

# Structural Factors Associated with Provincial Variation in False Emergency Medical Service Calls in Türkiye: An Ecological Analysis

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## Abstract

**Aim:** To evaluate provincial variation in false emergency medical service (EMS) call rates across Türkiye and to examine the association between education indicators and these rates after accounting for EMS accessibility and primary care availability.

**Materials and Methods:** This ecological study analyzed province-level data for 2024 from all 81 Turkish provinces using official datasets from the Ministry of Health General Directorate of Emergency Health Services, the Turkish Statistical Institute, and the Health Statistics Yearbook 2024. The dependent variable was the provincially reported false alarm rate (%), defined as a composite administrative measure including non-emergency conditions manageable in primary care, hoax or malicious calls, and refused transport after ambulance arrival. These three components likely reflect distinct underlying mechanisms: non-emergency calls may represent barriers to primary care access, hoax calls may reflect behavioral and social factors, and refused transport may indicate that the caller has reassessed urgency or is seeking alternative care. Because these components could not be analyzed separately in the available aggregated data, the composite outcome was interpreted cautiously as a system-level operational indicator, rather than as a homogeneous clinical or behavioral construct. Inter-provincial differences in triage protocols and documentation practices may further affect the consistency of classification. Education indicators, EMS accessibility measures, and primary care availability were examined. Pearson correlation analyses, independent-samples t-tests, and multiple linear regression analyses with robust standard errors were performed.

**Results:** The mean false alarm rate was  $8.75\% \pm 2.86\%$  (range 4.2%-14.7%). Metropolitan provinces had significantly higher rates than non-metropolitan provinces ( $10.12\% \pm 3.45\%$  vs.  $7.88\% \pm 1.89\%$ ,  $p < 0.001$ ). The university education rate showed a weak, non-significant correlation with the false alarm rate ( $r = 0.13$ ,  $p = 0.258$ ). Population per family physician unit showed a moderate positive correlation with the false alarm rate ( $r = 0.545$ ,  $p < 0.001$ ). In the multiple linear regression model ( $R^2 = 0.378$ ,  $p < 0.001$ ), the university education rate was not independently associated with false alarm rates ( $\beta = -0.062$ ,  $p = 0.434$ ), although the association's direction was negative (suggesting lower false alarm rates with higher education). Population served per EMS station ( $\beta = 0.134$ ,  $p = 0.006$ ) and population per family physician unit ( $\beta = 7.317$ ,  $p < 0.001$ ) showed independent, statistically significant associations. The number of EMS stations was not independently associated ( $\beta = 0.006$ ,  $p = 0.477$ ).

**Conclusion:** In this nationwide ecological analysis, provincial education levels were not independently associated with rates of false EMS calls after adjustment for EMS accessibility and primary care availability. Both EMS accessibility and primary care availability showed significant, independent associations with false alarm rates, suggesting that structural factors related to access to healthcare services are more strongly associated with provincial variation than educational indicators. The findings are consistent with the possibility that limited access to primary care may contribute to increased non-urgent EMS utilization at the population level.

**Keywords:** Emergency medical services, false EMS calls, EMS utilization, health service accessibility, primary care, ecological study, Türkiye



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## Introduction

Emergency medical services (EMS) are designed to provide rapid response to life-threatening conditions. However, non-urgent or inappropriate EMS utilization remains a persistent challenge worldwide and may contribute to increased workload, inefficient resource allocation, and potential delays for critically ill patients (1,2). Understanding the structural determinants of system-level EMS utilization patterns has therefore become an important focus of health services research.

Reported rates of non-urgent EMS use vary substantially across countries and healthcare systems (3,4). These variations are associated not only with individual patient behavior but also with structural characteristics such as service accessibility, dispatch organization, urbanization level, and primary care availability (5-9). Previous research has consistently reported that limited access to primary care services is correlated with higher non-urgent EMS utilization, as patients may use emergency services as an alternative access pathway when primary care is unavailable or inaccessible (2,4).

In Türkiye, EMS services are coordinated through a nationwide centralized dispatch structure via the 112 Emergency Call Centers, providing a standardized organizational framework suitable for evaluating inter-provincial variation using national administrative EMS datasets (10). Primary care services are delivered through the Family Medicine system, with each family physician unit serving a defined population (11). This ecological study therefore aimed to evaluate provincial variation in false EMS call rates across all 81 provinces of Türkiye and to examine whether education indicators were independently associated with these rates after accounting for EMS accessibility measures and primary care availability. As with all ecological analyses, interpretation of province-level associations should consider the potential for ecological fallacy (12).

