

*International Journal of Current  
Medical and Biological Sciences*

*Volume 4 Issue 3 December-2024*




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## **Information About the Journal**

IJCMBS was established in 2021 as an open access and peer-reviewed journal that accepts articles in English. IJCMBS is published 3 times a year. Articles submitted should not have been previously published or be currently under consideration for publication anywhere else and should report original unpublished research results. The journal does not expect any fees for publication.

## **Journal Management Location and Address**

Harran University Faculty of Medicine Osmanbey Campus Haliliye/ Sanlıurfa/Türkiye

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**Cardiac Complications in Hemorrhagic Strokes: Insights from a Unique Bigeminy Rhythm Presentation***Hemorajik İnmenin Kardiyak Komplikasyonu: Benzersiz Bigemine Ritim Varlığının Analizi***Alper Resit Gunduz<sup>1\*</sup>**, **Serkan Emre Eroglu<sup>1</sup>**, **Serdar Ozdemir<sup>1</sup>**<sup>1</sup>Department of Emergency, SBU Ümraniye Training and Research Hospital, University of Health Sciences, Ümraniye Training and Research Hospital, Istanbul/Türkiye**Abstract**

During the acute phase of subarachnoid hemorrhage, cardiac rhythm disturbances are frequently observed, affecting 50% to 100% of patients. Although benign arrhythmias like sinus tachycardia, sinus bradycardia, premature atrial contractions, and premature ventricular contractions are common, clinically significant arrhythmias such as ventricular tachycardia or atrial tachyarrhythmias manifest in only 1-4% of patients. This case report delves into the intricate connection between cardiac complications and neurological emergencies, using a distinctive bigeminy rhythm presentation in a 43-year-old male patient with aneurysmal subarachnoid hemorrhage.

**Keywords:** Hemorrhagic Stroke, Ventricular Premature Complexes, Subarachnoid Hemorrhage**ÖZ**

Akut subaraknoid kanama evresinde, kardiyak ritim bozuklukları sıkça gözlemlenmekte olup hastaların %50 ila %100'ünü etkileyebilmektedir. Sinüs taşikardisi, sinüs bradikardisi, prematür atriyal kontraksiyonlar ve prematür ventriküler kontraksiyonlar gibi zararsız aritmiler yaygın olarak görülmektedir; ancak klinik açıdan önemli aritmiler, örneğin ventriküler taşikardi veya atriyal taşiaritmiler, hastaların sadece %1 ila %4'ünde ortaya çıkmaktadır. Bu vaka raporu, bir anevrizmalı subaraknoid kanama geçirmiş 43 yaşındaki erkek bir hastada, özgün bir bigemini ritim sunumu kullanarak kardiyak komplikasyonlar ile nörolojik acil durumlar arasındaki karmaşık ilişkiye derinlemesine odaklanmaktadır.

**Anahtar kelimeler:** Hemorajik İnme, Ventriküler prematür kompleksler, Subaraknoid kanama**Highlights**

- Prolonged QTc intervals, frequently observed in SAH patients, are associated with increased ventricular myocardial excitability irregularities, contributing to the development of ectopic rhythms.
- The evolution of artificial intelligence (AI) may enhance the monitoring of ECG changes in SAH patients, enabling earlier detection of arrhythmias and improved patient outcomes.
- Atrial flutter, atrial fibrillation and ventricular arrhythmias are the most frequent arrhythmias in post-SAH patients.

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Received: 13April 2024

Accepted: 02 October 2024

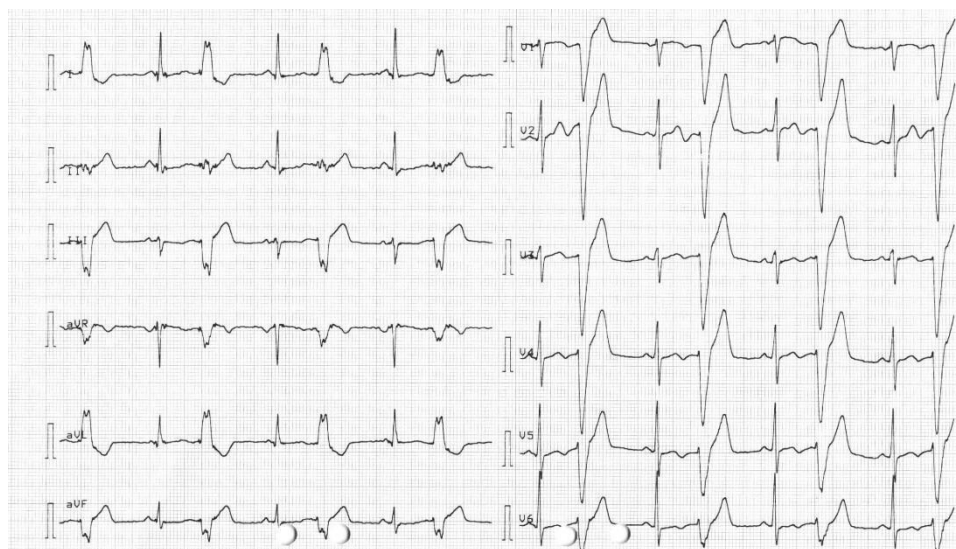
Cite as: GUNDUZ. A.R. et al Cardiac Complications in Hemorrhagic Strokes: Insights from a Unique Bigeminy Rhythm Presentation. IJCMBMS 2024; 4(3):90-3 doi.org/10.5281/zenodo.13881349

## Introduction

Hemorrhagic strokes account for approximately 20% of all stroke cases, with half of these attributed to subarachnoid hemorrhages (SAH). The predominant cause of spontaneous SAHs is the rupture of saccular aneurysms (1). The acute phase of SAH is frequently accompanied by cardiac rhythm disturbances, manifesting in 50% to 100% of patients. While benign arrhythmias such as sinus tachycardia, sinus bradycardia, premature atrial contractions, and premature ventricular contractions are prevalent, clinically significant arrhythmias like ventricular tachycardia or atrial tachyarrhythmias occur in only 1-4% of patients (2,3). This case report sheds light on a patient with aneurysmal subarachnoid hemorrhage who presented with a distinctive electrocardiographic (ECG) manifestation, namely the bigeminy rhythm, serving as an initial and noteworthy finding. The discussion of this case aims to contribute to the broader understanding of the diverse cardiac complications that can accompany SAH, emphasizing the significance of recognizing less common arrhythmias in the acute phase of this neurological emergency.

## Case report

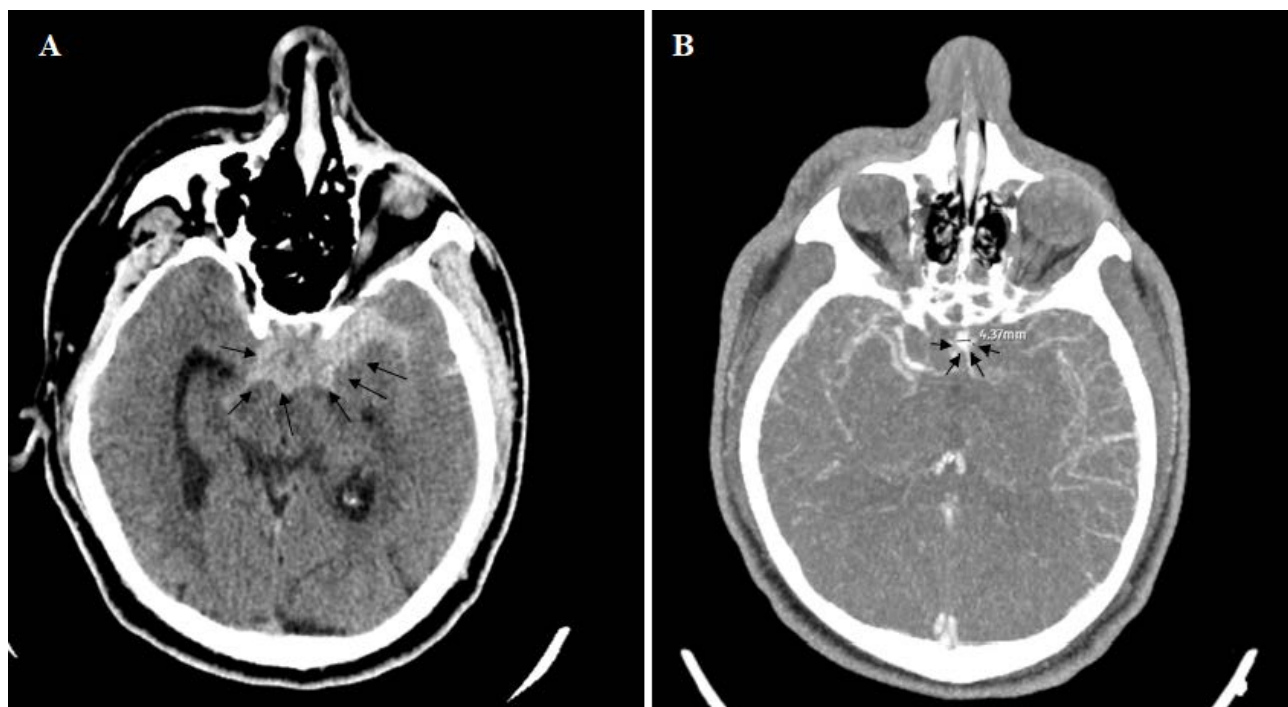
A 43-year-old male patient presented to the emergency department with complaints of dizziness and syncope that had commenced thirty minutes prior to admission. The patient denied experiencing headache, nausea, or vomiting, and there was no history of trauma or known chronic illnesses. Upon admission, vital signs were measured as follows: blood pressure 177/127 mmHg, heart rate 84 beats per minute, oxygen saturation 95%, and temperature 36.7 degrees Celsius (°C). An ECG revealed a bigeminy rhythm (**Figure 1**).



**Figure 1. An ECG reveals a bigeminy rhythm**

During the physical examination, the patient exhibited a Glasgow Coma Scale score of 15, was oriented and cooperative, and displayed isochoric pupils with a reactive light reflex. No focal neurological deficits, nystagmus, or neck stiffness were observed. Other systemic examinations yielded normal findings. Despite the normal neurological examination and the presence of bigeminy rhythm on ECG, cardiac causes were initially considered in the etiology of syncope. However, cranial imaging was planned to investigate the possibility of intracranial events related to cardiac arrhythmias. Investigations revealed a high-sensitivity troponin T level of 12.360 ng/L, white blood cell count of  $12.81 \times 10^3/\mu\text{L}$ , hemoglobin of 17 g/dL, platelet count of  $287 \times 10^3/\mu\text{L}$ , C-reactive protein of 1.73 mg/L, creatinine of 1.13 mg/dL, activated partial thromboplastin time of 26.1 seconds, prothrombin time of 13.5 seconds, INR of 1.01, potassium of 4.41 mEq/L, chloride of 102.6 mEq/L, calcium of 8.1 mg/dL in blood gas analysis; pH of 7.34, pCO<sub>2</sub> of 35.1 mmHg, anion gap of -3.7 mmol/L, bicarbonate of 20.4 mmol/L, lactate of 3.1 mmol/L. Contrast-free brain tomography revealed SAH areas in bilateral frontal and temporal sulci, and contrasted brain tomography angiography showed a 4.5-millimeter saccular aneurysm observed at the level of the anterior communicating artery (**Figure 2**). According to the Hunt & Hess classification, it was classified as grade 1. The patient underwent surgery performed by the neurosurgery team and was subsequently monitored in the intensive care unit (ICU) post-operation. During the patient's ICU follow-up, no cardiac arrhythmias were observed, and echocardiography revealed no structural heart disease. The patient was transferred from the ICU to the neurosurgery service after a week and was discharged after 11 days of neurosurgical service follow-up.

without any neurological deficits.



**Figure 2.** A. Contrast-free brain tomography. The arrows show subarachnoid hemorrhage areas. B. Contrast brain tomography angiography. The arrows show 4.5-millimeter saccular aneurysm observed at the level of the anterior communicating artery.

### Discussion

Aneurysmal SAH stands as one of the most catastrophic neurological events, carrying a mortality rate of up to 50%. The classical presentation of SAH involves a severe headache, often accompanied by an abrupt loss of consciousness, with vomiting being another prominent feature. Depending on the severity and localization of the hemorrhage, focal neurological symptoms may manifest (4). Notably, even in the absence of structural heart disease following acute cerebrovascular events, a high prevalence of ECG abnormalities and arrhythmias is observed. Such abnormalities are identified in 90% of patients experiencing ischemic stroke, intracerebral hemorrhage, or SAH. Moreover, up to 25% of patients without prior ECG abnormalities may exhibit new arrhythmias (5). Research indicates that approximately 5% of post-SAH patients encounter serious cardiac arrhythmias, with atrial flutter and atrial fibrillation being the most common (76%), followed by ventricular arrhythmias (16%) (6). ECG alterations subsequent to SAH, such as ST-T wave changes, are primarily associated with myocardial infarction. Additional frequently observed changes encompass high R wave (19%), ST depression (15%), U wave (47%), prolonged QTc intervals (23%), and broad flattened or notched T waves (32%) (7). The presence of a prolonged QTc interval has been correlated with the temporal dispersion of the recovery rate of ventricular myocardial cell excitability, a phenomenon contributing to ectopic rhythm development (8,9). The irregularity in ventricular myocardial excitability recovery increases with bradycardia and sympathetic nervous system stimulation. Both vagal and sympathetic stimulation have been identified in cases of intracranial bleeding, potentially leading to ectopic beats observed in SAH patients. The observed changes in rhythm, such as the bigeminy rhythm in our case, are believed to stem from this mechanism primarily associated with prolonged QTc intervals. With artificial intelligence (AI) evolution we believe ECG changes will be checked more regularly so we will be more aware of the arrhythmias (10). Advanced age, a history of arrhythmias, and abnormal ECG at admission emerge as independent risk factors for morbidity in aneurysmal or traumatic SAH patients. arrhythmias seen in SAH patients have been linked to potential complications (hyperglycemia, brainstem herniation, myocardial infarction), prolonged ICU stays, and unfavorable outcomes (6).

**Conclusion** In patients presenting with syncope, ECG findings offer vital diagnostic insights. Although initially suggestive of a cardiac etiology, the detection of arrhythmias should prompt clinicians to investigate potential intracranial events, even in the presence of a normal neurological examination.



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**Acknowledgements:** None.

**Ethical Approval:** This work is not necessary. Informed consent for case report was obtained from the patient.

**Author Contributions:** Concept: ARG, SEE, SÖ Literature Review: ARG, SEE, SÖ. Design: ARG, SEE, SÖ. Data acquisition: ARG, SEE, SÖ. Analysis and interpretation: ARG, SEE, SÖ. Writing manuscript: ARG, SEE, SÖ. Critical revision of manuscript: ARG, SEE, SÖ.

**Conflict of Interest:** The author(s) do not have any potential conflict of interest regarding the research. authorship and/or publication of this article.

**Financial Disclosure:** This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

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## Investigation of Care Burden and Burnout Levels of Elderly Care Providers Receiving Home Health Services

*Evde Sağlık Hizmeti Alan Yaşlılara Bakım Verenlerin Bakım Yükü ve Tükenmişlik Düzeylerinin İncelenmesi*

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### Abstract

**Background:** It was aimed to determine the care burden and burnout status of individuals caring for the elderly receiving home health care services and to reveal the needs of the caregiver for the determined situation.

**Materials and Methods:** This descriptive study was conducted between January 1 and April 1, 2022, with individuals who had been providing care to patients registered in the Home Health Services unit of Recep Tayyip Erdogan University Training and Research Hospital for at least 1 month, who were not paid for their caregiving work, and who agreed to participate in the study.

**Results:** The burnout scale short form score of caregivers was  $2.8 \pm 1.3$  in women and  $2.0 \pm 1.1$  in men ( $p=0.047$ ). As the dependency level of the care recipients increased, the time-dependency burden subscale scores of the caregivers increased and this result was statistically significant ( $p<0.001$ ). In this study, a significant negative correlation was found between the caregivers burden inventory time-dependency burden subscale score of caregivers and the Katz Activities of Daily Living (ADL) scale of care recipients ( $p<0.001$ ). A statistically significant strong positive correlation was found between the total Caregivers Burden Inventory (CBI) score of caregivers and the burnout scale short form score ( $p<0.001$ ).

**Conclusions:** A statistically significant positive correlation was found between the total CBI score and the Burnout Scale-Short Form score of caregivers. Burnout may lead to negative outcomes such as low self-esteem, low motivation and low performance in caregivers.

**Keywords:** Caregivers, burnout, caregiver burden

### ÖZ

**Amaç:** Evde sağlık hizmeti alan yaşlılara bakım veren bireylerin bakım yükü ve tükenmişlik durumunu belirlemek ve belirlenen durum için bakım verenin ihtiyaçlarını ortaya koymak amaçlanmıştır.

**Gereç ve Yöntem:** Gereç Yöntem: Tanımlayıcı tipteki bu çalışma, Recep Tayyip Erdoğan Üniversitesi Eğitim ve Araştırma Hastanesi Evde Sağlık Hizmetleri birimine kayıtlı hastalara en az 1 aydır bakım veren, bakım verme işi karşılığında ücret almayan ve çalışmaya katılmayı kabul eden kişilerle 1 Ocak-1 Nisan 2022 tarihleri arasında yapılmıştır.

**Bulgular:** Bakım verenlerin tükenmişlik ölçeği kısa form puanı kadınlarda  $2,8 \pm 1,3$  iken erkeklerde  $2,0 \pm 1,1$  idi ( $p=0,047$ ). Bakım alanların bağımlılık düzeyi arttıkça bakım verenlerin Bakım Verenlerin Yükü Envanteri (BVYE) zaman-bağımlılık yükü alt ölçek puanları artmaktaydı ve bu sonuç istatistiksel olarak anlamlıydı ( $p<0,001$ ). Bu çalışmada, bakım verenlerin BVYE zaman-bağımlılık yükü alt ölçeği puanı ile bakım alanların Katz günlük yaşam aktivitesi ölçeği arasında anlamlı olarak negatif korelasyon saptandı ( $p<0,001$ ). Bakım verenlerin toplam BVYE puanı ile tükenmişlik ölçeği kısa formu puanı arasında istatistiksel olarak anlamlı güçlü bir pozitif korelasyon saptandı ( $p<0,001$ ).

**Sonuç:** Bakım verenlerin toplam BVYE puanı ve Tükenmişlik Ölçeği-Kısa Form puanı arasında istatistiksel olarak anlamlı pozitif korelasyon saptanmıştır. Tükenmişlik durumu bakım verenlerde, düşük öz saygı, düşük motivasyon ve düşük performans gibi negatif sonuçlara neden olabilir.

**Anahtar kelimeler:** Bakıcılar, tükenmişlik, bakıcı yük

### Highlights

- With the holistic approach of family medicine, patients and caregivers were addressed on a common ground.
- Personal characteristics and needs of caregivers were analyzed.
- Caregiver burden and burnout were analyzed.

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Received: 07 July 2024

Accepted: 08 August 2024

Cite as: GOKTEPE. B. et al. Investigation of Care Burden and Burnout Levels of Elderly Care Providers Receiving Home Health Services. IJCMBMS 2024;4(3):94-102 doi.org/10.5281/zenodo.13787457

## Introduction

The incidence of chronic diseases is rising with increasing life expectancy. Therefore, the increase in the number of individuals with chronic diseases needing lifelong treatment and care has become an important health issue in the developed and developing countries (1). Family medicine specialists, who treat patients with a holistic and biopsychosocial approach, take an active role in both palliative care in inpatient services and home health services (2). Because of the increasing cost of caring for patients with chronic diseases combined with the limitation of bed capacities in hospitals, home-based care has become more preferable.

