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Original Article / Özgün Araştırma

What are the underlying factors contributing to the low achievement rate of target LDL levels in patients with coronary artery disease?

Ahmet Ferhat Kaya[1], **Kübra Korkmaz**[2], **Mehmet Özbek**[3]

1 Department of Cardiology, Muş State Hospital, Muş, Türkiye

2 Department of Cardiology, Erciş Şehir Rıdvan Çevik Devlet Hastanesi , Erciş Van , Türkiye

3 Department of Cardiology, Dicle University, Diyarbakır, Türkiye

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Abstract

Objective: Cardiovascular disease (CVD) is closely associated with traditional risk factors; however, the role of socioeconomic status (SES), as an important social determinant of health, has not been fully clarified. Understanding how SES contributes to cardiovascular risk may help identify and address health inequalities. In this study, we aimed to evaluate factors associated with failure to achieve target low-density lipoprotein (LDL) levels, with particular attention to socioeconomic status alongside conventional risk factors.

Methods: Patients presenting to the outpatient clinic with acute coronary syndrome (ACS) were prospectively included. Data were collected through structured, face-to-face interviews. The relationship between LDL target attainment and clinical variables—including body mass index (BMI), age, sex, diabetes mellitus (DM), hypertension (HT), smoking status, family history, chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD), socioeconomic status, and place of residence—was analyzed.

Results: Factors associated with failure to achieve target LDL levels were evaluated. Statistically significant associations were found for chronic kidney disease (CKD) ($p<0.001$), family history ($p=0.005$), and socioeconomic status ($p=0.012$). No significant associations were observed for the other variables examined.

Conclusion: In addition to established clinical risk factors, socioeconomic status may be associated with failure to achieve target LDL levels, possibly reflecting differences in access to care, treatment adherence, and health literacy. However, as this association was not significant in multivariate analysis, it should be interpreted cautiously. These findings suggest that both clinical and social factors should be considered when addressing residual cardiovascular risk and improving lipid management.

Keywords: coronary artery disease; LDL target; socioeconomic status; health disparities

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Correspondence / Yazışma Adresi: *Ahmet Ferhat Kaya, Department of Cardiology, Muş State Hospital, Muş, Türkiye e-mail: kayaferhatahmet@gmail.com*

Koroner arter hastalığı olan hastalarda hedef LDL düzeylerine ulaşılamamasına katkıda bulunan temel faktörler nelerdir?

Öz

Amaç: Kardiyovasküler hastalıkların (KVH) geleneksel risk faktörleriyle yakından ilişkili olduğu bilinmektedir; ancak sağlıkta sosyal belirleyicilerden biri olan sosyoekonomik statünün (SES) bu risk üzerindeki katkısı tam olarak açıklığa kavuşmamıştır. SES'in kardiyovasküler risk üzerindeki etkisinin daha iyi anlaşılması, sağlık eşitsizliklerinin belirlenmesi açısından önemlidir. Bu çalışmada, geleneksel risk faktörlerine ek olarak sosyoekonomik statü de dikkate alınarak, hedef düşük yoğunluklu lipoprotein (LDL) düzeylerine ulaşılamaması ile ilişkili faktörlerin değerlendirilmesi amaçlanmıştır.

Yöntemler: Akut koroner sendrom (AKS) nedeniyle polikliniğe başvuran hastalar prospektif olarak çalışmaya dahil edilmiştir. Veriler, yapılandırılmış anket formları kullanılarak yüz yüze görüşmelerle toplanmıştır. LDL hedeflerine ulaşma durumu ile beden kitle indeksi (BKİ), yaş, cinsiyet, diyabetes mellitus (DM), hipertansiyon (HT), sigara kullanımı, aile öyküsü, kronik böbrek hastalığı (KBH), kronik obstrüktif akciğer hastalığı (KOAH), sosyoekonomik statü ve yaşanılan yer arasındaki ilişkiler analiz edilmiştir.

Bulgular: Hedef LDL düzeylerine ulaşılamaması ile ilişkili faktörler değerlendirildiğinde, kronik böbrek hastalığı ($p<0,001$), aile öyküsü ($p=0,005$) ve sosyoekonomik statü ($p=0,012$) ile istatistiksel olarak anlamlı ilişkiler saptanmıştır. İncelenen diğer değişkenler ile anlamlı ilişki bulunmamıştır.