## Materials and Methods

This study used publicly available province-level aggregated administrative data and did not include individual patient-level information. Therefore, ethics committee approval and individual informed consent were not required.

### Study Design and Data Sources

This ecological study analyzed province-level aggregate data from all 81 provinces of Türkiye using publicly available 2024 national datasets. Data on provincially reported false EMS call rates and the number of emergency health stations were obtained from the Ministry of Health General Directorate of Emergency Health Services (10). Education attainment data were obtained from the

Turkish Statistical Institute National Education Statistics Database (13). Primary care availability data, including family physician unit numbers and population per family physician unit, were obtained from the Health Statistics Yearbook 2024, Table 7.20 (11).

### Statistical Analysis

Statistical analyses were performed using Python (version 3.12; pandas, SciPy, and statsmodels libraries). Descriptive statistics are presented as mean  $\pm$  standard deviation (SD). Bivariate associations were examined using Pearson correlation coefficients. Multiple linear regression with Huber-White robust standard errors was used to assess independent associations, with the dependent variable treated as a continuous proportion bounded between 0 and 1. Although fractional logit and beta regression are alternative modeling approaches for proportional outcomes, linear regression with robust standard errors provides consistent estimates of marginal effects and has been widely used in ecological and health services research involving bounded proportional outcomes, and was selected for direct comparability with prior ecological EMS utilization studies and ease of coefficient interpretation. Sensitivity analyses using fractional logit regression yielded qualitatively similar results (Appendix 1), and the primary findings were therefore considered robust to the choice of modeling framework. For the fractional logit sensitivity analysis, all percentage values were divided by 100 and modelled as fractional values on the 0-1 scale, as required by the bounded mean assumption of the fractional response model (14). Multicollinearity was evaluated using variance inflation factors (VIF).

## Results

### Provincial Characteristics

Table 1 presents descriptive statistics for the 81 provinces included in the analysis. The mean false alarm rate was 8.75% (SD=2.86%, range 4.2%-14.7%). The mean population per family physician unit was 2.89 thousand (SD=0.17, range 2.54-3.25), with a national average of 2.97 thousand according to the Health Statistics Yearbook 2024 (11).

Metropolitan provinces (n=31) had significantly higher false alarm rates than non-metropolitan provinces (n=50) (10.12% $\pm$ 3.45% vs. 7.88% $\pm$ 1.89%,  $p<0.001$ ).

### Bivariate Associations

Table 2 presents the correlation matrix for all study variables. Population per family physician unit showed a moderate positive correlation with false alarm rate ( $r=0.545$ ,  $p<0.001$ ), indicating that provinces with lower primary care accessibility (higher

population per family physician unit) experienced higher false EMS call rates. Population served per EMS station also showed a moderate positive correlation with false alarm rate ( $r=0.459$ ,  $p<0.001$ ). The university education rate showed a weak, non-significant correlation with the false alarm rate ( $r=0.13$ ,  $p=0.258$ ) (Figure 1).

### Multiple Regression Analysis

Table 3 presents the results of the multiple linear regression analysis. After adjustment for EMS accessibility measures and primary care availability, university education rate was not independently associated with false alarm rates [ $\beta=-0.062$ , standard error (SE)=0.079,  $p=0.434$ ], although the direction of the association was negative (suggesting lower false alarm rates with higher education). In contrast, both structural accessibility indicators showed statistically significant independent associations: population served per EMS station ( $\beta=0.134$ ,

SE=0.049,  $p=0.006$ ) and population per family physician unit ( $\beta=7.317$ , SE=1.797,  $p<0.001$ ). Number of EMS stations was not independently associated with false alarm rates ( $\beta=0.006$ , SE=0.008,  $p=0.477$ ). The overall model explained 37.8% of the variance in false alarm rates ( $R^2=0.378$ ,  $F=15.12$ ,  $p<0.001$ ). VIF were all below 2.0, indicating no substantial multicollinearity. The distribution of false alarm rates across Turkish provinces is shown in Figure 2.

