is retained by the investigators and available upon reasonable request.

3. Results

3.1. Baseline characteristics

From the baseline characteristics (Table 1), the median age of the overall cohort was 65 years (interquartile range [IQR]: 57–68; range 29–80), and mean BMI was 30.0 ± 5.2 kg/m² (range: 19.1–43.7). Cryoablation and RFA were

performed in 58.3% and 41.7% of patients, respectively.

In the overall cohort, male patients had a median age of 61 years (IQR: 57.5–66; range: 43–76) and a BMI of 29.3 ± 4.6 kg/m² (range: 22–43.7), with 62.5% undergoing cryoablation. Female patients had a median age of 67 years (IQR: 58.3–71; range: 29–80) and a BMI of 30.8 ± 5.7 kg/m² (range: 19.1–43), with 54.5% receiving cryoablation.

In the Kazakhstan cohort, the mean age was 60.6 ± 8.6 years (range: 37–77), and mean BMI was 29.4 ± 4.0 kg/m² (range: 21.6–37.2). Cryoablation and RFA were performed in 68.3% and 31.7% of patients, respectively. Male patients had a mean age of 57.8 ± 9.7 years (range: 37–73) and a BMI of 28.6 ± 3.8 kg/m² (range: 23.2–35.5), with 71.4% undergoing cryoablation. Female patients had a mean age of 63.5 ± 6.3 years (range: 53–77) and a BMI of 30.3 ± 4.0 kg/m² (range: 21.6–37.2), with 65.0% receiving cryoablation.

In the Georgia cohort, the median age was 67 years (IQR: 60–74; range: 29–80), and mean BMI was 30.7 ± 6.2 kg/m² (range: 19.1–43.7). RFA was slightly more frequent (51.2%) than cryoablation (48.8%). Male patients had a median age of 66 years (IQR: 60–68; range 40–76) and a BMI of 30.1 ± 5.4 kg/m² (range: 22.1–43.7), with 52.6% undergoing cryoablation. Female patients had a median age of 69 years (IQR: 63.3–74; range: 29–80) and a BMI of 31.2 ± 6.8 kg/m² (range: 19.1–43), with 45.8% receiving cryoablation.

3.2. Statistical analysis

Normality of BMI distribution was confirmed across all groups using the Shapiro–Wilk test (all $p > 0.05$), including the overall cohort ($p = 0.444$), Kazakhstan cohort ($p = 0.545$), and Georgia cohort ($p = 0.605$).

Table 1. Baseline characteristics of the cohort

Group	Age (years) ^a	BMI (kg/m ² [mean $\pm$ SD; range])	Cryoablation (n [%])	RFA (n [%])
Overall cohort ($n = 84$)	65 (57–68); 29–80	30 ± 5.2 ; 19.1–43.69	49 (58.3%)	35 (41.7%)
Male ($n = 40$)	61 (57.5–66); 43–76	29.3 ± 4.6 ; 22–43.7	25 (62.5%)	15 (37.5%)
Female ($n = 44$)	67 (58.3–71); 29–80	30.8 ± 5.7 ; 19.1–43	24 (54.5%)	20 (45.5%)
Kazakhstan cohort ($n = 41$)	60.6 ± 8.6 ; 37–77	29.4 ± 4 ; 21.6–37.2	28 (68.3%)	13 (31.7%)
Male ($n = 21$)	57.8 ± 9.7 ; 37–73	28.6 ± 3.8 ; 23.2–35.5	15 (71.4%)	6 (28.6%)
Female ($n = 20$)	63.5 ± 6.3 ; 53–77	30.3 ± 4 ; 21.6–37.2	13 (65%)	7 (35%)
Georgia cohort ($n = 43$)	67 (60–74); 29–80	30.7 ± 6.2 ; 19.1–43.7	21 (48.8%)	22 (51.2%)
Male ($n = 19$)	66 (60–68); 40–76	30.1 ± 5.4 ; 22.1–43.7	10 (52.6%)	9 (47.4%)
Female ($n = 24$)	69 (63.3–74); 29–80	31.2 ± 6.8 ; 19.1–43	11 (45.8%)	13 (54.2%)

Note: ^aData are presented as mean $\pm$ standard deviation for normally distributed data or median (IQR; range) for non-normally distributed data, with categorical variables presented as n (%).