Home Health Care Services (HHC) is defined as the provision of examination, examination and treatment in the home environment by a professional healthcare team to patients who are semi dependent/dependent in daily living activities and those who have difficulty in accessing health institutions due to various chronic or malignant diseases (3).

With the increasing number of chronically ill patients requiring home care services, caregivers are now required to provide long-term commitment. Family members or relatives are often the ones who are assigned to care for patients receiving HHC services in their homes. Evaluating and supporting people involved in long-term care in terms of biopsychosocial aspects in the process is one of the important tasks of HHC providers in the background. In Turkey, the care of sick and vulnerable people is usually provided by their families and is perceived as a family responsibility. Becoming a caregiver cannot be chosen or planned. Therefore, adaptation to this situation takes place after the need arises (4). Reducing the care burden and problems of the caregiver affects the quality of care they provide to the patient. Caregivers need help and support to meet their own physical and mental health needs in order to continue caregiving. Most caregivers do not have sufficient knowledge and skills to provide long-term care. Therefore, they may feel insecure and unprepared (5). A caregiver is a person who undertakes care work and provides physical, social, emotional and economic support to the patient. Caregiving is a difficult process for both the bedridden patient receiving care and the caregivers (6-7).

Patients who benefit from HHC services are typically those with advanced complicated diseases or highly life-limiting diagnoses and are at high risk of morbidity and mortality. These patients are among the growing number of older adults and frail persons who are often homebound due to multiple chronic diseases, including cognitive impairment, and, as a result, functional limitations and falls occur. Home caregivers may have to work very hard due to the many responsibilities they are burdened with, such as monitoring patients' health conditions, meeting their basic and personal needs, budget management, shopping, sharing the same home and improving the quality of life of the patients. Therefore, the care givers often get tired, stressed and even become exhausted.

The process of caregiving is very demanding for both the recipient and the provider. Therefore, determining the situation of the caregivers should be the first step of the process. At this point, this study aimed to determine the care burden and burnout status of individuals caring for the elderly receiving HHC services and to reveal the needs at the point of intervention to the caregiver.

## Material and Methods

### Study design

This descriptive study was conducted with patients and their relatives registered to Recep Tayyip Erdogan University University Training and Research Hospital Home Health Services unit between 1 January and 1 April 2022. Ethical approval (protocol number: 2022/17) was obtained from Recep Tayyip Erdogan University Faculty of Medicine Ethics Committee on 20.01.2022. In addition, informed consent forms were given by the caregivers. The patient's relatives are 75 people who have been providing care for at least 1 month, who do not receive remuneration for caregiving, and who agree to participate in the study. The research sample was calculated as at least 71 people with 95% power, 95% confidence interval and 0.40 effect size with G Power 3.1.9 program. The study was completed with 75 participants. (8) The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Sociodemographic and personal characteristics of the caregivers, Caregivers Burden Inventory (CBI) and Maslach Burnout Scale-Short Form were administered to the caregivers. The Katz Activities of Daily Living (ADL) Scale, age, presence of active pressure sores and diaper use status etc. of the patients were recorded.

CBI is for measuring the effect of caregiving on caregivers. It is a 5-point Likert-type scale consisting of 24 items developed by Novak and Guest (1989) (9). The burden of caregivers is analyzed in five sub-dimensions: time dependency burden (items 1-5), developmental burden (items 6-10), physical burden (items 11-14), social burden (items 15-19) and emotional burden (items 20-24). The total score of each individual varies between 0-100. A high

score indicates a high degree of burden and a low score indicates a low degree of burden. In the adaptation study (Kucukguclu, Esen and Yener, 2009), the Cronbach alpha value obtained for the entire inventory was 0.94; 0.93 for "time-dependent load", 0.94 for "developmental load", 0.94 for "physical load", 0.82 for "social load", 0.94 for "emotional load" (10). Time-dependency burden assesses how much time the caregiving task takes for the provider and the temporal dependency of the recipient on the caregiver. Developmental burden assesses the caregiver's own personal development and its relationship with caregiving. Physical burden assesses the sleep deprivation, physical problems and illnesses caused by caregiving. Social burden assesses the impact of caregiving on the caregiver's family and social relationships and occupational status. Emotional burden assesses the emotional reflection of the care receiver's behaviour and actions on the caregiver.

The Burnout Scale Short Form (Pines, 2005) expressed the need to create a 10-item short form of the tool for easier use of the 21-item Burnout Scale and the expansion of its application area (11). The 10 items of the short version were selected by applying theoretical analysis (and not by applying statistical analysis) of the 21-item version. The average burnout score obtained by applying both the long and short forms of the Burnout Scale was found to be the same. The Burnout Scale Short Form consists of 10 items with response options from 1 (Never) to 7 (Always). Those who scored higher on the scale reported more burnout and fatigue than those who scored lower. The internal consistency coefficients of the scale calculated with data obtained from different ethnicity, occupation and student groups vary between 0.85 and 0.92. The reliability of the Turkish version of the scale was analysed using Cronbach's alpha and test-retest techniques. Cronbach Alpha value was found to be 0.91 (12). One of the easiest ways to assess the health status of the elderly is to perform a functional assessment, which provides objective data indicating the state of decline.

The ADL Index was developed by Katz et al. in 1963 for use in the evaluation of treatment and prognosis in chronic diseases and the elderly (13). In six sub-sections, the patient is assessed in terms of the ability to control the functions related to bathing, dressing, toileting, transport, bowel and bladder, and the ability to perform the function of eating independently. Functions performed with assistance score 0 points, while functions performed independently score 1 full point. 6 points indicate independence, 4 points indicate semi-dependence, 2 points and below indicate full dependence.

### Statistical Analysis

SPSS Statistics 24.0 (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.) statistical package program was used for data analysis. Descriptive statistics of the evaluation results were given as number and percentage for categorical variables and mean and standard deviation for numerical variables. The conformity of the groups to normal distribution was determined by Kolmogorov-Smirnov test. The comparisons of numerical variables between two independent groups were evaluated by independent groups T test and Mann Whitney U test according to the conformity to normal distribution. Comparisons of numerical variables between three or more independent groups were evaluated by one-way ANOVA test and Kruskal-Wallis test according to the conformity to normal distribution. In case of significant differences in the Kruskal-Wallis test, post hoc comparisons were tested with Bonferroni. In the correlation analysis, Spearman correlation test was used. Statistical alpha significance level was accepted as  $p < 0.05$ .

Linear Regression Analysis was applied to determine the independent predictors of Burnout Scale. While creating the model,  $p < 0.25$  value was accepted in univariate analyses and the variables to be included in the model were determined.

### Results

The study included 75 caregivers; 81.3% (n:61) were female and 18.7% (n:14) were male. The mean age of the participants was  $50.85 \pm 10.08$  years. 56% of the caregivers were giving care to their first degree relatives. The rate of those receiving continuous care was 73%. The mean age of the care recipients was  $79.19 \pm 13.91$  years. In addition, 77.3% of the care recipients were fully dependent, 14.7% were semi-dependent and 8% were independent (Table 1).

**Table 1. Sociodemographic Parameters**

Parameters		n (%)
Gender	Female	61(81.3)
	Male	14(18.7)
Age (mean±SD)		50.85±10.08
	illiterate	4(5.3)

<b>Education Status</b>	Literate	2(2.7)
	Primary & secondary school	38(50.7)
	High school	24(32)
	Graduate	7(9.3)
<b>Marital status</b>	Single	6(8)
	Married	67(89.3)
	Divorcee	2(2.7)
<b>Employment status</b>	Unemployed	67(89.3)
	Employed	8(10.7)
<b>Income status</b>	Income less than expenditure	40(53.3)
	Income equals expenditure	31(41.3)
	Income more than expenditure	4(5.3)
<b>Number of people living at home (mean±ss)</b>		4.16±1.38
<b>Having children</b>	No	7(9.3)
	Yes	68(90.7)
<b>Number of children (mean±SD)</b>		2.20±1.17
<b>Child age</b>	0-6 years	7(9.3)
	7-17 years	25(33.3)
	18 years and over	55(73.3)
<b>Chronic disease</b>	Yes	35(46.7)
	No	40(53.3)
<b>Relation to the care recipient</b>	1 <sup>st</sup> degree relative/spouse	42(56)
	2 <sup>nd</sup> degree	6(8)
	3 <sup>rd</sup> degree relative /neighbour/acquaintance	27(36)
<b>Duration of maintenance (years, mean±ss)</b>		5.28±5.73
<b>Caregiving status</b>	Continuous care	55(73.3)
	Intermittent maintenance	20(26.7)
<b>Nutritional status of the care recipient</b>	Self-feeding	40(53.3)
	Being fed	35(46.7)
<b>Nutrient intake of the care recipient</b>	Oral	67(89.3)
	Tube	8(10.7)
<b>Age of care recipient (mean±SD)</b>		79.19±13.91
<b>Active decubit ulcer</b>	Yes	21(28)
	No	54(72)
<b>Use of nappies</b>	Yes	56(74.7)
	No	19(25.3)
<b>Psychological support received by the caregiver (n=64)</b>	Yes	10(15.6)
	No	54 (84.4)
<b>Dependency of the care recipient</b>	Fully depend	58 (77.3)
	Semi-dependent	11(14.7)
	Independent	6(8)

Abbreviations: SD: Standard Deviation

The burnout scale short form score of caregivers was 2.8±1.3 for females and 2.0±1.1 for males. This difference between both genders was statistically significant ( $p=0.047$ ). Female caregivers had higher burnout levels than men. The CBI developmental and emotional burden subscale scores of caregivers of 2nd and 3rd-degree relatives or neighbours were higher than the scores of caregivers of 1st-degree relatives, and this was statistically significant ( $p=0.018$ ,  $p=0.009$ ) (Table 2).

Table 2. Sociodemographic Data of Caregivers and Burnout Scale-Short Form and Caregiver Burden Inventory Scores

	Burnout Scale Short Form Score	Caregiver Burden Inventory Subscale and Total Scores						
		Time-dependency burden	Developmental burden	Physical load	Social burden	Emotional burden	Total CBI Score	
Gender	Female	2.8±1.3	16.6±4.3	10.7±5.6	9.0±5.9	3.9±4.7	2.1±2.7	42.4±15.8
	Male	2.0±1.1	13.5±6.2	6.5±5.6	5.8±5.8	3.4±4.3	0.7±1.4	31.1±15.7
	<i>p</i>	0.047**	0.321**	0.115**	0.304**	0.561**	0.372**	0.256**
Age	≤50 years	2.9±1.3	16.5±4.3	10.9±6.2	9.1±5.8	4.1±4.4	2.0±2.5	42.6±16.2
	>50 years	2.4±1.3	15.6±5.2	9.0±5.4	7.8±6.1	3.6±4.2	1.7±2.6	38.1±16.4
	<i>p</i>	0.084*	0.321**	0.115**	0.304**	0.561**	0.372**	0.237*
Marital status	Single-Divorced	2.7±1.3	17.1±3.5	8.1±5.4	7.3±6.4	2.3±3.4	0.5±1.1	35.3±15.5
	Married	2.6±1.3	15.9±4.9	10.1±5.9	8.5±6.0	4.0±4.3	2.0±2.6	40.9±16.4
	<i>p</i>	0.770**	0.526**	0.541**	0.558**	0.419**	0.107**	0.368*
Chronic disease	Yes	2.7±1.3	15.3±5.5	10.5±5.4	8.9±5.9	3.3±3.5	2.4±2.8	40.9±15.4
	No	2.6±1.4	16.7±4.1	9.4±6.2	8.0±6.1	4.3±4.8	1.4±2.2	39.9±17.3
	<i>p</i>	0.902*	0.156**	0.466**	0.526**	0.553**	0.093**	0.795**
Proximity to the care recipient	1st degree relative/spouse	2.6±1.4	16.6±4.6	8.5±5.6	7.8±6.1	3.3±4.0	1.3±2.2	37.6±16.3
	2nd degree close-3rd degree close/neighbor/relative	2.7±1.3	15.3±5.0	11.7±5.7	9.2±5.7	4.5±4.5	2.7±2.7	43.8±15.9
	<i>p</i>	0.582**	0.109**	0.018**	0.259**	0.237**	0.009**	0.102*
Duration of maintenance (years. mean±ss)	≤3 years	2.6±1.3	15.4±5.0	9.2±5.8	7.5±5.2	3.9±4.5	1.6±2.6	37.6±15.7
	>3 years	2.7±1.4	16.8±4.6	10.7±5.9	9.5±6.6	3.7±4.0	2.2±2.5	43.3±16.7
	<i>p</i>	0.929*	0.176**	0.282**	0.224**	0.965**	0.247**	0.134*
Status of receiving psychological support	Receiving	3.3±1.7	16.5±5.2	13.5±5.7	10.6±6.4	3.8±4.3	2.0±1.5	46.4±16.6
	Does not take	2.6±1.2	15.9±4.6	9.6±5.9	8.1±5.8	3.6±4.3	1.9±2.8	39.5±16.0
	<i>p</i>	0.240**	0.459**	0.068**	0.221**	0.839**	0.386**	0.213*

Abbreviations: CBI : Caregiver Burden Inventory \*Independent Groups T test. \*\*Mann-Whitney U test

As the level of dependency of the care recipients increased, the CBI time-dependency burden subscale scores of the caregivers increased and this was statistically significant ( $p<0.001$ ). If the care recipient was being fed by the caregiver, the caregiver's CBI time-dependency subscale score was higher than that of caregivers of self-fed patients, while the CBI emotional subscale score was lower ( $p<0.001$ ,  $p=0.045$ ). In addition, the CBI time-dependency burden subscale score of the caregivers of tube-fed patients was higher than that of the caregivers of orally fed patients ( $p=0.04$ ) (Table 3).

Table 3. Sociodemographic Data of Care Receivers and Levels of Caregiver Burnout Scale Short Form Scores and Caregiver Burden Inventory Scores

Burnout Scale-Short Form Score	Caregiver Burden Inventory Subscale and Total Scores					
	Time-dependency burden	Developmental burden	Physical load	Social burden	Emotional burden	Total CBI Score

Dependency of the carer	Fully dependent	2.7±1.4	17.4±3.9	9.7±5.9	8.6±6.3	4.1±4.5	1.7±2.5	41.7±16.5
	Semi-dependent	2.6±1.1	13.5±4.5	10.7±5.9	8.4±5.6	3.0±3.3	2.3±3.1	38.0±16.8
	Independent	2.7±0.8	7.5±2.3	10.0±5.9	7.1±3.0	3.2±3.4	2.8±2.2	30.6±11.3
	<i>p</i>	0.797 <sup>v</sup>	<0.001 <sup>v</sup>	0.902 <sup>v</sup>	0.919 <sup>v</sup>	0.825 <sup>v</sup>	0.294 <sup>v</sup>	0.249 <sup>†</sup>
	<i>Post Hoc</i>		P <sup>1-2</sup> :0.017 P <sup>1-3</sup> :<0.001 P <sup>2-3</sup> :0.335					
Nappy status of the care recipient	Diapering	2.6±1.3	17.4±3.4	10.0±5.7	8.7±6.4	3.7±4.2	1.5±2.3	41.6±15.5
	No nappies	2.9±1.4	11.9±6.0	9.7±6.3	7.6±4.5	4.4±4.4	2.9±2.9	36.6±18.6
	<i>p</i>	0.420*	<0.001**	0.888*	0.570*	0.601*	0.043*	0.252*
Nutritional status of the care recipient	Self-feeding	2.6±1.3	14.4±5.1	9.9±5.7	8.3±5.7	3.9±4.0	2.4±2.8	38.8±17.5
	Caregiver feeds	2.7±1.4	18.0±3.6	9.9±6.0	8.6±6.3	3.8±4.6	1.3±2.1	42.0±14.9
	<i>p</i>	0.861*	<0.001**	0.960*	0.928**	0.856**	0.045**	0.396*
Diet of the care recipient	Oral	2.6±1.3	15.7±5.0	9.9±5.7	8.2±5.9	3.7±4.3	2.0±2.6	39.7±16.4
	Tube	2.9±1.7	18.9±1.7	10.1±6.9	10.3±6.9	4.9±3.7	0.8±1.4	44.9±15.9
	<i>p</i>	0.634*	0.040**	0.830**	0.361**	0.198**	0.164**	0.399*

Table 4. The Relationship Between Caregiver Burden Inventory Subscales and Burnout Scale-Short Form Scores of Caregivers of Home Health Patients and Katz Activities of Daily Living Scale Score of Care Receivers\*

		Katz Activity of Daily Living Scale	Caregiver Burden Inventory					
			Time dependency load	Developmental burden	Physical load	Social burden	Emotional burden	Total CBI Score
Caregiver Burden Inventory	Time dependency load	r= -0.523 p<0.001	-	-	-	-	-	-
	Developmental burden	r= 0.047 p= 0.690	r= 0.172 p= 0.141	-	-	-	-	-
	Physical load	r= -0.029 p= 0.804	r= 0.299 p= 0.009	r=0.801 p<0.001	-	-	-	-
	Social burden	r= -0.064 p= 0.584	r= 0.116 p= 0.320	r=0.340 p=0.003	r=0.473 p<0.001	-	-	-
	Emotional burden	r= 0.150 p= 0.200	r= -0.032 p= 0.783	r=0.458 p<0.001	r=0.466 p<0.001	r=0.242 p=0.036	-	-
	Total CBI Score	r= -0.166 p= 0.154	r= 0.428 p<0.001	r=0.846 p<0.001	r=0.908 p<0.001	r=0.620 p<0.001	r=0.514 p<0.001	-
Burnout Scale-Short Form		r= 0.050 p= 0.668	r= 0.114 p= 0.329	r=0.652 p<0.001	r=0.638 p<0.001	r=0.474 p<0.001	r=0.336 p=0.003	r=0.661 p<0.001

In this study, a significant negative correlation was found between the CBI time-dependency burden subscale score of the caregivers and the Katz ADL scale of the care recipients ( $p<0.001$ ). In the Katz ADL scale, the dependency level decreases as the score of the care recipient increases. Therefore, as the dependency level of the care recipients increased, the time-dependency burden of the caregivers also increased.

A statistically significant strong positive correlation was found between the total CBI score of the caregivers and the burnout scale short form score ( $p<0.001$ ). In addition, significant positive correlations were found between each of the CBI subscales and other CBI subscales and the total CBI score. However, no significant positive correlation was found between the developmental, social and emotional burden subscales of the CBI and the time-dependency burden subscale of the CBI ( $p=0.141$ ,  $p=0.32$ ,  $p=0.783$ , respectively) (Table 4).

The results of linear regression analysis in predicting the Burnout Scale Score are shown in Table 5. CBI Score ( $\beta=0.620$ ;  $t=5.969$ ;  $p<0.001$ ) was found to be a predictor of the Burnout Scale score, while no statistically significant relationship was found for age, gender and receiving psychological support (Table 5).