Sonuç: Geleneksel klinik risk faktörlerine ek olarak, sosyoekonomik statü hedef LDL düzeylerine ulaşılamaması ile ilişkili olabilir ve bu durum sağlık hizmetlerine erişim, tedaviye uyum ve sağlık okuryazarlığı gibi faktörleri yansıtabilir. Ancak çok değişkenli analizde anlamlılık göstermemesi nedeniyle bu ilişkinin dikkatli yorumlanması gerekmektedir. Bulgular, kardiyovasküler riskin azaltılmasında klinik faktörlerin yanı sıra sosyal belirleyicilerin de göz önünde bulundurulması gerektiğini düşündürmektedir.

Anahtar kelimeler: koroner arter hastalığı; hedef LDL; sosyoekonomik statü; sağlık eşitsizlikleri.

INTRODUCTION

Cardiovascular disease (CVD) continues to be the leading cause of morbidity and mortality worldwide, despite major advances in prevention and treatment. The relationship between elevated serum lipid levels—particularly low-density lipoprotein cholesterol (LDL-C)—and atherosclerotic cardiovascular disease (ASCVD) is well established. The widespread use of 3-hydroxy-3-methylglutaryl-coenzyme A (HMG-CoA) reductase inhibitors (statins) has significantly improved clinical outcomes and contributed to reductions in cardiovascular events and mortality(1).

LDL-C is considered the primary modifiable factor in the development of atherosclerosis. Numerous studies have shown a clear association between elevated LDL-C levels and plaque formation, and lowering LDL-C has consistently been linked to reduced cardiovascular risk(2,3). For this reason, achieving recommended LDL-C targets remains a central goal in both primary and secondary prevention.

However, despite the availability of effective lipid-lowering therapies, LDL-C target attainment in routine clinical practice remains suboptimal. This discrepancy between guideline recommendations and real-world outcomes suggests that factors beyond traditional clinical risk determinants may play a role.

In recent years, socioeconomic status (SES) has gained increasing attention as an important determinant of cardiovascular health. Individuals with lower SES tend to have a higher burden of CVD, which may be related to differences in access to healthcare, treatment adherence, and health literacy, as well as behavioral and psychosocial factors(4-7).

In this context, the present study aimed to evaluate LDL-C target attainment in patients with coronary artery disease and to investigate factors associated with failure to achieve these targets, with particular focus on socioeconomic status. This study was conducted as a single-center, cross-sectional analysis.

METHODS

A total of 500 patients were included in this study. Patients who had been initiated on statin therapy following acute coronary syndrome (ACS) and subsequently attended the outpatient clinic were prospectively evaluated. Data were collected through structured, face-to-face interviews.

The study protocol was approved by the local ethics committee (Approval No: 80, Date: 19 February 2025), and all procedures were conducted in accordance with the principles of the Declaration of Helsinki.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as counts and percentages. The distribution of continuous variables was assessed using visual methods (histograms, Q-Q plots, and P-P plots) as well as analytical tests (Shapiro–Wilk and Lilliefors tests).

For comparisons between groups, the Student's t-test was used for normally distributed variables, while the Mann–Whitney U test was applied for non-normally distributed variables. Categorical variables were compared using the chi-square test.

To identify factors associated with failure to achieve target LDL levels, regression analysis was performed. Correlation analysis was conducted using Pearson correlation for normally distributed variables and Spearman correlation for non-normally distributed variables.

A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using appropriate statistical software.

RESULTS

The baseline demographic and clinical characteristics of the study population are presented in Table 1.

Table I: Baseline Demographic and Clinical Characteristics of the Study Population (n = 500)

Variable	Value	p-value
Body mass index (kg/m²)	28.6 ± 5.2	0.274
Age (years)	62.7 ± 10.8	0.091
Female sex, n (%)	191 (38.2)	0.055
Married, n (%)	500 (99.4)	0.736
Diabetes mellitus, n (%)	232 (46.1)	0.600
Hypertension, n (%)	315 (62.9)	0.197
Smoking, n (%)	161 (32.1)	0.797
Family history, n (%)	76 (15.1)	**0.005**
Chronic kidney disease, n (%)	26 (5.2)	**<0.001**
Chronic obstructive pulmonary disease, n (%)	58 (11.5)	0.936
Socioeconomic status	See Table 2	**0.035**
Place of residence	See Table 2	0.323

Abbreviations: BMI, body mass index; DM, diabetes mellitus; HT, hypertension; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease.