### Discussion

After adjustment for EMS accessibility indicators and primary care availability, provincial university education rate was not independently associated with false EMS call rates. In contrast, both EMS accessibility-related structural indicators and primary care availability remained significantly associated with inter-provincial variation. These findings suggest that crude associations between education indicators and false EMS calls

**Table 1. Provincial characteristics and key indicators (n=81)**

Variable	Mean ± SD	Min	Max
False alarm rate (%)	8.75±2.86	4.20	14.66
University and higher education rate (%)	14.26±3.69	8.08	23.40
Illiteracy rate (%)	2.87±1.15	0.99	4.96
Upper secondary education rate (%)	17.37±2.25	12.64	22.31
Population served per EMS station (1000s)	17.73±6.64	6.51	36.16
Number of EMS stations	50.79±39.00	8.00	149.44
Population per family physician unit (1000s)	2.89±0.17	2.54	3.25

EMS: Emergency medical service, SD: Standard deviation

**Table 2. Correlation matrix of education indicators, EMS accessibility, primary care availability, and false alarm rates**

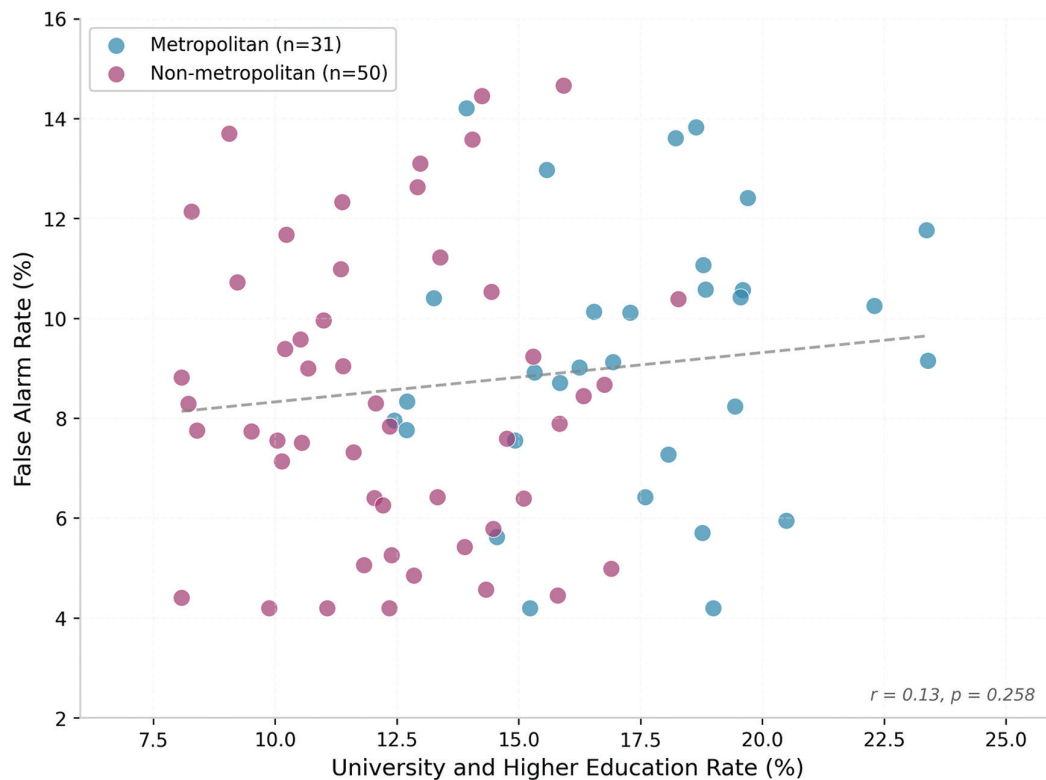
Variable	1	2	3	4	5	6	7
1. False alarm rate	1.00						
2. University education rate	0.13	1.00					
3. Illiteracy rate	-0.05	-0.80***	1.00				
4. Upper secondary rate	0.10	0.82***	-0.69***	1.00			
5. Pop per EMS station	0.46***	0.15	0.00	-0.01	1.00		
6. Number of EMS stations	0.09	0.54***	-0.45***	0.40***	-0.06	1.00	
7. Pop per family physician	0.55***	0.27*	-0.19	0.15	0.38***	0.18	1.00