Table 5. Linear Regression Analysis Results in Predicting Burnout Scale Score

Burnout Scale	B	SE	$\beta$	t	p
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Age	0.003	0.014	0.018	0.182	0.857
Gender	-0.279	0.358	-0.081	-0.779	0.439
Psychological Support	0.337	0.352	0.094	0.955	0.343
CBI Score	0.050	0.008	0.620	5.969	<0,001

Abbreviations: CBI: Caregiver Burden Inventory

## Discussion

In this study, the caregiving burden and burnout status of caregivers of the elderly receiving home health care services were examined and the relationship with demographic variables was investigated. There was a statistically significant positive correlation between the total CBI score and the Burnout Scale-Short Form score. Burnout is a condition that occurs when physical, emotional and mental fatigue levels are high. It should be noted that to date, no clear solution has been found to cope with burnout and caregiver stress caused by caregiving (14).

In societies, caregiving is mostly regarded as the role of women, and in this study, the majority of caregivers were women (7-15-16-17). Since it is mostly men who provide the household income by working in Turkish society, it may be mostly women who undertake the task of caring for the patient at home. In Turkey, women generally live longer than men and the difference in life expectancy at birth between men and women is 5.4 years (18). The fact that life expectancy is longer in women than in men may have caused them to undertake caregiving more than men.

In the study, no significant relationship was found between age, gender, marital status, income level, chronic disease and duration of caregiving, and care burden. In similar studies in the literature, different results were found regarding the effect of sociodemographic characteristics of caregivers on care burden. In the study of Dagdeviren et al. no significant relationship was found between age, gender, marital status, occupation, income level, number of children, duration of caregiving and closeness to the patient and care burden (18). Kahrirman's study revealed that age had an effect on care burden but gender, employment status and income level had no effect (20).

As a striking result in our study, it was found that caregiving did not create a social burden on the caregiver. Since Turkish society has a traditional structure that values intra-family relationships, patient care is seen as a responsibility that is appreciated and must be fulfilled by caregivers. Therefore, it can be concluded that caregiving does not impose a burden on the person in Turkish society, but rather brings tolerance and appreciation to the caregiver.

Many studies have revealed that patient care creates an intense physical and emotional burden on caregivers. A multidisciplinary approach is required in its management from primary health care to occupational health care (21). In our study, it was found that caregiving to second and third degree relatives/neighbors/relatives increased the developmental and emotional burden of CBI. This shows that the emotional burden of caregiving increases as the closeness of the individual with the caregiver decreases. It is known that close relative care brings an emotional burden. In this study, it was found that less emotional burden occurred in those who care for their closest relatives.

There are numerous studies conducted with CBI in the literature. However, there are a limited number of studies evaluating CBI subscales. One of the strengths of this study is that the CBI subscales were evaluated individually, and these subscales were also evaluated together with the Burnout Scale Short Form. In addition, this study was conducted face-to-face, on a one-to-one basis with patients and their caregivers, which is a more comprehensive approach that further strengthen this study.

In this study, 77.3% of home care recipients were fully dependent. There was a significant negative correlation between the CBI time-dependency burden subscale score of caregivers and the Katz ADL scale of care recipients. As the care recipient's score on the Katz ADL scale increases, so does the level of dependency. Therefore, as the Katz ADL scale scores of the care recipients decrease, their dependency level increase and this enhances the CBI time-dependency sub burden. This result was expected in this study. Yuksel et al. and Gayomali et al. found that the burden of caregiving increased as the dependency status of elderly patients in activities of daily life increased (22-23). In the study conducted by Isik, it was found that the burden of caregiving increased as the dependency status of elderly patients in activities of daily living increased (24).

In addition, in this study, it was found that the increase in the dependency level of the care recipient (being in diapers, fed by the caregiver and tube feeding) increased the CBI time-dependency sub burden. When other studies are examined, it is seen that the increase in the dependency level of the care recipient causes a significant increase in the burden of the caregiver (21-22).

While determining the determinants of the Burnout Scale score, a statistical relationship was found with the CBI



Score ( $\beta=0.620$ ;  $t=5.969$ ;  $p<0.001$ ). In the Turkish adaptation, validity and reliability study of the Burnout Scale Short Version, the analysis showed that the Burnout Scale Short Version scores correlated 0.48 with the Satisfaction with Life Scale scores, 0.73 with Depression scores, 0.70 with Anxiety scores and 0.70 with Stress scores ( $p<0.01$ ) (12).

### Study limitations

Some of the limitations of this study were that it was a single-center and cross-sectional study conducted in a certain time interval. Caregivers may not have responded to the questionnaire accurately enough because of apparent insufficiencies in their care of the patients, unwillingness to share their caregiving situation and show burnout symptoms that might be perceived as weakness. The study should be conducted with larger samples.

### Conclusion

Burnout may lead to negative outcomes such as low self-esteem, low motivation and low performance in caregivers. On the other hand, increased dependency level of the care recipient (being in diapers, fed by the caregiver and tube feeding) were found to increase the time-dependency sub burden of the CBI score. Therefore, appropriate measures should be taken to reduce burnout levels and caregiving burden of caregivers of home care patients. For example, caregivers may seek help from family and friends or get support from professional people. These professionals include HHC team members, primary care physicians, psychiatry specialists, nurses, psychologists, etc. They can reduce the stress of caregiving by taking time for themselves more frequently. The importance of medical support and multidisciplinary approach was once again emphasized in this study.

This study also shows that more detailed information about caregiving can be obtained by focusing on the subscales of the inventories and the necessary interventions can be determined.

Family medicine specialists should assess the physical and mental well-being of the caregivers. They should pioneer early diagnosis and effective measures before most conditions reach disease state. They should assume the responsibility of the patient and their relatives with a holistic approach.

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**Acknowledgements:** None.

**Ethical Approval:** The study was granted permission from the Ethics Committee of Recep Tayyip Erdogan University Faculty of Medicine (number: 2022/17, date: 01.04.2022). Informed consent was obtained from all patients.

**Author Contributions:** Concept: B.G., A.K., S.K. Literature Review: B.G., A.K., A.Y.A., A.K. Design: B.G., A.K., S.K. Data acquisition: B.G., A.K., A.Y.A., A.K., C.A., S.K. Analysis and interpretation: B.G., A.K., A.Y.A., A.K., C.A., S.K. Writing manuscript: B.G., A.K., A.Y.A., A.K., C.A., S.K. Critical revision of manuscript: B.G., A.K., A.Y.A., A.K., C.A., S.K.

**Conflict of Interest:** The author(s) do not have any potential conflict of interest regarding the research. authorship and/or publication of this article.

**Financial Disclosure:** This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

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## Determination of Foot Angles in Healthy Adult Turkish Population

*Sağlıklı Yetişkin Türk Popülasyonunda Ayak Açılarının Belirlenmesi*

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### Abstract

**Background:** It is well known that morphometric measurements taken from the foot are related to foot biomechanics. Radiographic angle and measurements of the certain parameters of the foot are reference sources in the treatment and surgical planning of foot and ankle deformities. This study has focused on measuring and evaluating the angular variables of the foot in terms of age and gender on foot radiographs of healthy adults.

**Materials and Methods:** A total of 300 individuals (150 females and 150 males) between the ages of 25 and 55 were grouped according to age and gender. Four angular variables were measured on lateral radiographs of the right foot taken with weight. The variables measured are as follows: Gissane Angle, Bohler Angle, Medial Arch Angle and Lateral Arch Angle. Statistical analyses were conducted with R (version 4.3.2 64-bit (2023-10-31 ucrt)) software.

**Results:** As a result of the analyses, the difference between genders was found to be statistically significant in the variables of Gissane Angle and Bohler Angle. While statistically significant difference was found only between the individuals in the third group in terms of Lateral Arch Angle variable, no significant result was found between the groups and the genders forming the groups for the variable of Medial Arch Angle.

**Conclusions:** Conclusion: The morphometric data acquired in this study with the use of the lateral radiographs of the foot can serve as a reference value for healthy Turkish population.

**Keywords:** Gissane Angle, Bohler Angle, Medial arch angle, Lateral Arch Angle, Reference values.

### ÖZ

**Amaç:** Ayaktan alınan morfometrik ölçümlerin ayak biyomekaniği ile ilişkili olduğu bilinmektedir. Ayak ve ayak bileği deformitelerinin tedavi ve cerrahi planlama süreçlerinde radyografik açı ve ölçüler referans kaynağı olmaktadır. Bu çalışmanın amacı, sağlıklı yetişkin bireylere ait ayak radyografi görüntüleri üzerinden ayağa ait açısal değişkenlerin yaşa ve cinsiyete göre değerlendirilmesini yapmaktır.

**Gereç ve Yöntem:** 25-55 yaş aralığındaki 300 kişi (150 kadın ve 150 erkek) yaşa ve cinsiyete göre gruplandırılmıştır. Bu kişilere ait vücut yüküyle çekilmiş sağ ayak lateral radyografi görüntüleri üzerinde belirlenen dört açısal değişken ölçülmüştür. Ölçümü yapılan değişkenler şu şekildedir: Gissane açısı, Bohler açısı, Medial ark açısı ve Lateral ark açısı. İstatistiksel analizler R (version 4.3.2 64-bit (2023-10-31 ucrt)) yazılım programı ile yapılmıştır.

**Bulgular:** Analizler sonucunda Gissane açısı ve Bohler açısı değişkenlerinde cinsiyetler arası farklılık istatistiksel olarak anlamlı bulunmuştur. Lateral ark açısı değişkeni için sadece 3. grubu oluşturan bireyler arasında istatistiksel açıdan anlamlı farklılık bulunurken, Medial ark açısı değişkeni için hiçbir grup ve grupları oluşturan cinsiyetler arasında anlamlı sonuç bulunmamıştır.

**Sonuç:** Ayağa ait lateral radyografi görüntülerinin kullanıldığı bu çalışmada, sağlıklı Türk popülasyonu ile ilgili referans oluşturabilecek morfometrik verilere ulaşılmıştır.

**Anahtar kelimeler:** Gissane açısı, Bohler açısı, Medial ark açısı, Lateral ark açısı, Referans değerler.

### Highlights

- Foot biomechanics has a complex anatomy formed by joint formations and muscles.
- The data obtained as a result of this study with a healthy group may be guiding in clinical processes.
- The available data can also be useful for age and sex determination in forensic and anthropological sciences.

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Received: 23 June 2024

Accepted: 22 August 2024

Cite as: RAY.G et al. Determination of Foot Angles in Healthy Adult Turkish Population. IJCMBS 2024;4(3):103-10 doi.org/ 10.5281/zenodo.13898924

## Introduction

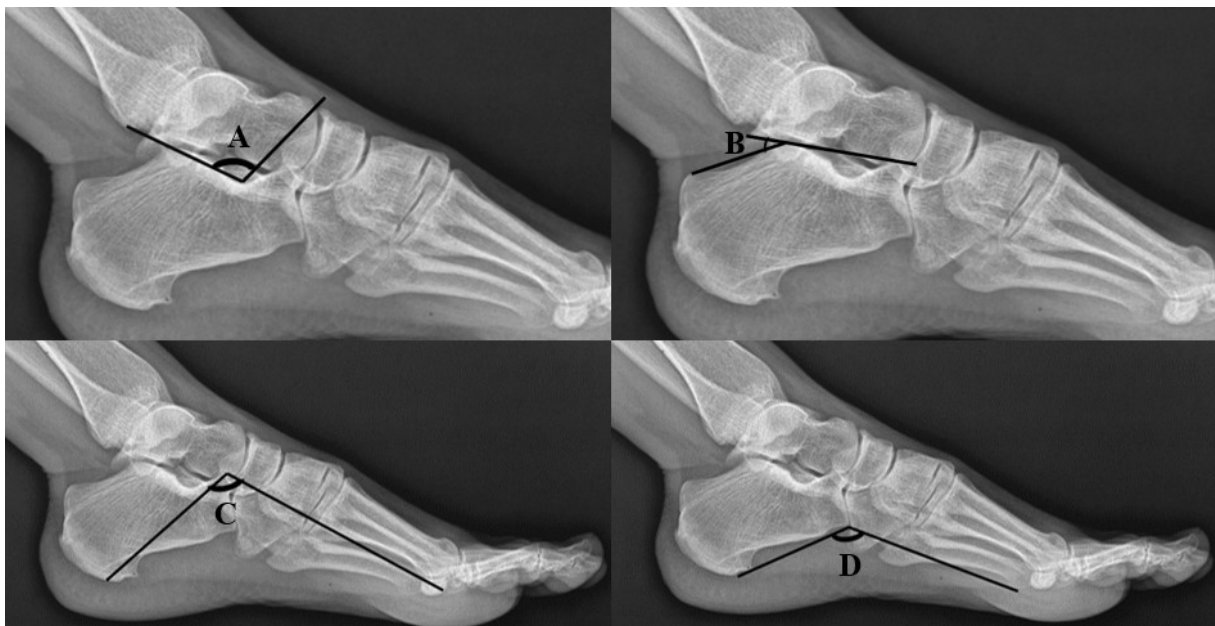
The maintenance of the arch in the static foot is utilized by a complex anatomy through perfect biomechanics and its stability is provided through the joint capsule, joint faces, ligaments, and muscles (1,2). Studies have documented data affecting foot biomechanics (3,4), are classified according to population specific ethnicity, gender, and age (5,6,7). Likewise, international data obtained from the angular measurements of the foot are used in interpretation of deformities such as pes planus (8), pes cavus (9), pes equinovarus (10), and in the detection and treatment of calcaneus (11) and talus (12) fractures. On the other hand, studies conducted in documenting the reference values of these angles to be used in the diagnosis and treatment follow-up in the clinics, have been limited in the healthy Turkish population (24-27). This study has therefore been designed to determine the varieties of angular measurements taken from the lateral foot radiographs of healthy adults living in the northwest of Turkey, focusing Bolu region.

The relationship between the shape of the foot and its bones varies in relation to whether the foot bears the weight of the body or not. Weight-bearing radiographs give better results than isolated bones to obtain functional relationships among the peculiarities of the foot. For this reason, weight-bearing foot radiographs were used in this study. The results will surely give profound contribution to the literature in terms of age and gender differences.

## Material and Methods

### Study design

The study was initiated after the 2023/410 numbered approval of Bolu Abant İzzet Baysal University Clinical Research Ethics Committee. (number: 2023/410. date:19.12.2023). Informed consent was obtained from all groups. It was conducted by using the right foot radiographs of 150 women and 150 men between the ages of 25 and 55, randomly selected from the Picture Archiving and Communication Systems (PACS) archive of Bolu Abant İzzet Baysal University Training and Research Hospital between November and December 2023. Patients with a history of surgery or fracture of the foot or ankle and those with a systemic disease were excluded from the study. The participants were divided into 3 groups as the first group (G1) between the ages of 25-34, the second group (G2) between the ages of 35-44 and the third group (G3) between the ages of 45-55 and each group consisted of 50 women and 50 men. The images taken in Dicom format were transferred to personal workstation Radiant Dicom Viewer (RDV) program from the system. The variables measured on the images are as follows: Gissane Angle (GA), Bohler Angle (BA), Medial Arch Angle (MAA) and Lateral Arch Angle (LAA). The variables were shown in **Figure 1**.



**Figure 1. Demonstration of the variables; A- GA, B- BA, C-MAA, D- LAA (GA: Gissane Angle, BA: Bohler Angle, MAA: Medial Arch Angle, LAA: Lateral Arch Angle).**

Bohler Angle is defined as the integral of the angle between the line combining the highest point of the tuber calcanei and the posterior facet of the calcaneus and the line uniting the highest point of the anterior calcanei

process and the posterior facet of the calcaneus (12). A decrease in the angle and negative measurement of the angle indicates the clinical picture of calcaneus fracture as documented by the literature (12,13). Likewise, GA is described as the angle between the anterior facet of the calcaneus and the lateral of the posterior facet (11).

Medial Arch Angle is defined as the angle between the lowest point of the talus head and the lines drawn to the lowest points of the first metatarsal head and calcaneal tuberosity (15). The value of the angle changes in pes planus and pes cavus deformities in which the medial longitudinal arch height is affected (8,9,15). Lateral Arch Angle is described as the angle between the lines drawn from the lowest point of calcaneocuboid joint to the lowest point of tuber calcanei and the apex of the 5th metatarsal bone (16).

Since a high prevalence of right foot dominance was found in Turkish population in the literature, lateral radiographs of the right foot were used in this study as suggested by the literature (17).

### Statistical Analysis

Statistical analyses were conducted with R (version 4.3.2 64-bit (2023-10-31 ucrt)) software. Conformity of the data to normal distribution was tested with Anderson Darling Test. In order to control the normality test, normal distribution of residuals was checked and evaluated by drawing four in one (normal probability plot, versus fit, histogram, versus order) graph. As a result of the analysis, the variables were found to be normally distributed. For this reason, no transformation was required. Two-way Anova was performed to find out the difference between groups. Post-hoc tests were not needed since no statistically significant result was found between groups as a result of variance analysis. Two Sample T Test was used to analyse differences between genders. Descriptive statistics of the data were calculated, and boxplot graphs were drawn to show the changes resulting from groups and gender.