The relationship between socioeconomic status and place of residence is presented in Table 2.

Table II: Distribution of Socioeconomic Status by Place of Residence (n = 500)

Place of residence	Low SES, n (%)	Medium SES, n (%)	High SES, n (%)	Total
Province	113 (44.3)	120 (47.1)	22 (8.6)	255
Town	75 (54.3)	59 (42.8)	4 (2.9)	138
Village	73 (68.2)	33 (30.8)	1 (0.9)	107
Total	261 (52.2)	212 (42.4)	27 (5.4)	500

Abbreviations: SES, socioeconomic status

Baseline laboratory parameters of the study population are summarized in Table 3.

Table III: Laboratory Parameters of the Study Population

Parameter	Mean ± SD
White blood cell (×10³/µL)	9.0 ± 2.7
Hemoglobin (g/dL)	13.4 ± 2.2
Hematocrit (%)	41.2 ± 6.0
Red cell distribution width (%)	13.9 ± 2.4
Platelet (×10³/µL)	272.3 ± 85.3
Mean platelet volume (fL)	10.5 ± 3.9
Lymphocyte (×10³/µL)	2.2 ± 1.3
Neutrophil (×10³/µL)	5.8 ± 2.2
Glucose (mg/dL)	160.8 ± 87.0
Urea (mg/dL)	41.0 ± 20.3
Creatinine (mg/dL)	0.9 ± 0.6
Estimated GFR (mL/min/1.73 m²)	82.5 ± 23.6
ALT (U/L)	27.2 ± 26.2
AST (U/L)	36.0 ± 45.1
Triglycerides (mg/dL)	177.7 ± 116.0
Total cholesterol (mg/dL)	188.4 ± 54.9
HDL cholesterol (mg/dL)	43.1 ± 10.1
LDL cholesterol (mg/dL)	113.2 ± 43.3
Uric acid (mg/dL)	5.7 ± 1.8
C-reactive protein (mg/dL)	1.3 ± 2.7
TSH (mIU/L)	1.7 ± 1.9
Free T4 (ng/dL)	1.2 ± 0.2
Free T3 (pg/mL)	3.1 ± 0.6

Abbreviations: WBC, white blood cell; HGB, hemoglobin; HCT, hematocrit; RDW, red cell distribution width; PLT, platelet; MPV, mean platelet volume; GFR, glomerular filtration rate; ALT, alanine aminotransferase; AST, aspartate aminotransferase; HDL, high-density lipoprotein; LDL, low-density lipoprotein; CRP, C-reactive protein; TSH, thyroid-stimulating hormone.

In this study, the proportion of patients achieving target LDL levels was low, with only 27 patients (5.4%) reaching the recommended threshold.

The association between LDL target attainment and various clinical and demographic variables—including BMI, age, sex, marital status, diabetes mellitus, hypertension, smoking status, family history, chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD), socioeconomic status, and place of residence—was evaluated. Statistically significant associations were observed for CKD ($p<0.001$), family history ($p=0.005$), and socioeconomic status ($p=0.012$) (Table 1). No significant associations were found for the remaining variables.

Correlation analysis revealed weak negative correlations between LDL target attainment and CKD ($r=-0.056$, $p<0.001$), family history ($r=-0.077$, $p=0.005$), and socioeconomic status ($r=-0.093$, $p=0.012$). A weak positive correlation was observed with sex ($r=0.079$, $p=0.055$) (Table 4).

Table IV: Correlation of Clinical Variables with LDL Target Attainment

Variable	Correlation coefficient (r)	p-value
Body mass index	0.023	NS
Age	0.072	NS
Sex	0.079	0.055
Marital status	0.015	NS
Diabetes mellitus	0.025	NS
Hypertension	0.055	NS
Smoking	-0.010	NS
Family history	-0.077	0.005
Chronic kidney disease	-0.056	<0.001
Chronic obstructive pulmonary disease	-0.004	NS
Socioeconomic status	-0.093	0.012
Place of residence	0.037	NS

Abbreviations: BMI, body mass index; DM, diabetes mellitus; HT, hypertension; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; SES, socioeconomic status.

Multivariable linear regression analysis was performed to evaluate factors associated with LDL target attainment. The overall model was statistically significant ($p=0.016$, $R^2=0.046$). Among the examined variables, only sex ($p=0.001$) and chronic kidney disease ($p=0.049$) were significantly associated with LDL target attainment, while the remaining variables were not statistically significant (Table 5).