Abbreviations: BMI: Body mass index; RFA: Radiofrequency ablation; SD: Standard deviation.

Age distribution showed mixed normality patterns. In the overall cohort, age was not normally distributed ($p = 0.002$), including females ($p = 0.001$), while males demonstrated approximate normality ($p = 0.056$). In the Kazakhstan cohort, age distribution did not significantly deviate from normality across subgroups (overall $p = 0.407$), whereas in the Georgia cohort, normality was not observed ($p < 0.05$ across subgroups).

For BMI, sex-related effect sizes were small in the combined cohort ($d = 0.27$) and in Georgia ($d = 0.17$), and moderate in Kazakhstan ($d = 0.42$). For age, effect sizes were medium in the combined cohort ($d = 0.55$), moderate in Georgia ($d = 0.40$), and largest in Kazakhstan ($d = 0.70$).

Between-sex differences in procedural distribution were negligible to small. For cryoablation, Cohen's h was -0.16 overall, -0.14 in Kazakhstan, and -0.14 in Georgia. Similarly, the corresponding effect sizes for RFA were small ($h = 0.16$ overall, 0.14 in Kazakhstan, and 0.14 in Georgia). Between-sex comparisons using independent-samples t -tests showed no significant differences in BMI overall ($t = 1.26$, $p = 0.21$), in Kazakhstan ($t = 1.34$, $p = 0.19$), or in Georgia ($t = 0.56$, $p = 0.58$). Age differences were significant when analyzing the entire study population ($t = 2.50$, $p = 0.014$) and in Kazakhstan ($t = 2.25$, $p = 0.031$), but not in Georgia ($p = 0.19$).

Effect sizes were interpreted according to conventional thresholds, with values of approximately 0.2, 0.5, and 0.8 representing small, medium, and large effects, respectively, for both Cohen's d and Cohen's h . F

3.3. Distribution analysis

Kernel density estimation (Figure 1), consistent with the statistical tests, indicated that BMI distributions were approximately normal across the cohort, with an estimated area under the curve of 0.97 across the observed BMI range. The overall BMI distribution had a slight positive skewness ($\gamma_1 = 0.35$) and a slightly platykurtic shape ($\gamma_2 = -0.22$). Male BMI distribution was moderately right-skewed ($\gamma_1 = 0.78$) and somewhat peaked ($\gamma_2 = 0.61$), whereas female BMI distribution was nearly symmetric ($\gamma_1 = 0.02$) with a slightly flattened peak ($\gamma_2 = -0.52$).

Because the area under a kernel density estimation integrates to 1 over the complete distribution, the observed area under the curve of 0.97 within the empirical BMI range indicates that approximately 97% of the estimated probability density was captured within the observed range of BMI values. This suggests that the study cohort covered most of the BMI variability observed within the sampled population. Nevertheless, despite this broad distributional coverage, interpretation of between-group comparisons remains limited by the modest sample size and statistical

power, particularly in the stratified subgroup analyses, as discussed above.

4. Discussion

4.1. Principal findings

The BMI distribution demonstrated slight platykurtosis, suggesting a relatively low proportion of extreme values within the study cohort. Despite the modest sample size, distributional analysis indicates that the observed BMI range captures a broad spectrum of variability within this sample, supporting internal consistency of the dataset.

Female patients were generally older than male patients, most notably in the Kazakhstan cohort (Cohen's $d = 0.70$; $p = 0.031$), whereas Georgia demonstrated a smaller, non-significant age difference with younger females compared with males. These findings suggest potential regional variability in patient demographics and timing of catheter ablation referral. Given the non-significant p -value of 0.19 for age differences in the Georgian cohort, the overall age difference observed between sexes was driven primarily by the Kazakhstan cohort.

Although female patients exhibited slightly higher BMI than male patients (30.8 ± 5.7 kg/m² vs. 29.3 ± 4.6 kg/m²; $d = 0.27$), these differences were not statistically significant in the combined cohort or within either cohort. The sex-related BMI difference was more pronounced in Kazakhstan, which may reflect regional differences in population characteristics or healthcare pathways; however, no causal inference can be drawn. Potential explanations may include differences in lifestyle patterns or demographic characteristics, although these factors were not directly assessed in the present study.