### Results

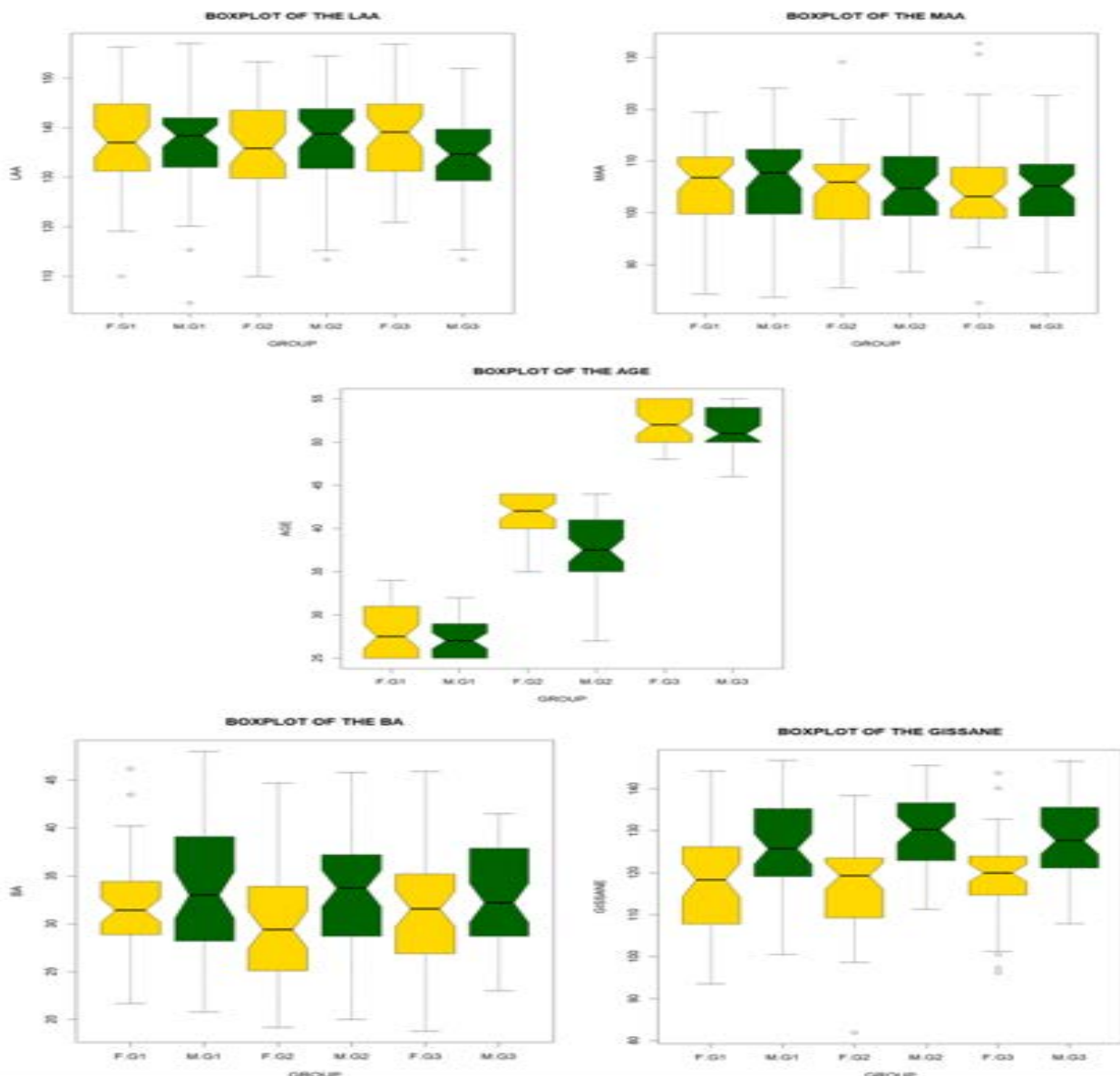
The variables were found to conform normal distribution. Variance analysis determined a statistically significant difference between the genders for the age ( $p < 0.001$ ). Hence, the two-sample t test found statistically significant difference between the first ( $p = 0.013$ ) and second groups ( $p < 0.001$ ) regarding the gender variance while no statistical significance was found for the third group ( $p = 0.131$ ). In terms of the variance analysis for GA variable, the difference between genders was found to be statistically significant ( $p < 0.001$ ) while the interaction among the groups and the interaction between the groups and gender were shown not to be statistically significant ( $p = 0.507$ ). Two-sample t test determined the difference between the genders of the three groups to be statistically significant. For the BA variable, no statistically significant result was found among the groups ( $p = 0.204$ ) while significant difference was obtained between genders ( $p = 0.001$ ) in terms of the interaction between the gender and groups. According to the results of the two-sample t test conducted to find out the differences between genders, while no statistically significant result was found between the genders in the first ( $p = 0.304$ ) and third ( $p = 0.121$ ) groups, statistically significant result was acquired between the genders in the second ( $p = 0.004$ ) group. Regarding the results of the variance analysis and two-sample t test for MAA variable, no statistically significant results were determined among the groups ( $p = 0.516$ ), in terms of the interaction between the groups and gender, and between the genders ( $p = 0.688$ ). As a result of the variance analysis for LAA variable, while no statistically significant result was found among the groups ( $p = 0.602$ ), in terms of the interaction between the groups and gender, and between the genders, the difference between the genders of the individuals in the third ( $p = 0.017$ ) group was found to be statistically significant as a result of the two-sample t test. The results of descriptive statistics, variance analysis, and two-sample t test were shown in **Table 1**. Boxplot graph depicting the comparison of the variables in terms of the group and gender was shown in **Figure 2**.

**Table 1. Descriptive statistics of the data, the results of variance analysis and two-sample t test analysis.**

Variables		G1 (n=100)	G2 (n=100)	G3 (n=100)	P value
Age	M (n=50)	37.8±3.5	51.3±2.7	37.8±3.5	0.570*
	F (n=50)	41.3±2.6	52.1±2.3	41.3±2.6	0.406**
	P value	0.013 <sup>‡</sup>	<0.001 <sup>‡</sup>	0.131 <sup>‡</sup>	<0.001 <sup>#</sup>
GA (°)	M (n=50)	130±9.5	128.4±9.5	130±9.5	0.507*
	F (n=50)	117.3±10.9	118.8±10	117.3±10.9	0.406**
	P value	<0.001 <sup>‡</sup>	<0.001 <sup>‡</sup>	<0.001 <sup>‡</sup>	<0.001 <sup>#</sup>

BA (°)	M (n=50)	32.9±5.6	32.9±4.9	32.9±5.6	0.204*
	F (n=50)	29.5±6	31.2±5.9	29.5±6	0.392**
	P value	0.308 <sup>†</sup>	0.004 <sup>‡</sup>	0.121 <sup>‡</sup>	0.001 <sup>#</sup>
MAA (°)	M (n=50)	105.5±7.9	104.3±7.9	105.5±7.9	0.516*
	F (n=50)	104.1±8.8	105.3±9	104.1±8.8	0.597**
	P value	0.653 <sup>‡</sup>	0.414 <sup>‡</sup>	0.575 <sup>‡</sup>	0.688 <sup>#</sup>
LAA (°)	M (n=50)	137.1±9.1	133.9±8.9	137.1±9.1	0.602*
	F (n=50)	135.7±10.5	138.2±8.8	135.7±10.5	0.094**
	P value	0.679 <sup>‡</sup>	0.458 <sup>‡</sup>	0.017 <sup>‡</sup>	0.267 <sup>#</sup>

**Abbreviations:** The data were displayed as mean ±standard deviation. \*p value as a result of the analysis of difference between groups. \*\* p value showing the interaction of gender and group factors. # p value as a result of the analysis of difference between genders. † p value showing the difference between genders forming the groups. (GA: Gissane Angle, BA:Bohler Angle, MAA: Medial Arch Angle, LAA: Lateral Arch Angle).



**Figure 1. Boxplot illustrating the changes in variables in terms of genders and groups (GA: Gissane Angle, BA: Bohler Angle, MAA: Medial Arch Angle, LAA: Lateral Arch Angle).**

**Discussion**

This study was designed to contribute to the accumulation of literature on the angular functional morphology of the foot in healthy adults. The results revealed statistically significant differences in all the groups for the variables of

GA and BA, taken from the lateral foot radiographs of healthy adults living in the northwest of Türkiye, focusing particularly on the data in terms of age and gender parameters.

Calcaneus is the most frequently fractured tarsal bone (11) and the values of BA and GA are taken as key reference during the diagnosis and treatment process of calcaneus fracture (12,18). Therefore, knowing the physiological range of these angles, which are also known as calcaneal angles, is very essential in terms of determining the degree of deformity and prognosis follow-up (18). The related literature has accumulated different reference ranges given for calcaneal angles in different populations (19-23).

A literature report has aimed to evaluate the relationship of calcaneal angles with age, gender and body side in healthy individuals in Egypt population, using foot radiographs of 220 individuals (5). This report has obtained similar mean values on these parameters as compared to those of our study except the fact that no relationship has been indicated between the calcaneal angles and age and gender. This may be due to the differences in the number and variation of population used, and age ranges and gender groups as well. A similar study has been designed to determine the reference values of foot and ankle angles in Saudi Arabia, using the radiographs of both feet of 100 individuals between the ages of 21 and 30, showing statistically significant difference between the genders, which is in parallel with the results of the present study (6). Another study conducted to reveal the relationship of BA with age, gender and laterality in adult Croatians, has reported higher BA values than those acquired in the present study, suggesting that BA value may not be associated with age, gender and laterality (11). Again, it is of valuable to stress the fact that this difference can also be due to different population and fewer participants used in the study. Research conducted on Chinese population to determine the physiological value of BA and to evaluate the possible factors that may affect the angle, has reported similar BA values as compared to the findings of our study, indicating no correlation with age, gender, and body side; thus, emphasizing that objective results cannot be obtained in individuals younger than 10 years of age (19). Similarly, a study to determine the physiological BA and GA values in Brazilian population, has found parallel results, indicating no significant correlation in terms of gender and age (20). Yet, another study performed on adults living in Serbia in terms of age and gender, has found the normal values of BA higher than the present study, indicating the effect of age and gender on the angles as statistically significant (21). Another research in Kwara population has documented similar BA and lower GA values as compared to the results of our study, suggesting no usage of the data in gender determination studies (22). Finally, another research conducted to show the relationship of calcaneal angles with gender, age, body mass index (BMI) and calcaneus morphometry on healthy adults living in India, has revealed significant correlation between calcaneal angles and BMI while documenting no significant correlation between calcaneal angles and age and gender (23). This research also has emphasized that calcaneal angles are associated with calcaneus morphometry and therefore surgical repairs of calcaneal fractures should be individualized. This report thus has found BA value similar to the present study in individuals with normal BMI but GA value is lower, which is probably due to the usage of different population studied and the fact that BMI has not been taken into account in the evaluations.

Few studies have evaluated calcaneal angles in healthy Turkish population by using foot radiographs (24-27). A literature report designed to determine the mean values of angular variables of the foot, and to show the relationship of these with age, gender and body size, has documented parallel mean calcaneal angles, as is the case the present study, highlighting no significant correlation between the angles and age and gender, which may again be due to the fact that age and gender have not been grouped homogeneously (24). Another study examining the relationship of calcaneal angles with pes planus deformity, has reported no statistically significant correlation between the calcaneal angles and pes planus, and different mean values of the angles from those in the present study (25). This difference may be because the sample group of the study consists of unhealthy individuals. Another research done to compare the reliability of a smart phone application iPinPoint and computer based SECTRA program in the measurement of calcaneal angles, has shown both their reliabilities and reproducibility in the evaluation of angles, and BA was found to be lower than that of the present study (26). This difference may be due to the fact that the study has been conducted on the patients and different measurement techniques have been applied. Another report performed to evaluate the radiological and demographic characteristics of patients diagnosed with plantar calcaneal spur in terms of age and BMI, and to show the differences between these patients and the control group, has found no significant difference, revealing higher mean values than those of the present study (27). This difference may be since the present study has been performed on healthy individuals and BMI has not been calculated. It is important to know and maintain the physiological values of calcaneal angles for quick and painless healing of calcaneus and talus fractures during and after surgery. Yet, angular values are lower in the present study than in the reports used patients diagnosed with talus and calcaneus fracture (13,28,29).

Several static and dynamic methods have been developed to define and evaluate the medial arch structure of the foot such as calcaneal inclination angle and calcaneus 1st metatarsal angle (3), dynamic plantar pressure measurement (30), arch index (31), and navicular drop test (32). The methods are applied mostly to the clinical cases of the related anatomical structures. On the other hand, there are very limited studies examining the LAA in healthy individuals (35, 36). This study has attempted to constitute reference values of arch angles in healthy adults, stressing particularly the fact that while the difference between genders was statistically significant in LAA variable in individuals in the third group, no difference was found between genders in MAA variable.

In a study examining the correlation of MAA with foot length in healthy individuals by using foot radiograph, no statistically significant difference has been found between MAA and gender, parallel to the results of the present study (3). Sample group of another study (30) which has aimed to compare dynamic plantar measurement system and radiographic measurements in MLA evaluation has consisted of healthy adults, reporting the dynamic and static methods given consistent results for MLA evaluation. In addition, parallel with the present study, no significant correlation has been achieved between the MLA angle and gender. Likewise, another report (31) searching for the relationship between the arch structure of the foot and gender, age and dominance, the arch height and stiffness of the participants have been measured, indicating no difference between the genders neither any correlation between the age and arch angles, in parallel with the present study. Yet, a different study conducted on the USA population has been designed to present basic data on the angular and linear variables of the foot in healthy individuals, and to show the difference between genders, finding no statistically significant difference between the genders but angular values higher than the present study (33). A similar result has also been reported in another study which has examined the angular measurements of the foot in Saudi Arabia in terms of age and gender (34). The lower angular values found in the present study may be due to the comparison of different populations and smaller sample sizes used in those studies. Finally, unlike the present study, a report (35-37) aiming to evaluate arch angles and the differences of the foot morphometry resulting from age, gender, and side by using foot radiographs of adolescents and adults, has shown significant differences between the genders, and higher arch angles. This is obviously due to the fact that the adolescent group has not been included in the present study.

### Study limitations

Since the present study was designed retrospectively, important points such as the arch of the foot or the alignment of the posterior part of the foot could not be intervened in the X-ray images. This may affect the measurement of foot angles and is considered as a limitation of the study.

### Conclusion

As a conclusion, the findings of the present study contribute to calcaneal and arch angle data in literature in terms of healthy Turkish population. They may be useful reference values serving a guide in the treatment and follow-up processes of calcaneus and talus fractures and in the determination of foot arch deformities

**Acknowledgements:** None.

**Ethical Approval:** The study was granted permission from the Bolu Abant İzzet Baysal University Clinical Research Ethics Committee (number: 2023/410. date: 19.12.2023). Informed consent was obtained from all patients.

**Author Contributions:** Concept: G.R; İ.K; A.R; G.T.Ş; Literature Review: G.R; İ.K; A.R; G.T.Ş; Design: G.R; İ.K; A.R; G.T.Ş; Data acquisition: G.R; A.R; Analysis and interpretation: A.R; Writing manuscript: G.R; İ.K; A.R; G.T.Ş; Critical revision of manuscript: G.R; İ.K; A.R; G.T.Ş;

**Conflict of Interest:** The author(s) do not have any potential conflict of interest regarding the research, authorship and/or publication of this article.

**Financial Disclosure:** This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

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## Comparison of the Effect of Transurethral and Suprapubic Catheterization on Transurethral Prostatectomy Results in Patients with Acute Urinary Retention Secondary to Benign Prostatic Hyperplasia

*Benign Prostat Hiperplazisine Sekonder Akut İdrar Retansiyonu Olan Hastalarda İntraüretral veya Suprapubik Kateter Kullanımının Transüretral Prostatektomi Sonuçlarına Etkisinin Karşılaştırılması*

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### Abstract

**Background:** We aimed to evaluate the impact of different catheterization methods on transurethral resection of the prostate outcomes in patients with benign prostatic hyperplasia related acute urinary retention.

**Materials and Methods:** Between 2019 and 2023, a retrospective examination was conducted on patients experiencing acute urinary retention secondary to benign prostatic hyperplasia. The study encompassed 89 patients who underwent transurethral resection of the prostate. The patients' demographic data, preoperative uroflowmetry results, pathology reports and the data obtained during their follow-up up to the 12th month were recorded. The patients' data were divided into two groups based on catheterization status: percutaneous cystostomy and Foley catheter, and compared.

**Results:** The study included 76 patients with a transurethral Foley catheter and 13 with a percutaneous suprapubic cystostomy. No significant differences were observed in preoperative parameters or postoperative complications and pathology results between the groups. Uroflowmetry showed a significant decrease in postoperative postvoiding residual urine volume in the suprapubic catheter group but no significant difference in maximum flow rate. In the Foley catheter group both maximum flow rate and postvoiding residual urine volume showed significant changes postoperatively. However, when comparing uroflowmetry results between groups no significant differences were observed.

**Conclusions:** Catheterization methods are utilized in the emergency management of acute urinary retention caused by benign prostate enlargement. Advantages and disadvantages should be carefully considered when selecting the appropriate method. Our study has shed light on this aspect. We believe that conducting more comprehensive prospective studies could yield more reliable results.

**Keywords:** Urinary retention, benign prostatic hyperplasia, urethral catheterization, suprapubic cystostomy

### ÖZ

**Amaç:** Bu çalışmada benign prostat hiperplazisi ile ilişkili akut üriner retansiyonu olan hastalarda farklı kateterizasyon yöntemlerinin transüretral prostat rezeksiyonu sonuçlarına etkisini değerlendirmeyi amaçladık

**Gereç ve Yöntem:** 2019-2023 yılları arasında benign prostat hiperplazisine sekonder akut üriner retansiyonu gelişen hastalar retrospektif olarak değerlendirildi. Çalışmaya transüretral prostat rezeksiyonu uygulanan 89 hasta dahil edildi. Hastaların demografik verileri, preoperatif üroflowmetride post voiding rezidü ve maksimum akış hızı, patoloji raporları ve postoperatif 12. aya kadarki takiplerinde elde edilen verileri kaydedildi. Hastaların verileri kateterizasyon durumuna göre perkütan sistostomi ve foley kateter olmak üzere iki gruba ayırarak karşılaştırıldı.

**Bulgular:** Çalışmaya transüretral Foley kateterli 76 hasta ve perkütan suprapubik sistostomili 13 hasta dahil edildi. Gruplar arasında ameliyat öncesi parametreler açısından anlamlı fark yoktu. Postoperatif komplikasyon ve patoloji sonuçları gruplar arasında anlamlı farklılık göstermedi. Suprapubik kateterizasyon grubunda işeme sonrası rezidüel idrar hacminde anlamlı bir azalma gözlemlendi ancak maksimum akış hızında anlamlı bir fark yoktu. Foley kateter grubunda ise hem maksimum akış hızı hem de işeme sonrası rezidüel idrar hacminde ameliyat sonrası önemli değişiklikler gösterdi. Ancak gruplar arasında üroflowmetri sonuçları karşılaştırıldığında anlamlı bir fark gözlenmedi.

**Sonuç:** Benign prostat büyümesinin neden olduğu akut üriner retansiyonun acil tedavisinde transüretral veya suprapubik kateterizasyon yöntemlerinden yararlanılmaktadır. Uygun yöntemi seçerken avantajlar ve dezavantajlar dikkatle değerlendirilmelidir. Çalışmamız bu konuya dikkati çekmektedir. Prospektif ve geniş serili çalışmalar ile daha sağlıklı sonuçların elde edileceğine inanıyoruz.

**Anahtar kelimeler:** İdrar retansiyonu, benign prostatik hiperplazi, üretral kateterizasyon, suprapubik sistostomi

### Highlights

- Patients with acute urinary retention were analyzed
- Preoperative characteristics of acute urinary retention patients with BPH were analyzed.
- The effect of catheterization types on prostate surgery results was evaluated.

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Received: 07 July 2024

Accepted: 08 August 2024

Cite as: TUNÇEKİN.A et al. Comparison of the Effect of Transurethral and Suprapubic Catheterization on Transurethral Prostatectomy Results in Patients with Acute Urinary Retention Secondary to Benign Prostatic Hyperplasia. *IJCMBMS* 2024;4(3): 111-7 doi.org/ 10.5281/zenodo.13898285

## Introduction

Acute urinary retention is characterized by the sudden inability to pass urine, requiring urgent urological intervention (1). It is often associated with benign prostatic enlargement and can also occur secondary to bladder dysfunction, post-surgical complications, medications and various urogenital infections (2,3). The prevalence of acute urinary retention in men varies with age particularly affecting approximately 10-30% of elderly individuals (4).

In the emergency management of acute urinary retention, drainage is achieved through urethral catheterization. In cases where urethral catheterization is not feasible, bladder drainage is accomplished via percutaneous cystostomy (5). Following catheterization management primarily focuses on treating the underlying cause. In cases of acute urinary retention secondary to benign prostatic enlargement alpha-blockers are initiated and a trial of voiding without a catheter is typically attempted after approximately 3-10 days (6). If these attempts are unsuccessful surgical interventions such as transurethral resection of the prostate (TUR-P) may be necessary to relieve bladder outlet obstruction (BOO) (7).

Uroflowmetry is a used non-invasive urodynamic test to assess urinary flow rate. Voided volume, maximum flow rate ( $Q_{max}$ ), flow pattern and post void residual urine (PVR) are the key parameters for detecting BOO (8). PVR urine assess by transabdominal ultrasound, catheterisation or bladder scan (9). The diagnostic accuracy of this findings for detecting BOO varies and influenced by threshold values. Using a PVR threshold of 50 mL, the diagnostic accuracy of PVR has a positive predictive value (PPV) of 63% and a negative predictive value (NPV) of 52% for the prediction of BOO (10). A threshold  $Q_{max}$  of 10 mL/s has a specificity of 70%, a PPV of 70% and a sensitivity of 47% for BOO. Using a threshold  $Q_{max}$  of 15 mL/s the specificity was 38%, the PPV 67% and the sensitivity 82% (11).