\* $p<0.05$ , \*\*\* $p<0.001$ , EMS: Emergency medical service

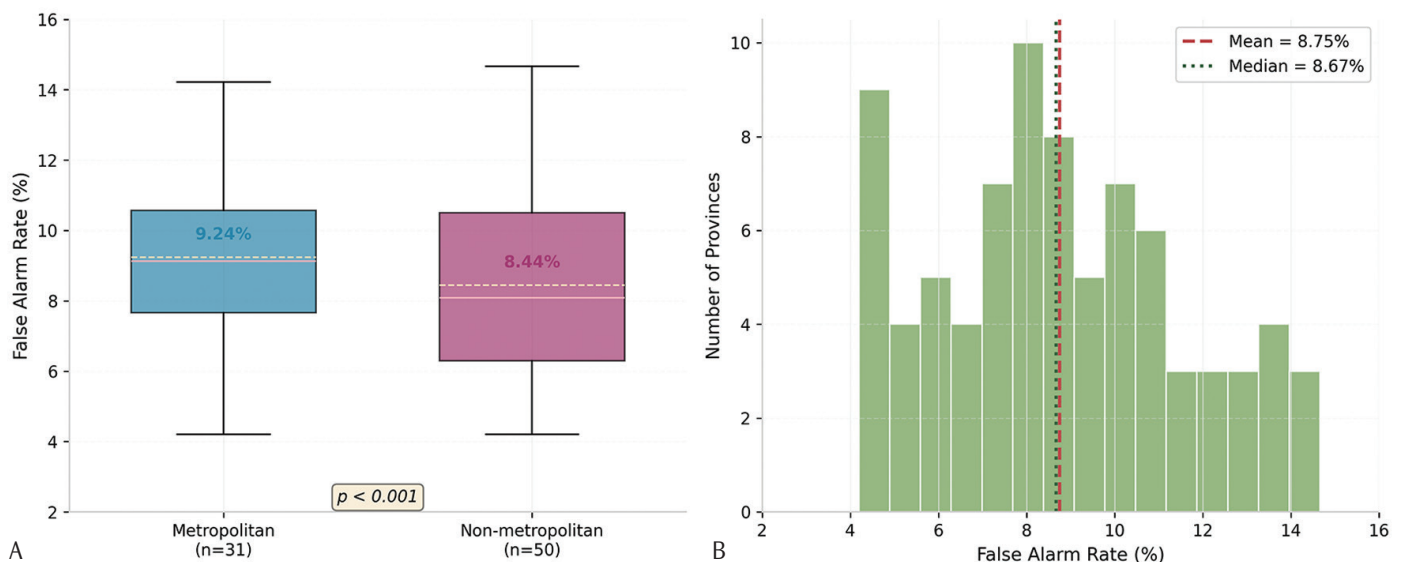
**Table 3. Multiple linear regression analysis of factors associated with false alarm rates**

Variable	$\beta$	SE	t	p	95% CI
Constant	-14.158	4.634	-3.055	0.002	-23.240 to -5.075
University education rate (%)	-0.062	0.079	-0.782	0.434	-0.217 to 0.093
Population served per station (1000s)	0.134	0.049	2.763	0.006	0.039 to 0.229
Number of EMS stations	0.006	0.008	0.711	0.477	-0.010 to 0.022
Population per family physician unit (1000s)	7.317	1.797	4.072	<0.001	3.795 to 10.839

$R^2=0.378$ ,  $F=15.12$ ,  $p<0.001$ , EMS: Emergency medical service, SE: Standard error, CI: Confidence interval



**Figure 1.** Relationship between university education rate and false alarm rates by province type  
Metropolitan provinces (blue, n=31) had higher education rates but showed similar false alarm patterns compared to non-metropolitan provinces (purple, n=50). The correlation was not statistically significant ( $r=0.13$ ,  $p=0.258$ )



**Figure 2.** Distribution of false alarm rates across Turkish provinces  
(A) Boxplot comparing metropolitan and non-metropolitan provinces showing significantly higher rates in metropolitan areas ( $p<0.001$ ) Metropolitan median: 9.24%, non-metropolitan median: 8.44% (B) Histogram of false alarm rate distribution across all 81 provinces with overall mean (8.75%) and median (8.67%) indicated

are more likely to reflect differences in service accessibility and healthcare infrastructure than differences in education level itself.

The finding that population per family physician unit was independently associated with false EMS call rates represents an important contribution of this analysis. This finding is compatible with prior literature suggesting that limited access to primary care services may be associated with greater non-urgent EMS utilization. Previous studies have consistently reported that inadequate primary care availability is correlated with inappropriate emergency service use, as patients may resort to EMS when timely primary care access is unavailable (2,4,15). Our results extend these findings to the Turkish context, observing that provinces with better primary care accessibility tend to have lower false EMS call rates.