Cryoablation was more frequently utilized than RFA across the cohorts. The most notable sex imbalance in procedural distribution was observed in Kazakhstan among male patients. In contrast, Georgia demonstrated a slight tendency toward RFA in females. These findings highlight potential heterogeneity in procedural selection patterns.

4.2. Exploratory procedural implications

Elimination or reduction of fluoroscopy has become increasingly feasible in contemporary electrophysiology, particularly through the integration of electroanatomic mapping systems and intracardiac echocardiography (ICE).²² However, the extent to which zero-fluoroscopy workflows are adopted varies across procedural modalities.²³

Radiofrequency ablation is more commonly integrated into established zero- or low-fluoroscopy workflows due to

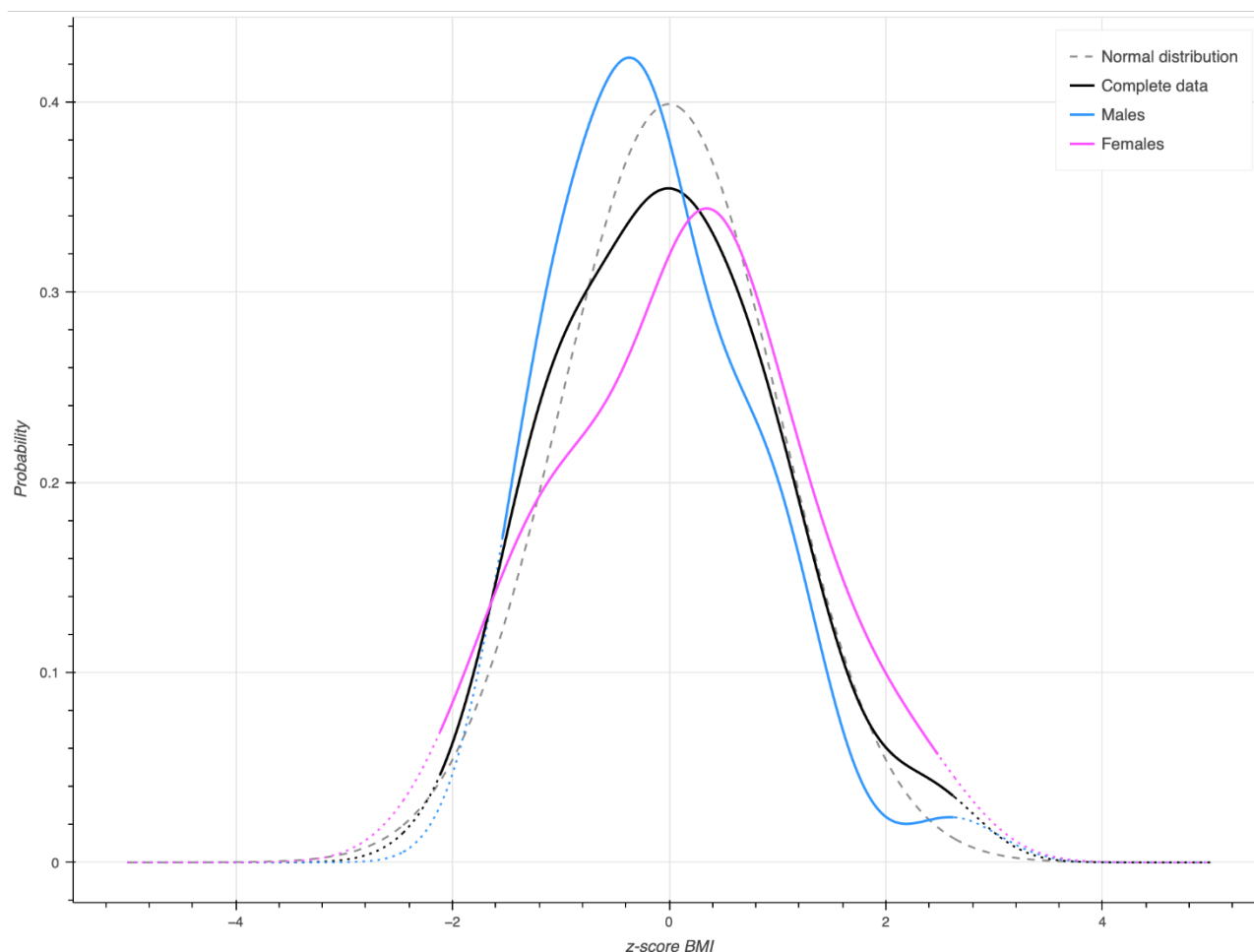


Figure 1. Kernel density estimation of body mass index (BMI) distributions. The graph shows the probability density of BMI values standardized as z-scores. The dotted lines represent the extended distribution range, whereas the bold lines indicate the observed BMI range of the cohort. A normal distribution curve is plotted for reference.

its compatibility with real-time electroanatomic mapping and catheter visualization.²⁴ In contrast, cryoablation, while technically compatible with reduced fluoroscopy strategies, has traditionally incorporated fluoroscopic guidance for balloon positioning and therefore may require additional workflow adaptation in fully fluoroscopy-minimized approaches.²⁵

Sex-related anatomical differences, including smaller vascular caliber and older age at presentation in female patients, may be relevant in the context of fluoroscopy reduction strategies, as these factors can influence vascular access complexity and catheter manipulation. However, the present study does not directly assess procedural difficulty or fluoroscopy use.

Similarly, BMI may be relevant to procedural planning

through its association with vascular access and imaging conditions, although its impact appears to be more related to procedural logistics than to ablation efficacy.

Within this exploratory cohort, the observed regional differences in procedural strategy and sex distribution may provide contextual insight into variability in electrophysiology practice patterns. However, these findings should be interpreted as hypothesis-generating rather than indicative of procedural superiority or a direct impact on fluoroscopy reduction feasibility.

Regional differences in the distribution of cryoablation and RFA may also reflect differences in institutional workflows and operator preferences and may provide contextual relevance for future adaptation of low-fluoroscopy workflows.