This study aims to evaluate the impact of different catheterization methods on the outcomes of transurethral prostate resection in patients with acute urinary retention secondary to benign prostatic enlargement.

## Material and Methods

### Study design

The study commenced after obtaining approval from Uşak University local ethics committee (dated 15.02.2024/decision number 309-309-08). Records of patients presenting with acute urinary retention to our clinic between 2019 and 2023 were retrospectively reviewed. Patients with acute urinary retention secondary to benign prostatic hyperplasia (BPH) who underwent emergency management with either percutaneous cystostomy or transurethral Foley catheterization were included in the study. Patients with acute urinary retention due to factors other than benign prostatic hyperplasia, as well as those with chronic urinary retention, were excluded. The initial amount of urine drained after catheterization was measured as acute urinary retention capacity. Following catheterization, patients who were initiated on alpha-blocker therapy and had their transurethral catheters removed approximately 3 days later as well as those with suprapubic cystostomy catheters whose voiding status was assessed using uroflowmetry were evaluated. A total of 89 patients who continued to exhibit obstructive voiding symptoms and subsequently underwent TUR-P were included in the study.

Patients with acute urinary retention due to causes other than BPH and those who had normal voiding function on follow-up without undergoing TUR-P were excluded from the study. Data on patients' ages, comorbidities, BPH histories, alpha-blocker usage histories, prostate-specific antigen (PSA) values, preoperative uroflowmetry results (PVR and  $Q_{max}$ ), pathology reports, postoperative (3-5 days) uroflowmetry results after catheter removal and follow-up data obtained at 1st, 3rd, 6th and 12th months were recorded.

Patients' data were divided into two groups based on the catheterization method (percutaneous cystostomy and Foley catheter). Comparisons between groups were made regarding age, PSA value, prostate volume, uroflowmetry findings, operative time, length of hospital stay, pathology reports, postoperative uroflowmetry results and complications.

### Statistical Analysis

For statistical analysis sample size was calculated with at least 80% power and a 5% error rate. Normal distribution was assessed using the Shapiro-Wilk and Skewness-Kurtosis tests and non-parametric tests were applied. Descriptive statistics (mean, standard deviation, median, interquartile range, minimum, maximum, n and %) were used for continuous variables. Mann-Whitney U test was used for comparisons between groups and the Wilcoxon test was used for comparisons between preoperative and postoperative measurements. The Chi-

square (Fisher's exact) test was employed to determine relationships between categorical variables. A significance level of  $p < 0.05$  was adopted and SPSS (IBM SPSS for Windows ver.26) statistical software was utilized for analysis.

## Results

The average age of the patients was 71, with a mean PSA level of 6.75 and an average length of hospital stay of 4 days. Out of the patients, 76 (85.4%) underwent transurethral Foley catheterization, while 13 (14.6%) received percutaneous cystostomy. Patients without a history of BPH before AUR were more prevalent (80.8%). The distribution of other preoperative variables is presented in **Table 1**. Perioperative continuous measurements were compared between groups based on the catheter type. However, no statistically significant differences were observed in age, PSA or any other parameters. Detailed information on all variables and p-values is provided in **Table 2**.

**Table 1. Preoperative Data of Patients**

Variables, N (%)		Percutaneous Cystostomy (n=13)	Foley Catheter (n=76)
BPH History before AUR		3 (17.7)	14 (82.3)
Alpha blocker usage		3 (17.7)	14 (82.3)
Additional comorbidity	Diabetes Mellitus + Hypertension	2 (28.5)	5 (71.5)
	Chronic Obstructive Pulmoner Disease	0 (0)	2 (100)
	Hypertension	1 (25)	3 (75)
	Diabetes Mellitus	1 (33.3)	2 (66.7)
	Hyperlipidemia	0 (0)	1 (100)
	Laryngeal cancer	0 (0)	1 (100)
Surgical history	Left Nephrectomy	1 (100)	0 (0)
	Thyroidectomy	0 (0)	1 (100)
	Inguinal Hernia Repair	0 (0)	4 (100)
	Coronary Bypass	0 (0)	2 (100)
DRE	Grade-1	2 (20)	8 (80)
	Grade-2	2 (9.5)	19 (90.5)
	Grade-3	1 (33.3)	2 (66.7)
Urine culture	E. Coli	1 (50)	1 (50)
	Klebsiella	0 (0)	1 (100)
	Pseudomonas	0 (0)	1 (100)

**Abbreviations:** AUR; acute urinary retention, BPH; benign prostatic hyperplasia, DRE; digital rectal examination, n; number of patients, USG; ultrasonography

When evaluated for complications during postoperative follow-ups at 1st, 3rd, 6th and 12th months, no statistically significant relationship was observed between the groups. Similarly, pathology results showed that BPH was the most common diagnosis in both groups with no statistically significant difference between them. The data for these variables and their p-values are detailed in **Table 3**. When evaluating uroflowmetry results, a statistically significant difference was observed between preoperative and postoperative PVR values in the percutaneous cystostomy group ( $p=0.009$ ), indicating a significant decrease in PVR postoperatively. However, in this group no statistically significant difference was found in preoperative and postoperative Qmax values ( $p=0.508$ ), indicating similar Qmax values. In the Foley catheter group statistically significant differences were observed between preoperative and postoperative Qmax ( $p=0.003$ ) and PVR ( $p=0.001$ ) values, indicating a significant increase in Qmax and decrease in PVR postoperatively. When comparing uroflowmetry results between the two groups no statistically significant differences were found in preoperative ( $p=0.730$ ) and postoperative ( $p=0.817$ ) Qmax values, as well as preoperative ( $p=0.786$ ) and postoperative ( $p=0.759$ ) PVR values. The uroflowmetry findings are detailed in **Table 4** and depicted in **Figure 1**.

**Table 2. Comparison of Perioperative Continuous Measurements by Catheter Type**

Variables	Percutaneous Cystostomy (n=13)		Foley Catheter (n=76)		*P value
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	
Age/ years	71.69 ± 9.10	70.0 (64.0-78.0)	70.99 ± 6.69	71.0 (66.3-75.0)	0.963
PSA/ ng/ml	6.47 ± 9.12	2.2 (1.04-12.2)	6.78 ± 8.12	3.9 (2.2-7.6)	0.457
Prostate volume/cc	58.15 ± 18.18	63.0 (42.5-75.0)	61.29 ± 4.97	62.0 (50.0-72.3)	0.785
AUR capacity/ml	810.54 ± 367.60	700.0 (575.0-950.0)	811.00±356.91	750.0 (550-1000)	0.963
Preoperative catheterization duration/days	35.08 ± 18.67	34.0 (22.5-46.0)	47.96 ± 32.05	35.5 (25.3-63.8)	0.261
Postoperative hospitalization/days	5.69 ± 5.56	4.0 (2.5-7.0)	3.87 ± 3.75	2.0 (1.0-5.0)	0.123
Postoperative catheterization duration/days	4.00 ± 1.10	4.0 (3.0-5.0)	3.40 ± 0.81	3.0 (3.0-3.0)	0.118

**Abbreviations:** AUR; acute urinary retention. PSA; prostate specific antigen. SD; standard deviation. IQR; Interquartile range \* Significance levels according to Mann-Whitney U test results

**Table 3. Data on Postoperative Follow-up and Pathology Results**

Variables. N (%)		Percutaneous Cystostomy (n=13)	Foley Catheter (n=76)	*P value
Pathology	BPH	11 (15.7)	59 (84.3)	0.894
	BPH. Chronic Prostatitis	2 (18.1)	11 (81.9)	
	Prostate Adenocarcinoma	0 (0)	6 (100)	
Postoperative 1st Month Follow-up	Hematuria	1 (25)	3 (75)	0.651
	Urge incontinence	1 (25)	3 (75)	
	Stress incontinence	0 (0)	3 (100)	
	Dysuria	0 (0)	4 (100)	
	Straining during urination	1 (33.3)	2 (66.7)	
Postoperative 3rd Month Follow-up	Urge incontinence	0 (0)	2 (100)	0.395
	Dysuria	0 (0)	2 (100)	
	Straining during urination	2 (50)	2 (50)	
	Orchitis	1 (33.3)	2 (66.7)	
	Edema in penis and scrotum	1 (100)	0 (0)	
Postoperative 6th Month Follow-up	Urge incontinence	1 (100)	0 (0)	0.290
	Dysuria	0 (0)	2 (100)	
	Straining during urination	1 (100)	1 (100)	
	Orchitis	0 (0)	1 (100)	
Postoperative 12th Month Follow-up	Hematuria	1 (100)	0 (0)	0.223
	Urge incontinence	1 (100)	0 (0)	
	Dysuria	0 (0)	3 (100)	
	Straining during urination	1 (50)	1 (50)	

	Orchitis	0 (0)	1 (100)
	Acute urinary retention	1 (100)	0 (0)

Abbreviations: BPH; benign prostatic hyperplasia. \* Significance level according to chi-square (Fisher's exact) test results

Table 4: Two-way comparison results of uroflowmetry findings by Groups and Preop-Postop periods

Variables	Percutaneous Cystostomy (n=13)		Foley Catheter (n=76)		*P value
	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	
Qmax Preop	4.00 ± 3.34	5.0 (0.0-5.5)	3.67± 3.13	4.0 (0.0-6.0)	0.730
Qmax Postop	5.80 ± 7.78	0.1 (0.0-13.8)	6.33± 7.54	0.1 (0.0-14.6)	0.817
<b>**P value</b>	0.508		0.003		
PVR Preop	202.92±221.03	153.0 (0.0-295.0)	187.83 ± 177.74	178.0 (0.0-267.0)	0.786
PVR Postop	16.15± 23.73	0.1 (0.0-35.0)	14.28± 19.68	0.2 (0.0-25.0)	0.759
<b>**P value</b>	0.009		0.001		

Abbreviations: n; number of patients. PVR; post voiding residue. Qmax; maximum flow rate. SD; standard deviation. IQR; Interquartile range. \*Significance level according to Mann-Whitney-U Test; \*\*Significance level between "Preop-Postop" according to Wilcoxon test

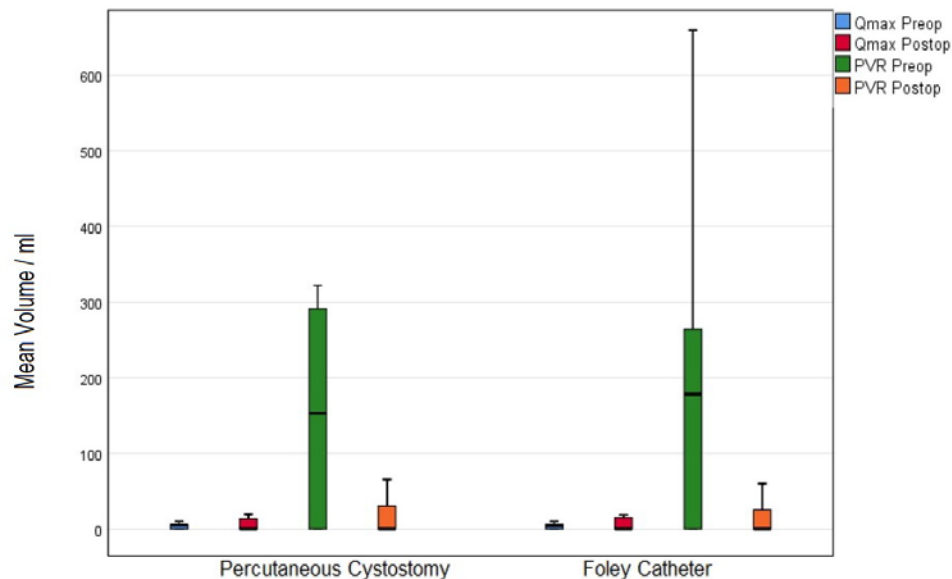


Figure 1: Comparison of uroflowmetry findings by Catheter Type

## Discussion

BPH occurs in men and is common, with the incidence increasing with age affecting approximately 75% of men aged 80 and above (12). About 40% of patients with BPH may require treatment due to the progression of prostate enlargement (13). AUR is a distressing condition often associated with BPH requiring urgent treatment (14). AUR is the most common indication for TUR-P with approximately 70% of patients undergoing TUR-P following AUR.

especially in elderly patients (15).

The management of AUR lacks a standardized treatment algorithm but typically involves initial transurethral catheterization. If unsuccessful, suprapubic catheterization is performed (16,17). While suprapubic catheterization has disadvantages such as catheter displacement and bowel injury, it offers advantages such as a lower risk of urethral stricture and infection and no need for repeated catheterization after failed voiding (18). To increase the success rate of trial without catheter alpha blockers should be started after catheterization and the first voiding attempt should be made approximately 2-3 days later (19).

In our study, patients with AUR secondary to benign prostatic enlargement were managed with transurethral Foley catheterization followed by the initiation of alpha-blockers immediately after catheterization with a trial of voiding approximately three days later.

In patients with percutaneous cystostomy, the catheter was clamped for voiding trials. Elective surgery was performed on patients with unsuccessful voiding trials. Some patients initially refused surgery and were managed with catheterization until later opting for surgery, resulting in a longer duration between catheterization and surgery. This led to a higher observed duration between catheterization and surgery. In the study by Cathcart et al., the rate of patients undergoing surgery after acute urinary retention was reported to be approximately 20-32% (20). In our study, we also observed a similar rate with 27.6% of patients undergoing surgery.

When evaluating the effectiveness of different catheterization methods on postoperative outcomes of TUR-P, we found that in the transurethral catheterization group postoperative Qmax significantly increased compared to preoperative values, while PVR significantly decreased. In the percutaneous cystostomy group PVR significantly decreased after voiding but there was no significant difference in Qmax values. However, when comparing both groups there was no significant difference in Qmax and PVR values. Despite the lack of significant increase in Qmax values in the percutaneous cystostomy group, the decrease in residual urine and similar rates of voiding difficulty suggest that suprapubic catheterization does not adversely affect voiding.

When evaluating complication rates, early complications (within the first postoperative month) were observed in 4.4% for hematuria, 4.4% for dysuria, 3.3% for voiding difficulty, 6.7% for urinary tract infection and 7.8% for incontinence. Complications observed at 12 months included 1.1% for hematuria, 3.3% for dysuria, 2.2% for voiding difficulty, 1.1% for urinary tract infection, 1.1% for AUR and 1.1% for incontinence. There was no significant difference in complication rates between the groups during the 12-month follow-up period. All patients were followed conservatively. Huang et al. observed similar postoperative complication rates ranging from 1.27% to 31.65% in their studies (21).

In a study by Chen et al. it was found that the risk of complications was elevated in TUR-P procedures performed after acute urinary retention (22). Additionally, another study reported a high incidence of repeat catheterization and risk of urethral stenosis in transurethral catheterization suggesting that suprapubic catheterization should be prioritized (23). In our study one patient in the percutaneous cystostomy group required a repeat catheter at the 12th month follow-up, which was managed by inserting a transurethral Foley catheter.

Our study has several limitations including its retrospective nature and being conducted at a single center, which may have resulted in insufficient or inaccessible data. Voiding status was evaluated intermittently with uroflowmetry tests and symptom evaluation data, such as the International Prostate Symptom Score (IPSS), could have provided a more comprehensive assessment. However, a sufficient number of IPSS scores could not be obtained in our study. Additionally, repeated postoperative uroflowmetry results were not available in sufficient numbers so only the initial results were compared. Access to these data could have significantly contributed to the study.

#### **Study limitations**

Some of the limitations of this study were that it was a single-center and cross-sectional study conducted in a certain time interval. Caregivers may not have responded to the questionnaire accurately enough because of apparent insufficiencies in their care of the patients, unwillingness to share their caregiving situation and show burnout symptoms that might be perceived as weakness. The study should be conducted with larger samples.

#### **Conclusion**

Transurethral or suprapubic catheterization methods are utilized in the emergency management of AUR caused by benign prostate enlargement. When choosing the appropriate method, it is important to carefully weigh the pros and cons. Our study has shed light on this aspect. We believe that conducting more comprehensive prospective studies could yield more reliable results.



**Acknowledgements:** None.

**Ethical Approval:** The study was granted permission from the Ethics Committee of Uşak University Faculty of Medicine (number: 309-309-08. date: 15.02.2024).

**Author Contributions:** Concept: A.Tu. Literature Review: A.Tu.. A.T.o. Design: A.Tu.. A.T.o Data acquisition: A.Tu.. A.T.o Analysis and interpretation: A.Tu.. A.T.o Writing manuscript: : A.Tu. Critical revision of manuscript: A.Tu.. A.T.o

**Conflict of Interest:** The author(s) do not have any potential conflict of interest regarding the research. authorship and/or publication of this article.

**Financial Disclosure:** This research received no specific grant from any funding agency in the public. commercial. or not-for-profit sectors

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## Assessing Colistin Resistance Among Clinical Isolates: A Comparative Study of BD Phoenix System versus Broth Microdilution Method

Klinik İzolatlarda Kolistin Direncinin Değerlendirilmesi: BD Phoenix Sistemi ile Sıvı Mikrodilüsyon Yönteminin Karşılaştırmalı Çalışması

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### Abstract

**Background:** This study aims to compare the colistin susceptibility detected by the BD Phoenix automated system among multidrug-resistant bacteria with the broth microdilution (BMD) method results.

**Materials and Methods:** The study included 236 isolates (92 *A. baumannii*, 68 *K. pneumoniae*, 55 *P. aeruginosa*, and 21 *E. coli*) isolated from clinical samples submitted to the bacteriology laboratory of Dicle University Hospital. The BD Phoenix 100 automated system was evaluated using BMD as a reference method. Categorical agreement (CA, the number of concordant results), major errors (ME, results falsely categorized as resistant by the automated system despite being sensitive by the reference method), and very major errors (VME, results falsely categorized as sensitive by the automated system despite being resistant by the reference method) were calculated.

**Results:** Of the 236 isolates, colistin resistance was found in 34 (14.4%) isolates, with *A. baumannii*, *K. pneumoniae*, *P. aeruginosa*, and *E. coli* exhibiting resistance rates of 15.2%, 20.6%, 1.8%, and 23.8%, respectively. *A. baumannii* showed 89.1% CA between the two methods, with 10.8% VME. *K. pneumoniae* had an 83.8% CA with a 14.7% VME rate. *P. aeruginosa* exhibited a 98.1% CA with a 1.8% VME rate, while *E. coli* showed an 80.9% CA with a 19% VME rate. The BD Phoenix 100 automated systems had a 10.5% VME rate compared to BMD. The automated system identified 9 out of 34 isolates as susceptible, contrary to the reference method which reported them as resistant.

**Conclusions:** Categorical agreement rates of the automated system varied according to bacterial isolates. The high VME rate of the BD Phoenix 100 system demonstrated the need to confirm colistin results reported as susceptible to SMD.

**Keywords:** Colistin, Antibiotic resistance, *Acinetobacter baumannii*, *Klebsiella pneumoniae*

### ÖZ

**Amaç:** Amaç: Bu çalışma, çoklu ilaca dirençli bakterilerde BD Phoenix otomatize sistem tarafından tespit edilen kolistin duyarlılığını, sıvı mikrodilüsyon (SMD) yönteminin sonuçları ile karşılaştırmayı amaçlamaktadır.