The magnitude of the association is substantial at the provincial level: each 1000-person increase in population per family physician unit was associated with approximately 7.3 percentage points higher false alarm rate, after controlling for EMS accessibility and education. This finding suggests that provinces with the lowest primary care accessibility (3.25 thousand population per unit) had false alarm rates approximately 5.2 percentage points higher than provinces with the best accessibility (2.54 thousand population per unit), based on model predictions.

The non-significant association between number of EMS stations and false alarm rates, after controlling for population served per station and primary care availability, may reflect the endogenous nature of EMS station allocation based on historical demand patterns. This finding is consistent with the reverse causality concern that EMS stations are typically allocated according to historical service demand rather than being an exogenous determinant of utilization patterns.

The inclusion of primary care accessibility indicators represents an important strength of this analysis compared with previous ecological studies of EMS utilization. By adjusting for both EMS and primary care structural characteristics, our model provides a more comprehensive assessment of the structural determinants of provincial variation in false EMS calls. However, the cross-sectional design precludes determination of whether improvements in primary care accessibility would lead to reductions in false EMS call rates over time.

From a policy perspective, the findings suggest that interventions focusing solely on general education level are unlikely to be associated with substantially lower false EMS call rates at the population level. Instead, system-level demand management

strategies—such as improved public guidance on appropriate EMS use, telephone triage systems, community paramedicine programs, and strengthened after-hours primary care access—may provide more effective approaches for optimizing EMS utilization patterns. The significant association between primary care availability and false EMS calls suggests that provinces with lower population-to-family-physician ratios tended to demonstrate lower false EMS call rates.

### Study Limitations

This study has several important limitations. First, the ecological design limits interpretation to province-level associations and does not allow individual-level inference. The ecological fallacy risk (14) is particularly relevant for the education-related findings: provincial-level education rates may not reflect the educational characteristics of individual EMS callers, and the absence of an association at the aggregate level does not preclude individual-level associations between health literacy and appropriate EMS use. Second, the dependent variable represents a composite administrative indicator combining non-emergency calls, hoax or malicious calls, and refused transport after ambulance arrival. These components likely reflect different underlying behavioral and structural mechanisms and could not be analyzed separately due to data aggregation. This aggregation may attenuate or mask associations that would be detectable if the components were analyzed separately; for example, if primary care accessibility is strongly associated with non-emergency calls but only weakly associated with hoax calls, the composite measure would dilute the true magnitude of that relationship. Third, the cross-sectional design precludes any causal inference; all reported associations are observational and may be subject to unmeasured confounding. Fourth, several potentially important confounders could not be included due to data availability, including provincial socioeconomic status indicators (unemployment rates, income levels), urbanization gradients beyond the metropolitan versus non-metropolitan dichotomy, regional variations in EMS triage protocols and documentation practices, cultural differences in healthcare-seeking behavior, and after-hours primary care availability. Fifth, although population per family physician unit was included as a proxy for primary care accessibility, this measure does not capture geographic accessibility within provinces, quality of primary care services, or informal care networks. Residual confounding related to unmet primary care demand and unobserved provincial characteristics therefore cannot be fully excluded (2,4). Finally, inter-provincial differences in how false calls are classified and reported may introduce measurement heterogeneity that could affect the observed associations.

## Conclusion

In this nationwide ecological analysis including all 81 provinces of Türkiye, provincial university education rate was not independently associated with false EMS call rates after adjustment for EMS accessibility indicators and primary care availability. Both EMS accessibility measures and primary care availability showed significant independent associations with inter-provincial variation in false EMS call patterns, with population per family physician unit demonstrating the strongest association among the structural factors examined.

These findings suggest that system-level demand management strategies—such as improving guidance on appropriate EMS use, strengthening primary care accessibility, and implementing alternative triage pathways—may represent more effective approaches than interventions focusing solely on general education level. Region-specific planning approaches may be particularly important given the observed differences between metropolitan and non-metropolitan provinces, and provinces with lower population-to-family-physician ratios tended to demonstrate lower false EMS call rates.

## Ethics

**Ethics Committee Approval:** This study used publicly available province-level aggregated administrative data and did not include individual patient-level information. Therefore, ethics committee approval were not required.

**Informed Consent:** Patient consent was not required, as this study used publicly available aggregated administrative data and did not include individual patient-level data.

## Footnotes

**Financial Disclosure:** The author declared that this study received no financial support.

**Appendix:** <https://d2v96fxpocvxx.cloudfront.net/8a9ff4da-541a-42fa-9980-1a9a3ab6d6c5/content-images/3d1a5056-178d-402b-8660-e7dd238196f7.pdf>

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