An important contemporary trend is the transition toward fluoroscopy-minimizing workflows. In the AdmIRE trial, nearly one-quarter of PVI procedures were successfully performed without fluoroscopy through the combined use of electroanatomic mapping and intracardiac echocardiography. As electrophysiology laboratories increasingly adopt advanced imaging technologies, fluoroscopy exposure may become a less meaningful differentiator between ablation techniques, with greater emphasis placed on procedural efficiency, lesion quality, and patient safety.²⁶

4.3. Limitations

The retrospective design and modest sample size limit the strength of causal inference. Importantly, fluoroscopy-related parameters—including fluoroscopy time, dose, or zero-fluoroscopy utilization—were not available, preventing direct evaluation of fluoroscopy reduction strategies.

An important contextual consideration when interpreting the present findings is the relatively limited volume of catheter ablation procedures performed at the participating centers compared with high-volume electrophysiology programs in Western Europe and North America. In countries such as Georgia and Kazakhstan, catheter ablation remains associated with substantial procedural costs and variable accessibility, which may influence referral patterns and the timing of intervention. Consequently, many patients may undergo rhythm-control procedures later in the disease course, potentially after progression from paroxysmal to more advanced forms of AF, where procedural complexity and recurrence rates are generally higher. These healthcare-system and socioeconomic factors may contribute to the relatively modest number of eligible patients undergoing catheter ablation within a given time period. Therefore, larger multicenter studies involving broader regional collaboration will be important for further characterizing demographic and procedural differences across these populations.

Although the two cohorts were derived from different recruitment periods (Kazakhstan: 2019–2022; Georgia: 2022–2024), this temporal distinction also reflects the evolving landscape of contemporary electrophysiology practice. During this interval, AF ablation strategies underwent progressive technological and procedural refinement, including broader integration of electroanatomic mapping systems, intracardiac echocardiography, reduced-fluoroscopy workflows, and the emergence of novel ablation platforms. Therefore,

differences observed between the cohorts should not be interpreted as isolated geographic effects, but rather as variations arising from distinct real-world practice environments shaped by regional healthcare systems, institutional workflows, technological availability, and procedural evolution. Importantly, the purpose of this study was not to establish causal differences between Georgia and Kazakhstan, but to characterize patient populations from understudied regions and describe procedural patterns within their respective clinical contexts. In this regard, these cohorts provide a contemporary reference framework for future prospective studies designed to disentangle the relative contributions of geography, time period, institutional practice, and evolving ablation technology.