**Gereç ve Yöntem:** Çalışma, Dicle Üniversitesi Hastanesi bakteriyoloji laboratuvarına gönderilen klinik örneklerden izole edilen 236 izolatı (*A. baumannii*-92 izolat, *K. pneumoniae*-68 izolat, *P. aeruginosa*-55 izolat ve *E. coli*-21 izolat) içermektedir. Çalışmada BD Phoenix otomatize sistem sonuçları, referans yöntem olarak kabul edilen SMD ile karşılaştırılmıştır. Otomatize sistem sonuçlarının kategorik uyum (KU, uyumlu sonuçların oranı), büyük hata (BH, referans yöntem ile duyarlı olup otomatize sistem tarafından dirençli bulunan sonuçlar) ve çok büyük hata (ÇBH, referans yöntem ile dirençli olup otomatize sistem tarafından duyarlı bulunan sonuçlar) oranları hesaplanmıştır.

**Bulgular:** Toplam 236 izolatın 34'ünde (%14,4) kolistin direnci saptanmış olup, *A. baumannii*, *K. pneumoniae*, *P. aeruginosa* ve *E. coli* izolatları sırasıyla %15,2, %20,6, %1,8 ve %23,8 direnç oranlarına sahiptir. *A. baumannii* izolatlarında iki yöntem arasında %89,1 kategorik uyum (KU) ve %10,8 ÇBH saptanırken *K. pneumoniae* izolatlarında %83,8 KU, %14,7 ÇBH saptanmıştır. *P. aeruginosa* ve *E. coli* izolatlarında ise KU oranları sırasıyla %98,1 ve %80,9, ÇBH oranları sırasıyla %1,8 ve %19 olarak bulunmuştur. BD Phoenix 100 otomatik sistem, SMD ile karşılaştırıldığında %10,5 ÇBH oranına sahiptir; referans yöntemin dirençli bulduğu 34 izolattan 9'unu duyarlı olarak raporlamıştır.

**Sonuç:** Otomatize sistemin kategorik uyum oranları bakteri izolatlarına göre değişkenlik göstermektedir. BD Phoenix 100 sisteminin yüksek ÇBH oranı, otomatize sistemde duyarlı olarak raporlanan kolistin sonuçlarının SMD ile doğrulanması gerekliliğini ortaya koymaktadır.

**Anahtar kelimeler:** Kolistin, antibiyotik direnci, *Acinetobacter baumannii*, *Klebsiella pneumoniae*

### Highlights

- Categorical agreement between the BD Phoenix 100 system and BMD ranged from 80.9% to 98.1%.
- The BD Phoenix 100 system misidentified 9 out of 34 resistant isolates as susceptible.
- The high VME rate highlights the need to confirm colistin susceptibility results.

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Received: 05 July 2024  
Accepted: 07 November 2024

## Introduction

Colistin is a polymyxin group antimicrobial agent which was synthesized in the 1940s and remained in use till the late 1970s. Among approximately thirty different polymyxin compounds, polymyxin B and polymyxin E (colistin) share a similar structure and are used in clinical application (1). Since the 1970s, the intravenous administration of colistin has decreased gradually because of its considerable harmful effects on the kidneys and nerves. However, the emergence of resistance against aminoglycosides followed by carbapenem groups in Gram-negative bacteria has led to the resurgence of parenteral colistin use in the 2000s (2,3). The unnecessary use of antibiotics and incorrect antibiotic use policies, including clinicians' preference for broad-spectrum antibiotics over narrow-spectrum ones, have contributed to the rise in carbapenem resistance, prominent antibiotics in recent decades. Consequently, the necessity of employing colistin in treating carbapenem-resistant bacteria or incorporating it into combination therapies has become unavoidable. With the rising demand for colistin, particularly in combating multidrug-resistant (MDR) strains of *Acinetobacter baumannii* (*A. baumannii*), carbapenem-resistant *Pseudomonas aeruginosa*, and various Enterobacterales, the significance of colistin sensitivity testing has become increasingly apparent. Various methods have been employed to compare the effectiveness of colistin against resistant bacterial strains, including *A. baumannii*, such as diffusion (Kirby Bauer disc diffusion and gradient diffusion) tests and dilution (agar dilution, broth microdilution) tests (4-6). Studies have shown that methods based on diffusion (disc and gradient diffusion tests) which are commonly used in microbiology labs due to their simplicity, are not dependable for testing colistin susceptibility. Therefore, the Clinical and Laboratory Standards Institute (CLSI) and the European Committee on Antimicrobial Susceptibility Testing (EUCAST) do not suggest the use of diffusion tests for detecting colistin sensitivity (5,7,8). The same publications also indicate that semi-automated systems lack validation for colistin testing and advocate for the broth microdilution method as the sole reliable approach for determining colistin sensitivity (7-9).

This study aims to compare colistin susceptibilities detected by BD Phoenix automated system among drug resistant bacterial isolates (such as *K. pneumoniae*, *A. baumannii*, *E. coli* and *P. aeruginosa*) with the broth microdilution (BMD) method's results.

## Material and Methods

### Study design

A total of 236 clinical isolates were included in the study, comprising 92 *A. baumannii* isolates, 68 *K. pneumoniae* isolates, 55 *P. aeruginosa* isolates, and 21 *E. coli* isolates. These were obtained from clinical samples that were sent to the Central Laboratory Bacteriology unit of xxxxxx Hospital. Sterile body fluids, including peripheral and catheter blood samples, cerebrospinal fluid (CSF), joint fluid, and pleural fluid, were collected into Bactec Plus aerobic/F or BD Bactec Peds Plus/F bottles and incubated in the BACTEC FX system (Becton Dickinson, U.S.A.). Subcultures were then prepared from the bottles onto solid media, including 5% Sheep Blood Agar, Eosine Methylene Blue Agar, and Sabouraud Dextrose Agar (all from RTA, Turkey). Urine, nephrostomy, tracheal aspirate, and bronchoalveolar lavage samples were inoculated into the media using the quantitative method. Other samples were inoculated using the streak plate method. Gram staining was performed initially for tracheal aspirate and sputum samples. Samples with a Bartlett score greater than zero were evaluated using the Bartlett scoring system (10). Wound culture samples were evaluated using the Quality (Q) scoring system. Samples with a Q score greater than zero were considered (11). For catheter-related bloodstream infections, a blood culture was taken simultaneously from the catheter tip and/or catheter blood culture and a peripheral vein. In case of growth in both the catheter tip and/or catheter blood culture and the blood culture sample taken from the peripheral vein, catheter-related bacteremia was considered (12). The infectious agents that grew in culture were identified using the mass spectrometry method (Matrix-Assisted Laser Desorption/Ionization-Time Of Flight-Mass Spectrometry: MALDI-TOF-MS) with the Maldi Biotyper 3 (Bruker Daltonics, USA) system. Antimicrobial susceptibility tests (AST) tests were conducted using the BD Phoenix 100 (Becton Dickinson, U.S.A.) automated microbiology system. The Phoenix UNMIC-401/ID Panel and NMIC-400/ID panels were used for urine and other samples, respectively. EUCAST v.13.0 criteria and expert guidelines were used to evaluate the AST results (13).

The results of the colistin sensitivity tests conducted by the automated system were recorded. Both the broth microdilution (BMD) method and the automated system were used to test colistin sensitivity in multidrug-resistant bacteria. The BMD studies were conducted following the American Clinical Standards Institute M7 guidelines (14). To prepare for the study, the following steps were taken:

First, 100 µl of cation-adjusted Mueller Hinton Broth (CAMHB) was added to all the wells. Then, 100 µl of the

antibiotic stock solution (at a concentration of 256 mg/L) was added to the wells in the eleventh column.

Next, 100 µl was taken from the wells in the 11th column and transferred to the wells in the 10th column, creating a serial dilution from the 11th column to the first column.

The solutions taken from the wells in the first column (100 µl each) were discarded. As a result, the final antibiotic concentrations in the wells were 0.125, 0.25, 0.5, 1, 2, 4, 8, 16, 32, 64, and 128 mg/L, respectively.

A bacterial suspension was prepared to achieve a turbidity of 0.5 McFarland, followed by a 1/100 dilution. Subsequently, 10 µl of the bacterial suspension was added to each well, resulting in a bacterial concentration of 10<sup>5</sup> colony-forming units (CFU)/ml in each well. In each study, bacterial suspensions of colistin-sensitive (*E. coli* ATCC 25922) and colistin-resistant (mcr-1-carrying *E. coli* NCTC 13846) were used as quality control isolates. Following the addition of bacterial suspensions, the plates were covered and then incubated for 16-18 hours at 35-37 °C. Subsequently, the wells were examined for turbidity, with the MIC value recorded as the concentration at the first well showing no turbidity. In each study, one well was designated as a growth control (bacteria present, no antibiotics) and another as a medium sterility control (only medium present, no bacteria or antibiotics). During the plate evaluation phase, the tests were deemed valid if there was no bacterial growth in the medium's sterility control well, if growth was observed in the growth control well, and if the MIC values of the quality control isolates fell within the expected ranges.

In the current study, the MIC limit values were adopted as established by EUCAST for Enterobacterales, *P. aeruginosa* and *A. baumannii*. Accordingly, for *A. baumannii* and Enterobacterales (*K. pneumoniae* and *E. coli*) isolates, those with MIC values of 2 mg/L or lower were classified as susceptible, while those with values above 2 mg/L were deemed resistant. Similarly, for *P. aeruginosa*, isolates with MIC values of 4 mg/L or lower were classified as susceptible, whereas those with values exceeding 4 mg/L were considered resistant.

### Analysis

The BD Phoenix 100 automated system was evaluated using BMD as a reference method. Categorical agreement (CA; the rate of concordant results), major errors (ME; results falsely categorized as resistant by the automated system despite being sensitive by the reference method), and very major errors (VME; results falsely categorized as sensitive by the automated system despite being resistant by the reference method) were calculated. Results were assessed according to International Organization for Standardization (ISO) criteria (CA higher than 90%, ME lower than 3%, VME lower than 3%) (15). Percentages were calculated to express the distribution of categorical variables

### Results

The study encompassed a total of 236 multidrug resistant isolates isolated from various clinical samples (**Table 1**). Of 92 *A. baumannii* strains, 78 (84.7%) were classified as sensitive by the broth microdilution (BMD) method, whereas 88 (95.6%) were classified as sensitive by the automated system. Among the *A. baumannii* isolates, 14 were deemed resistant by BMD, of which 10 were classified as susceptible by the automated system (MIC ≤less than or equal to 1 mg/L in 9 isolates, MIC equal to 2 mg/L in one isolate). The CA rate for *A. baumannii* isolates was 89.1%, with a VME rate of 10.8%; no major errors were observed. Four *A. baumannii* isolates identified as resistant by the automated system were also classified as resistant by BMD. **Table 2** summarized the MIC values of *A. baumannii* isolates determined by the BD Phoenix 100 system and the BMD method.

**Table 1. Number of clinical samples from which the isolates included in the study**

Variables	Tracheal Aspirate	Urine	Blood	Wound	Abscess	Drain	Pleura	Total
<i>A. baumannii</i>	46	11	18	13	0	2	2	92
<i>K. pneumoniae</i>	6	37	19	2	2	0	2	68
<i>P. aeruginosa</i>	11	9	9	26	0	0	0	55
<i>E. coli</i>	2	7	5	3	2	2	0	21
<b>Total</b>	65	64	51	44	4	4	4	236

**Table 2. The number of *Acinetobacter baumannii* isolates with colistin minimal inhibitory concentration (MIC) values determined by BD Phoenix automated system and broth microdilution.**

		Broth Microdilution MIC levels (mg/L)										Total n	
		≤0.125(n)	0.25(n)	0.5(n)	1(n)	2(n)	4(n)	8(n)	16(n)	32(n)	64(n)		≥128(n)
BD Phoenix MIC levels	≤1 n	1		11	53	13	4	2	1	1		1	87
	2 n											1	1
	≥4 n										3	1	4
<b>Total n</b>		1		11	53	13	4	2	1	1	3	3	92

Abbreviations: MIC: Minimum inhibitory concentration, n: number of isolates, ≤: less than or equal to, ≥: more than or equal to

Upon examining *K. pneumoniae* isolates, it was found that 54 out of 68 strains (79.4%) were sensitive with the BMD method, while 63 (92.6%) were found to be sensitive with the BD Phoenix 100 automated system. Among the *K. pneumoniae* isolates, 14 were deemed resistant by BMD, of which 10 were classified as susceptible by the BD Phoenix 100 automated system. Conversely, one isolate classified as susceptible by BMD was deemed resistant by the automated system. The CA rate for *K. pneumoniae* isolates was 83.8%, with a VME rate of 14.7% and ME rate of 1.4%. Four of the five *K. pneumoniae* strains classified as resistant by the automated system were also classified as resistant by BMD, while one strain was classified as sensitive. **Table 3** provided a summary of the MIC values of *K. pneumoniae* isolates determined by the BD Phoenix automated system and the BMD method.

**Table 3. The number of *Klebsiella pneumoniae* isolates with colistin minimal inhibitory concentration (MIC) values determined by BD Phoenix automated system and broth microdilution.**

		Broth Microdilution MIC levels (mg/L)										Total n	
		≤0.125(n)	0.25(n)	0.5(n)	1(n)	2(n)	4(n)	8(n)	16(n)	32(n)	64(n)		≥128(n)
BD Phoenix MIC levels	≤1 n			24	21	7	5	2		1		2	62
	2 n				1								1
	≥4 n			1				1	1		1	1	5
<b>Total n</b>				25	22	7	5	3	1	1	1	3	68

Abbreviations: MIC: Minimum inhibitory concentration, n: number of isolates, ≤: less than or equal to, ≥: more than or equal to

Out of the *P.aeruginosa* isolates that were examined, 54 (98.1%) were found to be sensitive when tested with BMD, whereas 55 (100%) were found to be sensitive when performed with the automated system. Only one *P. aeruginosa* isolate was deemed resistant by BMD, but this isolate was classified as susceptible by the Phoenix 100 automated system. For *P. aeruginosa* isolates, CA rate was 98.1%, with a VME rate of 1.8%, and no ME were detected. The MIC values of *P. aeruginosa* isolates determined by the BD Phoenix system and the BMD method were summarized in **Table 4**.

**Table 4. The number of *Pseudomonas aeruginosa* isolates with colistin minimal inhibitory concentration (MIC) values determined by BD Phoenix automated system and broth microdilution.**

		Broth Microdilution MIC levels (mg/L)										Total n	
		≤0.125(n)	0.25(n)	0.5(n)	1(n)	2(n)	4(n)	8(n)	16(n)	32(n)	64(n)		≥128(n)
BD Phoenix MIC levels	≤1 n			6	39	7	2					1	55
	2 n												
	≥4 n												
<b>Total n</b>				6	39	7	2					1	55

Abbreviations: MIC: Minimum inhibitory concentration, n: number of isolates, ≤: less than or equal to, ≥: more than or equal to

When evaluating *E. coli* isolates, 16 (76.1%) were classified as sensitive by BMD method, whereas 20 (95.2%) were classified as susceptible by automated system. Among 5 *E. coli* isolates which were deemed resistant by BMD, four

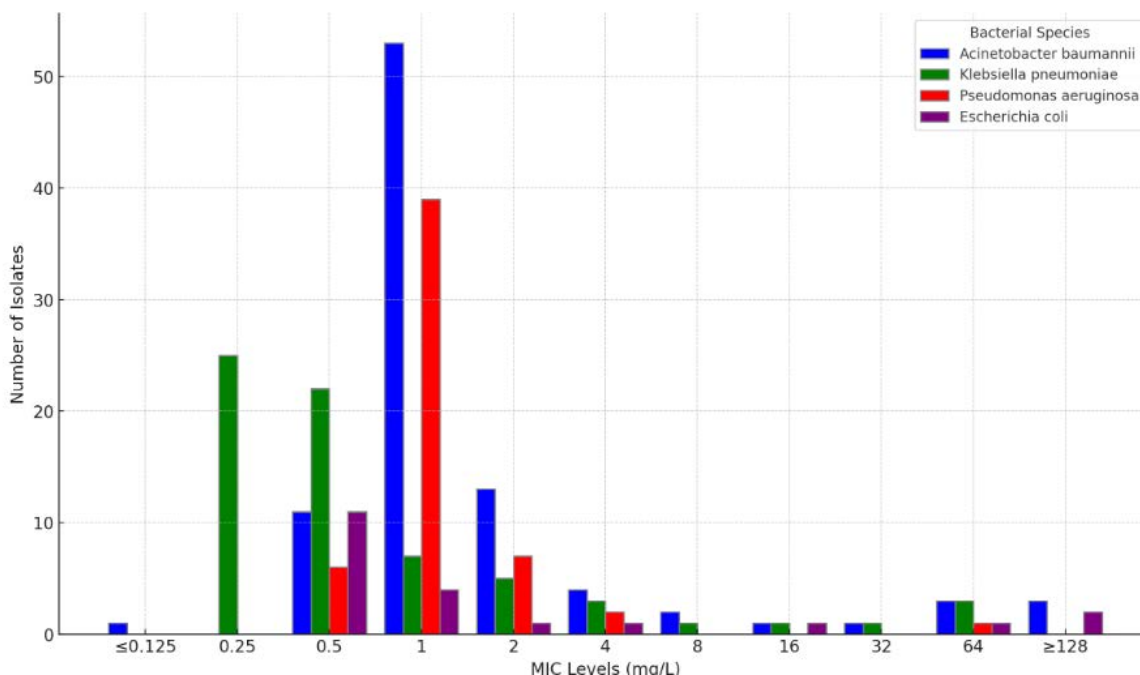
were classified as susceptible by the Phoenix 100 automated system while 1 isolate classified as resistant by both systems. For *E. coli* isolates, CA rate was 80.9%, with a VME rate of 19%, and no ME were detected. The MIC values of *E. coli* isolates determined by the BD Phoenix system and the BMD method were summarized in **Table 5**.

**Table 5. The number of *Escherichia coli* isolates with colistin minimal inhibitory concentration (MIC) values determined by BD Phoenix automated system and broth microdilution.**

		Broth Microdilution MIC levels (mg/L)										Total n	
		≤0.125(n)	0.25(n)	0.5(n)	1(n)	2(n)	4(n)	8(n)	16(n)	32(n)	64(n)		≥128(n)
BD Phoenix MIC (mg/L) levels	≤1 n			11	4	1	1		1	1		1	20
	2 n												
	≥4 n											1	1
Total n				11	4	1	1		1	1		2	21

Abbreviations: MIC: Minimum inhibitory concentration, n: number of isolates, ≤: less than or equal to, ≥: more than or equal to

Resistance to colistin by BMD was detected in 34 (14.4%) of the total 236 isolates. Colistin resistance among multidrug-resistant isolates of *E. coli*, *K. pneumoniae*, *A. baumannii* and *P. aeruginosa* included in the study was 23.8% (5 out of 21 isolates), 20.6% (14 out of 68 isolates), 15.2% (14 out of 92 isolates) and 1.8% (1 out of 55 isolates) respectively. The bar graph illustrates the MIC values of isolates from four bacterial species as determined by the broth microdilution method (**Figure 1**). Upon evaluating all isolates in the study, it was observed that 9 out of the 34 isolates identified as resistant by BMD also appeared resistant in the automated system, while 25 were found as susceptible by the automated microbiology system. Therefore, VME rate of the BD Phoenix 100 automated system was determined as 10.5%. Out of the 10 isolates identified as resistant by the automated system, 9 were found to be resistant and 1 was found to be sensitive by BMD.