Table V: Multivariable Linear Regression Analysis of Factors Associated with LDL Target Attainment

Variable	β coefficient	p-value
Body mass index	0.074	0.115
Sex	0.180	0.001
Age	0.053	0.280
Diabetes mellitus	0.044	0.352
Hypertension	0.074	0.137
Smoking	-0.061	0.237
Family history	-0.052	0.253
Chronic kidney disease	-0.091	0.049
Chronic obstructive pulmonary disease	0.011	0.811
Socioeconomic status	-0.080	0.097
Place of residence	0.046	0.319

Abbreviations: BMI, body mass index; DM, diabetes mellitus; HT, hypertension; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; SES, socioeconomic status.

DISCUSSION

In this study, we observed a very low rate of LDL target attainment, with only 5.4% of patients reaching recommended levels. This finding highlights a substantial gap between guideline recommendations and real-world clinical practice.

We found that chronic kidney disease (CKD), family history, and socioeconomic status were associated with failure to achieve LDL targets in univariate analysis. However, in multivariable analysis, only sex and CKD remained independently associated with LDL target attainment, while the association with socioeconomic status did not persist. This suggests that although socioeconomic factors may influence lipid control, their independent effect may be limited or mediated through other clinical and behavioral variables.

Previous studies from Turkey have reported LDL target attainment rates between 15% and 25%, based on a target of <100 mg/dL (8–10). In contrast, the lower rate observed in our study (5.4%) may be explained by the use of a stricter LDL target (<70 mg/dL) in accordance with current guideline recommendations.

Although statin use was high in our cohort (97%), the use of combination lipid-lowering therapy was extremely limited, with only 0.4% of patients receiving ezetimibe. This finding suggests that insufficient treatment intensification may be a key contributor to poor LDL target attainment. Previous studies have similarly shown that lipid-lowering therapy is often not optimized, with dose escalation or combination therapy underutilized in patients who fail to reach LDL targets(11-15).

Non-adherence to statin therapy is another important factor that may contribute to inadequate lipid control. Prior reports from Turkey have indicated that discontinuation of statins is common and is often influenced by negative media coverage and social perceptions(16,17). Such factors may reduce adherence and ultimately affect treatment outcomes.

The role of CKD in our study is consistent with previous findings, as patients with CKD often have a higher cardiovascular risk burden and may require more intensive management(18-23). Similarly, the association with family history may reflect underlying genetic susceptibility and clustering of risk factors.

We also observed a trend toward lower LDL target attainment among women, although this did not reach statistical significance. This finding is in line with previous reports suggesting potential sex-related differences in lipid management, which may be influenced by factors such as treatment adherence, prescribing patterns, and perceived side effects(19-29).

Socioeconomic status showed a significant association in univariate analysis but did not remain significant after adjustment. This finding should be interpreted cautiously. While SES may influence access to healthcare, treatment adherence, and health literacy, its effect may be indirect and mediated through

other factors(30,31). Therefore, our results do not support a strong independent association between SES and LDL target attainment but suggest a potential contributory role.

Overall, the low rate of LDL target achievement observed in this study is likely multifactorial, reflecting a combination of clinical characteristics, treatment-related factors, and broader social determinants of health.

Additionally, since LDL target attainment is a binary outcome, the use of linear regression may have certain methodological limitations compared to logistic regression. Therefore, the findings should be interpreted with caution.

CONCLUSION

In conclusion, LDL target attainment in patients with coronary artery disease remains suboptimal. While clinical factors such as CKD appear to play an important role, treatment-related issues—particularly the limited use of combination lipid-lowering therapy—may be key contributors.

Although socioeconomic status may influence lipid control, its independent effect appears limited after adjustment. These findings highlight the need for improved treatment optimization and a more comprehensive approach that considers both clinical and social factors in cardiovascular risk management.

Authors' Contributions

asada: Conceptualization, Data curation, Formal Analysis, Writing–originaldraft, Writing–review&editing. AFK: Conceptualization, Data curation, Formal Analysis, Writing–originaldraft, Writing–review&editing. KK: Formal Analysis, Writing–originaldraft. KK, MÖ: Conceptualization, Data curation, Writing–originaldraft.

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Conflict of Interest: The author(s) declare that there is no financial conflict of interest related to this article.

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