Additionally, key clinical covariates such as hypertension, diabetes mellitus, obstructive sleep apnea, coronary artery disease, left atrial size, CHA₂DS₂-VASc score, and AF burden were not included, which may confound the interpretation of procedural selection patterns.

Finally, regional differences in recruitment periods and institutional practice evolution may introduce temporal heterogeneity that cannot be fully adjusted for in the present analysis. Thus, direct comparisons between regions are limited, and the findings should be interpreted as exploratory and hypothesis-generating.

4.4. Future directions

Future electrophysiology practice is increasingly moving toward fluoroscopy reduction and, in selected settings, complete elimination of fluoroscopy exposure in selected procedures through integration of electroanatomic mapping systems and ICE. Within this evolving framework, understanding patient-level and regional variability may be relevant for optimizing procedural workflows and adoption of zero-fluoroscopy strategies.

Prospective studies incorporating direct fluoroscopy metrics, imaging integration (including ICE), and procedural workflow parameters are needed to clarify how demographic and institutional factors interact with emerging zero-fluoroscopy technologies.

As PFA becomes increasingly incorporated into clinical practice, future research should determine whether patient characteristics, including sex and BMI, as well as regional practice patterns, influence the adoption and implementation of emerging ablation technologies. Comparative multicenter studies across different ablation technologies may help optimize personalized treatment strategies for AF.²⁶

5. Conclusion

This study contributes new evidence on demographic characteristics and catheter ablation patterns among patients with PAF from Georgia and Kazakhstan—patient populations from regions that have received limited attention in the electrophysiology literature. Although no significant sex-related differences in BMI were observed, female patients underwent catheter ablation at an older age, particularly within the Kazakhstan cohort. Differences in the utilization of cryoballoon and RFA were also observed between regions, suggesting variability in clinical practice and procedural decision-making.

While the present findings do not establish causal relationships, they demonstrate that patient demographics and treatment patterns may differ substantially across the studied populations, even among patients undergoing similar procedures for the same arrhythmia. These observations are relevant as catheter ablation continues to evolve toward increasingly individualized treatment strategies and greater adoption of advanced imaging and mapping technologies.

Several important questions require further evaluation in future studies. The factors responsible for the observed differences in patient age at the time of ablation and ablation modality selection cannot be determined from the available data and may reflect variations in healthcare systems, referral pathways, operator preferences, resource availability, or underlying disease characteristics. In addition, the study was not designed to evaluate procedural complexity, fluoroscopy exposure, procedural success, recurrence rates, or long-term clinical outcomes, all of which may be influenced by demographic and anthropometric characteristics.

Further multicenter prospective studies with larger patient populations are needed to better characterize these relationships and determine whether regional and sex-related differences translate into meaningful differences in procedural characteristics or clinical outcomes. The incorporation of clinical comorbidities, atrial structural parameters, procedural metrics, and long-term follow-up data will be essential for improving our understanding of patient selection and treatment strategies in contemporary AF ablation practice.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

Conceptualization: Jay Nemade, Teimurazi Tchikhorja, Roin Rekvava

Data curation: Jay Nemade, Gulnoza Dussekeyeva, Nino Javakhidze

Formal analysis: Jay Nemade, Nino Javakhidze

Investigation: All authors

Methodology: Jay Nemade, Teimurazi Tchikhorja

Supervision: Roin Rekvava, Gulnoza Dussekeyeva

Visualization: Jay Nemade, Teimurazi Tchikhorja

Writing—original draft: Jay Nemade, Teimurazi Tchikhorja

Writing—review & editing: Gulnoza Dussekeyeva, Nino Javakhidze, Roin Rekvava

All authors have read and approved the final manuscript.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. The study was exempt from formal ethical review under local regulations governing retrospective observational studies involving de-identified data (Personal Data Protection Service, Georgia) for both centers. Consent documentation is retained by the investigators and available upon reasonable request.

Consent for publication

All data were fully anonymized prior to analysis. Consent documentation is retained by the investigators and available upon reasonable request.

Availability of data

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Further disclosure

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