**Figure 1. Bar chart showing the minimal inhibitory concentration (MIC) values for the four bacterial species using the broth microdilution method**

## Discussion

There is an increasing incidence of infections caused by drug resistant Gram-negative bacteria (16). This has led to the reconsideration of using colistin for treating infections caused by multidrug-resistant *P.aeruginosa*, *A.baumannii* and Enterobacterales members (3,17,18). Colistin, which was avoided before the 2000s due to its side effects on kidneys, is now being used for treating infections of resistant microorganisms, either alone or in combination with other treatments, locally or systemically (2,19,20).

In a joint statement issued in 2016, EUCAST and CLSI declared that BMD was the sole reliable method for testing colistin susceptibility. However, the practical application of BMD poses challenges, prompting the development of alternative methods. Among these alternatives, automated systems have emerged as viable options (21). Widely adopted in clinical microbiology laboratories, automated systems alleviate workload burdens, ensure high repeatability, facilitate expert system analysis for data management, and expedite result generation (22).

Jayol et al. carried on a study about colistin sensitivity of 123 clinical isolates of Enterobacterales. Out of these, 40 isolates were sensitive to colistin while 83 were resistant. They used BMD, BD Phoenix 100, and Rapid Polymyxin NP tests for the study. Based on the results, the BD Phoenix 100 system missed detecting 10 colistin-resistant isolates when compared to the BMD method used as the standard reference. Seven of these isolates were *Enterobacter spp.*, and one isolate each was *Salmonella enterica*, *K. pneumoniae* and *E. coli*. Researchers reported that the Rapid Polymyxin NP test effectively detected all colistin-resistant isolates, with the exception of a single *E. coli* isolate. Furthermore, they noted that the test provided rapid results within a time-frame of 2 hours. The VME rate of the BD Phoenix 100 automated microbiology system was found to be 12% (10 out of 83 isolates) and as a result, it was emphasized that isolates detected as susceptible by the Phoenix 100 automated system should be confirmed with BMD method (6).

In a 2017 study by Vourli et al. in Greece, the susceptibility of 117 *A.baumannii* isolates to colistin was tested using various methods. The study utilized the BMD method as the standard reference, alongside evaluations of the BD Phoenix 100 and Vitek-2 systems—commonly employed in microbiology labs—and the agar dilution (AD) method. While the BMD method yielded a resistance rate of 24.8%, alternative methods displayed different rates: 35.9% with the AD method, 16.2% with the Vitek 2 system, and 15.4% with the Phoenix 100 system. Notably, both automated systems exhibited high rates of VME, recording 41.4% with Phoenix 100 and 37.9% with Vitek 2, while ME rates were exceptionally low at 1.1% for both systems. In contrast, the AD method displayed a considerably higher ME rate of 15.9%. These findings underscore the potential limitations of relying solely on automated systems for detecting colistin-resistant *A. baumannii* isolates, particularly those with a MIC value of 2 mg/L. The study suggests the necessity of confirming isolates using standardized BMD methods to ensure accurate detection (9).

In 2015, a study was conducted by Dafopoulou et al. to test the reliability of gradient tests, which is one of the methods used to detect MIC. The study tested 61 carbapenem-resistant isolates, including 40 *K. pneumoniae* and 21 *A. baumannii* isolates. The study performed gradient test, AD test, Vitek-2 automated system, and MIC test strips (MTS), with the BMD method used as a reference. The study found that the VME rate was 39.3% and 31.1% in the gradient test and MTS, respectively. However, the AD method showed a low VME rate of only 3.3%, and there was no VME detected in the Vitek-2 automated system. The ME rate was also very low in all methods. Based on these results, Dafopoulou et al. concluded that gradient diffusion methods (strip test and MTS) could lead to inappropriate colistin treatments due to falsely sensitive results (23).

In their study, Tuzemen et al. investigated the efficacy of the BMD and gradient test methods, utilizing 36 *K. pneumoniae*, 9 *A. baumannii*, and 5 *P. aeruginosa* isolates previously identified as colistin-resistant by the BD Phoenix 100 system. In comparison to the BMD method, acknowledged as the gold standard, the CA rate of the Phoenix™ 100 automated system was determined to be 92% across all isolates tested. Specifically, the CA rate was 100% for *K. pneumoniae*, 77.8% for *A. baumannii*, and 60% for *P. aeruginosa*. Notably, the VME rate was recorded at 0% for all isolates, while the ME rate was 8%. Specifically the ME rate was 0% for *K. pneumoniae*, 22.2% for *A. baumannii*, and 40% for *P. aeruginosa*. In the study, the gradient test diffusion method exhibited a VME rate of 80% across all isolates tested, with specific rates of 83.3%, 77.8%, and 60% observed in *K. pneumoniae*, *A. baumannii*, and *P. aeruginosa* isolates, respectively. It was noteworthy that the isolates analyzed in this study were pre-identified as resistant by the Phoenix 100 automated system, which accounts for the absence of VME detection within the Phoenix 100 system. While the study indicated that the gradient test diffusion method was inadequate for detecting colistin resistance, it was essential to note that the exclusion of isolates identified as susceptible by the Phoenix 100 system limited the study's ability to provide comprehensive insights into the automated system's detection rate for resistant isolates (24).

Aytac et al. conducted a study to assess the colistin sensitivity of 100 multidrug-resistant *A. baumannii* isolates using Sensititre™ microdilution methods, BD Phoenix™ 100, and MicroScan WalkAway™ automatic systems, with the BMD method as the reference. The study revealed that the categorical agreement of the BD Phoenix 100 automated system was 79%, with a ME rate of 10% and a VME rate of 11%. Based on their findings, Aytac et al. concluded that optimizing and standardizing commercial methods for colistin sensitivity assessment was imperative (25).

Koyuncu Ozyurt et al. conducted a study to investigate colistin sensitivity using 163 *A. baumannii*, 199 *K. pneumoniae*,

and 34 *E. coli* isolates. They employed the Colistin Disc Elution (CDE) method and the BD Phoenix 100 automated system, with the BMD reference method. In their study, the CA rate for *A. baumannii* isolates was found to be 96.3%, with a VME rate of 3.7%. For *K. pneumoniae* and *E. coli*, the CA rate was 94.1%, and VME rate was 5.9%. Their study revealed that the very large error rate associated with the BD Phoenix 100 system exceeded acceptable limits. Consequently, they concluded that isolates identified as sensitive to colistin should undergo confirmation (26).

In a thesis study conducted with 41 *A. baumannii* isolates in our country, colistin sensitivity was assessed using the BD Phoenix™ 100 automated system in comparison with the reference BMD method. According to the data from the study, the CA between the BD Phoenix™ 100 automated system BMD method was found to be 100%. Furthermore, no discordant results, such as discordant ME or VME were observed (27).

Ceylan et al. analyzed 782 drug-resistant Gram-negative bacterial isolates, including *K. pneumoniae* (n=175), *P. aeruginosa* (n=99), and *A. baumannii* (n=508). The categorical agreement rates were 90.3%, 93.9%, and 94.5%, respectively. The Phoenix M50 system showed a VME rate of 40.4% totally. When examining the VME for each species individually, the rates were 17.7% for *K. pneumoniae*, 75.0% for *A. baumannii*, and 100.0% for *P. aeruginosa* (28). The VME rates for *A. baumannii* and *P. aeruginosa* were higher than in our findings, while the VME rates for *K. pneumoniae* isolates were similar to ours.

### Study limitations

A limitation of this study was the small sample size, particularly the limited number of colistin-resistant isolates. Nonetheless, this research can serve as a pioneering study, guiding future investigations that involve larger isolate numbers and employ various testing methods

### Conclusion

It was concluded that isolates identified as sensitive to colistin should undergo confirmation using the reference method. This recommendation stems from the observed low categorical agreement and high error rates associated with the BD Phoenix 100 automated microbiology systems when compared to the reference method. Based on the results obtained from our study, further investigations using diverse strains are warranted to ascertain the resistance profiles accurately using the automated system.

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**Acknowledgements:** None.

**Ethical Approval:** This Study approval was obtained from the Dicle University Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (number: 236. date: 06.06.2018).

**Author Contributions:** Concept: KG, SY. Literature Review: NO, SY. Design: KG, SY Data acquisition: SY, NA Analysis and interpretation: SY, NO. Writing manuscript: NO. Critical revision of manuscript: NO, SY, KG.

**Conflict of Interest:** The author(s) do not have any potential conflict of interest regarding the research. authorship and/or publication of this article.

**Financial Disclosure:** This study was funded by the Dicle University Scientific Research Projects Coordination with project number TIP.19.001. date:

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## Sociodemographic and Clinical Characteristics of Patients Hospitalized for Suicide in an Intensive Care Unit in Turkey: A Retrospective Study

*Türkiye'deki Bir Yoğun Bakım Ünitesinde İntihar Nedeniyle Yatan Hastaların Sosyodemografik ve Klinik Özellikleri: Retrospektif Bir Çalışma*

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### Abstract

**Background:** Increasing suicide rates, mental health problems and the need for intensive care have become an important health problem. Therefore, analyzing the sociodemographic and clinical characteristics of patients hospitalized in intensive care for suicide attempts is critical for developing effective intervention and prevention strategies. This study aims to analyze the sociodemographic characteristics and mental health of individuals who attempted suicide.

**Materials and Methods:** In this retrospective descriptive study, suicide cases in the adult intensive care unit of a university hospital between 01.11.2017 and 01.11.2023 were analyzed through the hospital automation system.

**Results:** The mean age of patients hospitalized in the intensive care unit in the last 10 years was 27.06 ± 10.15 years and 61% were female. 79.6% of the patients were admitted with a prediagnosis of suicide and 17.7% with alcohol or substance intoxication. Family pressure (32.7%), economic problems (17.7%) and psychiatric problems (15%) were the main reasons for suicide. The most common methods of suicide were drug abuse (67%), insecticide use (26%) and hanging (4%). Seventy per cent of the patients were discharged with nausea and vomiting, 92 per cent were discharged, and 8 per cent died. Suicide cases occurred mostly in July (15%) in 2017 (21%) and 2022 (18%). Suicides were frequently observed at night, especially at 23:00 (14.6%).

**Conclusions:** This study investigated the sociodemographic and clinical characteristics of patients admitted to an intensive care unit in Turkey for suicide attempts. Results showed that most patients were young females who often attempted suicide by drug ingestion. Key contributing factors included family pressure, economic challenges, and psychiatric issues, with suicide cases peaking in the summer. These findings may aid in developing targeted prevention and intervention strategies by identifying high-risk groups and periods.

**Keywords:** Suicide, Poisoning, Intensive care unit, Retrospective, Psychiatric illness.

### ÖZ

**Amaç:** Artan intihar oranları, ruh sağlığı sorunları ve yoğun bakım gereksinimi önemli bir sağlık sorunu haline gelmiştir. Bu nedenle, intihar girişimi nedeniyle yoğun bakımda yatan hastaların sosyodemografik ve klinik özelliklerinin incelenmesi, etkili müdahale ve önleme stratejileri geliştirmek açısından kritik öneme sahiptir.

Bu çalışmanın amacı, Türkiye'deki bir yoğun bakım ünitesinde intihar girişimi nedeniyle yatan hastaların sosyodemografik ve klinik özelliklerini analiz etmektir.

**Gereç ve Yöntem:** Bu retrospektif tanımlayıcı çalışmada, 01.11.2017 ve 01.11.2023 tarihleri arasında bir üniversite hastanesinin erişkin yoğun bakım ünitesindeki intihar olguları hastane otomasyon sistemi üzerinden taranarak incelenmiştir.

**Bulgular:** Son 10 yılda yoğun bakımda yatan hastaların ortalama yaşı 27.06 ± 10.15 olup, %61'i kadındır. Hastaların %79,6'sı intihar ön tanısıyla, %17,7'si alkol veya madde intoksikasyonu ile kabul edilmiştir. İntihar nedenleri arasında aile baskısı (%32,7), ekonomik sorunlar (%10,4) ve psikiyatrik problemler (%15) ön plandadır. En sık intihar yöntemleri ilaç içme (%67), insektisit kullanma (%26) ve asma (%4) olarak belirlenmiştir. Hastaların %70'i bulantı ve kusma şikayetiyle hastaneye başvurmuş, %92'si taburcu olurken, %8'i hayatını kaybetmiştir. İntihar vakaları en çok 2017 (%21) ve 2022 (%18) yıllarında ve temmuz aylarında (%15) gerçekleşmiştir. Gece saatlerinde, özellikle 23:00'de (%14,6) intiharların sık olduğu gözlemlenmiştir.

**Sonuç:** Bu çalışmada, Türkiye'de bir yoğun bakım ünitesine intihar girişimi nedeniyle kabul edilen hastaların sosyodemografik ve klinik özellikleri araştırılmıştır. Sonuçlar, hastaların çoğunun genç kadınlar olduğunu ve sıklıkla ilaç içerek intihar girişiminde bulduklarını göstermiştir. Katkıda bulunan başlıca faktörler arasında aile baskısı, ekonomik zorluklar ve psikiyatrik sorunlar yer alırken, intihar vakaları yaz aylarında zirve yapmaktadır. Bu bulgular, yüksek riskli grupları ve dönemleri belirleyerek hedefe yönelik önleme ve müdahale stratejilerinin geliştirilmesine yardımcı olabilir.

**Anahtar kelimeler:** İntihar, Zehirlenme, Yoğun bakım ünitesi, Retrospektif, Psikiyatrik hastalık.

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Received: 29 September 2024

Accepted: 19 November 2024

**Highlights**

- Suicide attempts are more common in young adults, with women attempting more often, but men have a higher mortality rate due to lethal methods.
- Key suicide risk factors include substance abuse, economic stress, family issues, psychiatric disorders, and loneliness, emphasizing the need for targeted interventions.
- Suicide rates peak in summer and fall, with higher occurrences at night and early morning, suggesting the role of circadian rhythms and emotional vulnerability.

**Introduction**

Suicide is recognized as a serious health problem worldwide as it has a significant negative impact on the quality of life of the individual and the social fabric of society (1). The World Health Organization (2023) reported that suicide is the fourth leading cause of death for individuals between the ages of 15 and 29, more than 700,000 people die each year due to suicide and many more people attempt suicide (2). When the 2020 suicide rates were analyzed, it was found that the suicide rate was 10.3 per 100 thousand people in Germany, 11.92 in Poland, 13.47 in France, 9.4 in Romania, 5.61 in Italy, and 6.88 in Slovakia, and that these rates tended to decrease compared to previous years (3). The number of suicides in Turkey seems to be lower than in other countries. However, contrary to the data on the decline in suicide rates in European countries, 58,985 people have committed suicide in Turkey in the last 19 years, the suicide prevalence in 2019 was 4.4, the highest suicide prevalence was in 2021, and it increased by 12% compared to the previous year (2,4). Even if this figure is lower than the world average, one person dies by suicide every 3.5 hours in Turkey. Therefore, suicide and suicidal ideation are common in Turkey and require urgent intervention (1,5). According to the existing literature, socioeconomic status, family structure, education level, unemployment rates and lack of social support mechanisms are important reasons for the increase in suicide rates in Turkey (2,4,6-10). In addition, social norms and cultural pressures may lead to the restriction of emotional expression, especially among men, which may trigger suicide attempts (6, 7). In this regard, Kavaklı (2023) emphasized that low-income levels and high unemployment negatively affect the mental health of individuals in Turkey and increase suicidal ideation, and that the effects of socioeconomic factors on suicide rates differ by gender, highlighting the need for individualized prevention strategies. He also reported that unemployment significantly increases suicide rates during periods of economic recession, indicating the negative impact of economic instability. In addition, he reported that social norms and cultural pressures in Turkey lead to the restriction of emotional expression, especially among men, which triggers suicide attempts (7). Therefore, it is important to consider regional socio-economic factors and develop targeted prevention strategies to reduce suicide rates in Turkey.

Intensive care units are important clinics where the diagnosis and treatment processes of patients who attempt suicide are frequently followed (10). However, when the existing literature was examined, it was found that the existing studies were mostly conducted in emergency department clinics, and the studies conducted in intensive care units were limited (7). In this context, in a study conducted by Öztürk et al. (2020) in the toxicology intensive care unit between 2018- 2019, it was found that one-fifth of the patients attempted suicide at least once before the current attempt, and two-thirds of the patients had high scores in terms of depression to be considered risky (9) In the study conducted by Erol et al. (2018), it was determined that patients hospitalized in the intensive care unit (ICU) between 2015-2018 used antidepressant drugs due to psychiatric problems. However, in this study, only patients admitted to the ICU for intoxication within this 3-year period were included in the sample (10). Muhammedoğlu et al., (2014), suicide and intoxication cases admitted to the intensive care unit between 2011-2013 were examined, it was determined that suicide cases were mostly young people and women, and antidepressants, paracetamol-antigripal type drugs were preferred as suicide means (11). Although this study presented valuable data from another region of Turkey, it did not include data on changes in suicide rates by hour, month and year. Therefore, although each of these studies provides valuable data, they do not provide a broad perspective on how the proportion of patients who attempt suicide varies from year to year, month to month, and hour to hour, because they focus on short periods of time and specific drug groups. This limited perspective makes a comprehensive assessment of patients who attempt suicide difficult.

This retrospective descriptive study can contribute to the existing literature by covering a wider time period and analyzing the sociodemographic characteristics and clinical conditions of the patients comprehensively without being limited to a specific drug group or a short period of time. It also aims to reveal the sociodemographic and clinical determinants behind suicide by examining factors such as age, gender, education level and suicide

methods of patients who attempted suicide. This study fills an important gap in both theoretical and applied areas by making a number of original contributions to the literature. By comprehensively addressing the socio-demographic and clinical characteristics of patients with suicide attempts admitted to an intensive care unit in southeastern Turkey, the study provides a better understanding of the contextual factors associated with suicide attempts. In particular, by analysing the demographic characteristics of the patients, such as age, gender, method of suicide, time of suicide (hour, month, year), the factors that increase the risk of suicide are examined in more detail. In this context, it provides a broader perspective by analysing a longer period of time. Unlike the existing literature in Turkey, it focuses on a more diverse patient profile rather than being limited to a short period of time or a specific drug group. The results of the study are expected to provide a more detailed and comprehensive perspective on suicide rates in Turkey than previous studies. The results of the study may contribute to the development of targeted interventions by providing a better identification of suicide risk groups. For example, highlighting differences between urban and rural areas may encourage the tailoring of suicide prevention strategies to cultural and socio-demographic characteristics. In addition, providing details of the profile of patients who have attempted suicide may provide health professionals with relevant information and awareness. It may also allow health services to plan resources more effectively and optimise post-suicide care. Understanding the contextual factors associated with suicide can contribute to such intervention efforts at both national and international levels. In terms of future research, the comprehensive dataset provided by this study can form the basis for more detailed longitudinal studies of suicide attempts. In particular, it can provide a starting point for research to monitor the effects of socio-demographic and clinical variables over time. In addition to theoretical knowledge, this study also supports the identification of strategies to improve public health in a practical sense.

## **Material and Methods**

### **Place and time of study**

This study is retrospective descriptive. The study was conducted in the adult intensive care unit of the only university hospital with a large capacity in the city center. This hospital is a center where many emergency and surgical procedures can be performed, patients can self-refer, and cases can be transported from the surrounding area by land and air ambulances.

### **Study population and sample**

Patients aged 18 years and over received inpatient treatment in the intensive care unit between 01.11.2017 and 01.11.2023 due to suicide attempt and whose medical reports contained complete data were included in the study. Patients who did not meet these criteria, i.e. who were younger than 18 years of age or whose medical reports did not contain sufficient data, were excluded from the study. In total, the files of 263 patients admitted for suicide attempt were examined and 260 of these patients were found to meet the study criteria. The data obtained from the file records included the sociodemographic characteristics of the patients (age, gender, education level, marital status), clinical findings, triggering factors leading to suicide attempts, the nature of the suicide attempts, the drugs used in suicides with medication, and the examinations of the patients by mental health and illness specialists. The data were evaluated to analyze the diagnosis and treatment processes of the patients in detail. The findings of this study were reported in accordance with The Reporting of studies Conducted using Observational Routinely collected health Data (RECORD) guidelines (11).

### **Ethics Approval**

The study was approved by Harran Clinical Research Ethics Committee (date: 17.08.2023, decision no: 251354). After ethics committee approval, institutional approval to conduct the study was obtained from the administration of a tertiary university hospital. As the study was based on retrospective document review, case information forms were collected anonymously. The study was conducted in accordance with the principles of the Declaration of Helsinki. Due to the retrospective nature of the study, informed consent was not required.

### **Statistical Analysis**

All data were recorded on a computer using the IBM SPSS Statistics 25 and descriptive statistics, which provided frequency and percentage values.

### **Results**

Table 1 shows the distribution of sociodemographic characteristics of patients hospitalized in the intensive care unit due to suicide in the last 10 years. The mean age of patients who committed suicide was  $27.06 \pm 10.15$  years and the majority (61%) were female (Table 1).

### **Table 1. Sociodemographic characteristics of patients hospitalized in the intensive care unit due to suicide**

Variables		Mean $\pm$ SD	Median (Min-Max)
Age, year		27.06 $\pm$ 10.15	24 (18-65)
		<b>n</b>	<b>%</b>
Gender	Male	102	39
	Female	158	61
Place of residence	Province	216	83
	District	44	17

Table 2 shows the distribution of clinical characteristics of patients who committed suicide. When the data were analyzed, it was determined that 79.6% of the patients were admitted to the intensive care unit with a prediagnosis of suicide, 17.7% with alcohol or drug intoxication, and 2.7% with substance abuse. It was determined that patients committed suicide due to family and community pressure (32.7%), economic problems (17.7%), psychiatric problems (15%), problems related to interpersonal relationships (10.4%), unknown reasons (21.2%) and loneliness (3.1%). It was found that 67% of the patients preferred drinking drugs, 26% used insecticides, pesticides and herbicides, 4% used hanging and 3% used firearms as suicide methods (**Table 2**).

**Table 2. Clinical characteristics of patients hospitalized in the intensive care unit due to suicide**

Variables		n (%)
Preliminary diagnosis of the patient	Drug and Alcohol Intoxication	46 (17.7)
	Substance abuse	7 (2.7)
	Suicide	207 (79.6)
Cause of suicide	Problems with interpersonal relationships	27 (10.4)
	Family and community pressure	85 (32.7)
	Economic problems	46 (17.7)
	Loneliness	8 (3.1)
	Psychiatric problems	39 (15.0)
	Unknown causes	55 (21.2)
	Ace	11 (4)
Suicide method	Firearm	7 (3)
	Drinking medicine	175 (67)
	Insecticides. pesticides and herbicides	67 (26)
Substances and drugs used in suicide	Organophosphate	65 (25)
	Anti-inflammatory	24 (9.2)
	Antidepressant	22 (8.5)
	Unspecified. Undetermined	19 (7.3)
	Multiple drug overdose	17 (6.6)
	Antipsychotic	15 (5.8)
	Proton pump inhibitor	13 (5)
	Anticonvulsant	11 (4.2)
	Antispasmodic	9 (3.5)

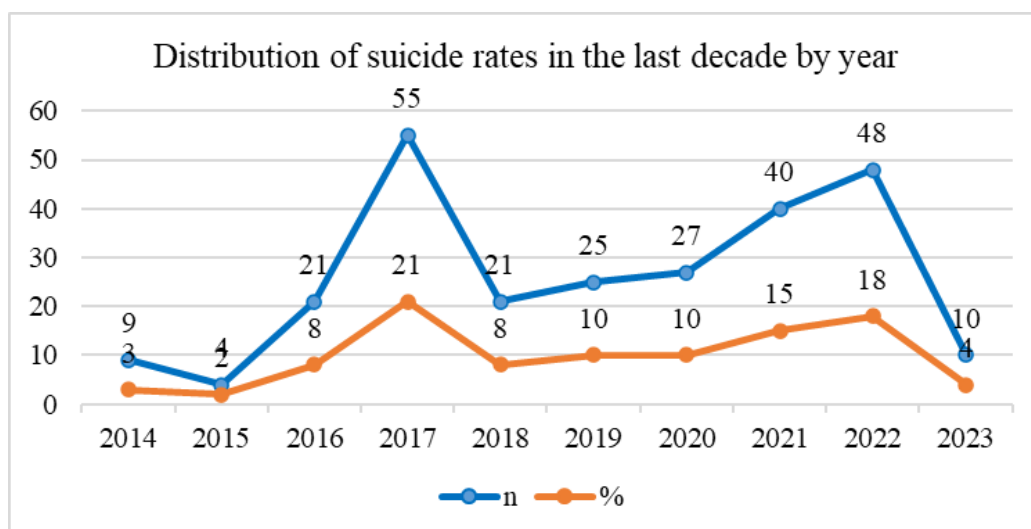
	Antibiotics	7 (2.7)
	Antiaggregant	5 (1.9)
	Antiarrhythmic	5 (1.9)
	Chemical agents (cleaning agents)	5 (1.9)
	Alcohol	4 (1.5)
	Antidiabetic	3 (1.2)
	Heroin	3 (1.2)
	Anxiolytic	2 (0.8)
	Diuretics	2 (0.8)
	Antihistamine	2 (0.8)
	Other	2 (0.8)
<b>Ways of taking suicidal drugs and substances</b>	Oral	257 (98.8)
	IV	3 (1.2)
<b>Complaint of hospital admission</b>	Blurred consciousness	26 (10)
	Loss of consciousness	18 (7)
	Nausea-Vomiting	183 (70)
	Restlessness-Abdominal Pain	6 (2)
	Respiratory Distress or Failure	16 (6)
	Suicidally intended ace	7 (3)
	Soft tissue disorder	4 (2)
<b>The person who brought him to the hospital</b>	Unspecified	14 (5.4)
	Parent	75 (28.8)
	Wife	2 (0.8)
	Himself	169 (65.0)
<b>Number of days hospitalized</b>	1	118 (45.4)
	2	99 (38.1)
	3	23 (8.8)
	4	14 (5.4)
	5 and above	6 (2.4)
<b>Comorbid psychiatric illness</b>	Alcohol dependence	1 (0.4)
	Depression	18 (6.9)
	Mood disorder	2 (0.8)
	Substance abuse	7 (2.7)

	Psychotic disorder	2 (0.8)
	Not specified	230 (88.5)
<b>The result of a suicide attempt</b>	Death	22 (8)
	Discharge after hospitalization	238 (92)

It was determined that patients used many drugs and substances as a means of suicide, but most of them took organophosphates (25%), anti-inflammatory drugs (9.2%), antidepressants (8.5%) and antipsychotics (5.8%), 6.6% used multiple drugs in overdose, 7.3% drank drugs, but the drugs they drank were not specified in the records and almost all of these drugs (98.8%) were taken orally.

The patients who committed suicide were admitted to the hospital with complaints of nausea and vomiting in 70%, confusion in 10%, loss of consciousness in 7%, respiratory distress or failure in 6% and mostly individually, 45.4% of them stayed in the intensive care unit for one day, 38.1% for two days, 8.1% stayed in the intensive care unit for one day, 38.1% for two days, 8.1% for three days, 5.4% for four days and 2.4% for 5 days, 88.5% did not know whether they had a comorbid disease, and the most common comorbid disease was depression (6.9%). It was also determined that 92% of the patients were discharged after treatment, but 8% of them died (6 males-2 females) (**Table 2**).

Figure 1 shows the distribution of suicide rates by year in the last decade. When the data were analyzed, it was determined that the highest rates of suicide cases were realized in 2017 (21%), 2022 (18%), 2021 (15%), 2020 (10%), 2019 (10%), 2018 (8%), 2016 (8%), 2023 (4%), 2014 (3%), and 2015 (2%), respectively (**Figure 1**).



**Figure 1. Distribution of suicide rates in the last decade by year**

Figure 2 shows the distribution of suicide rates by month in the last ten years. When the data were analyzed, it was found that suicide cases were frequently committed in July (15%), October (13%), August (11%) and May (10%) (**Figure 2**).

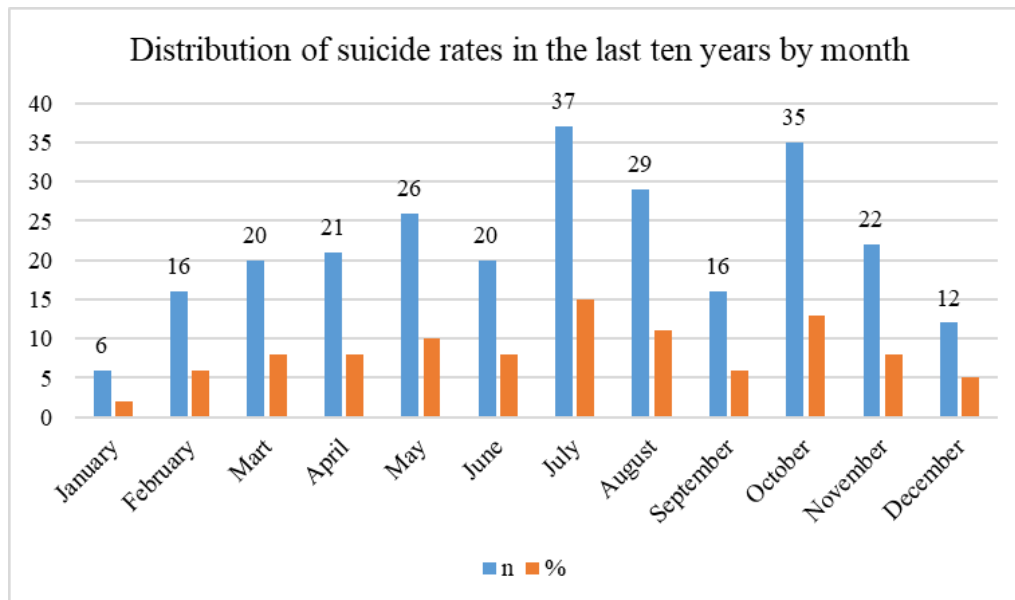


Figure 2. Distribution of suicide rates in the last ten years by month

Figure 3 shows the distribution of suicide rates according to hours in the last decade. When the data were analyzed, it was found that suicide cases were frequently committed between 23:00 (14.6%), 01:00 (9.2%), 17:00 (6.5%) and 11:00 (6.2%) (Figure 3).

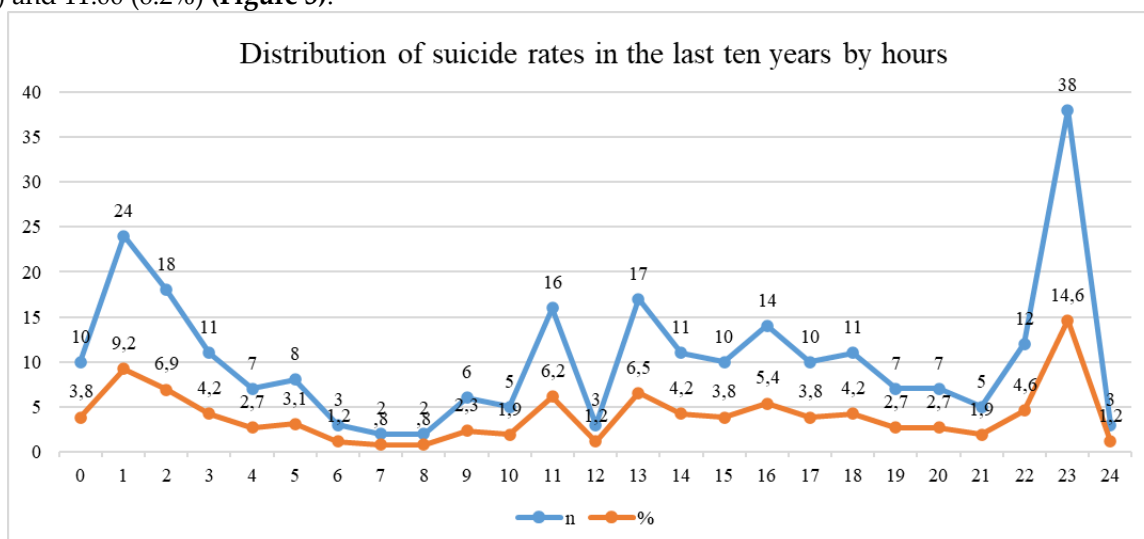


Figure 3. Distribution of suicide rates in the last ten years by hours

**Discussion**

This retrospective descriptive study sheds light on the profile of patients admitted to intensive care for suicide by examining the sociodemographic and clinical characteristics of patients treated for suicide in an intensive care unit in southeastern Turkey between 2014 and 2023. The study aims to fill the gaps in literature by examining the impact of sociological and psychological factors on suicide. Analyzing the data on this group of patients, especially those hospitalized in the intensive care unit, is important in terms of shedding light on the profile of patients admitted to intensive care units and contributing to the elimination of gaps in literature. Such data provides an important basis for better understanding the risk factors associated with suicide and for developing effective interventions for this critical patient group.

In this study, it was found that individuals in the age group of 27.06 ± 10.15 years were more prone to suicide and women had a higher rate of suicide than men. In studies evaluating the socio-demographic characteristics of suicide cases, it was found that the cases were mostly young adults and suicide mortality was higher in men than women in



all age groups (13,14). Literature shows that suicidal thoughts become more common as stress increases in young adults. This has become a widespread problem in society (15-17). In addition, it is a common finding in the literature that women make more suicide attempts, but men have a higher suicide mortality rate (15,16). Although women attempt suicide more frequently, men tend to use more lethal methods, which may explain the higher suicide success rate in men. This difference is often related to gender roles, cultural norms and psychosocial dynamics. For example, a study by Parin (2020) found that women's help-seeking behaviour is more common and that suicide attempts can generally be seen as a cry for help. Men, on the other hand, may be more likely to use more lethal methods because of social pressures to be seen as 'strong' and 'emotionally in control' (6). In addition, men's greater risk-taking behaviour and easier access to violent methods may explain this difference (15,16). In women, it has been suggested that emotional factors such as depression, anxiety and other psychiatric disorders may influence suicide attempts. In men, factors associated with suicide have generally been found to be related to environmental stressors such as substance use, unemployment and social isolation (1-7). In this study, the majority of patients lived in urban areas. The literature often highlights that individuals in urban areas may be more vulnerable to suicide risk due to the fast pace of life, increasing competitive pressures, social isolation and economic stressors (4,6,15). In addition, the literature suggests that social support networks may be stronger in rural areas, but stigma towards suicide and help-seeking behaviour may be lower in these areas (6). It is important to determine the reasons behind this situation and to develop early detection and intervention strategies for individuals in this age group (13-15). Emotional and socio-cultural difficulties faced by people at risk of suicide need to be identified and intervened in a timely manner.

In this study, the patients were admitted to the intensive care unit with a prediagnosis of alcohol-substance abuse and drug intoxication in addition to suicide. In the literature, it has been reported that the majority of suicide cases are closely related to alcohol-substance abuse or drug intoxication. In this context, Baziki Çetin et al. (2024) found that alcohol and drug abuse increased the risk of suicide (18). In the study conducted by Delibaş and Erdoğan (2024), it was reported that drug intoxication cases were mostly suicidal (19). In line with the existing literature, these findings suggest that alcohol and substance abuse and drug intoxication are common risk factors in suicide cases. Alcohol and drugs are known to trigger suicidal thoughts and attempts by disrupting individuals' cognitive control and emotional balance (20). In this context, increasing early intervention programs for alcohol and substance abuse and providing psychological support to intoxication cases in intensive care units may be useful in preventing suicide (18,19).

According to Turkish Statistical Institute reports, the cause of 61.8% of suicide cases is unknown (4). Similarly, in this study, the cause of 21.2% of suicide cases could not be elucidated. In Turkey, reasons such as incomplete records of suicide cases in intensive care units, inadequate filling of forms, lack of a common language, writing the final cause of death and difficulty in determining the cause of death make it difficult to determine the exact causes of suicide (9). However, when the parameter coded as "unknown reasons" was excluded in this study, it was determined that the most common reasons were family and community pressure, economic problems, psychiatric problems, problems related to interpersonal relationships and loneliness. Consistent with the results of this study, Emiral et al. (2022) reported that disease states, economic problems, commercial failure and educational failure triggered suicide (21). Amiri & Khan (2023) stated that the most common cause of non-fatal suicide attempts was familial and psychiatric problems, while the most common cause of fatal suicides was unemployment and poverty (22). These data suggest that suicide is the result of a complex interaction between personal and environmental factors and that preventive interventions targeting different risk groups are necessary (23,24). In order to prevent suicide, economic support programs, policies to combat unemployment, expansion of counseling services for family problems, early diagnosis and treatment of psychiatric problems and strengthening social support networks against loneliness may be useful (9,21-24).

In this study, the most common methods used in suicide attempts were insecticide, pesticide and herbicide ingestion, hanging and firearms. While taking medication was the most common method of suicide, organophosphates, anti-inflammatory drugs, antidepressants and antipsychotics were found to be the most frequently preferred methods. This finding has been frequently emphasized in the national and international literature since the 1980s, and it has been reported that oral ingestion of drugs and chemicals is due to the easy accessibility of these substances (15,25,26). The prevalence of these methods in literature has often been associated with the inadequacy of how societies and health systems address this condition (15,25). According to the results of many studies, the limited adequate supervision and control mechanisms in the prescription and distribution processes of drugs in Turkey and the widespread use of pesticides increase easy access to these substances and thus the likelihood of their use in suicide attempts (8,9,14). This highlights the need to raise public awareness of such

chemicals and restrict their access. Thus, the diversity and long-term prevalence of suicide methods also highlights the ineffectiveness of measures and policies in this area (8,14).

In this study, it was determined that suicide cases were mostly admitted to the hospital individually and due to nausea-vomiting, loss of consciousness/unconsciousness, respiratory distress or failure, most patients were discharged after treatment, and 8 individuals died. Ayaz et al. (2014) reported that short-term hospitalization after suicidal drug intake decreased the duration of hospitalization and mortality (25). These findings emphasize the importance of emergency medical intervention in suicide attempts and show that rapid hospitalization can reduce life-threatening situations.

The psychiatric history of people who attempt suicide is often complex. These individuals are affected by social and environmental factors as well as mental disorders. In a study, at least one axis-I disorder was detected in 93% of suicide victims as a result of psychiatric autopsy (27). In a study conducted by Erensoy et al. (2020), 82.98% of the patients received at least one psychiatric diagnosis and the diagnoses were frequently major depression, adjustment disorder, alcoholism and anxiety disorders (28). In this study, it was found that it was not known whether most of the patients had a comorbid illness, but the most common comorbid illness was depression. These findings emphasize the prevalence of psychiatric disorders and especially depression in individuals at risk of suicide. The prevalence and severity of depression highlights how critical an effective intervention and treatment strategy is. Therefore, it is clear that a comprehensive psychiatric assessment and appropriate treatment approaches should be prioritized to reduce suicide risk. In particular, early diagnosis of common and severe comorbid disorders such as depression is of great importance for the health of both individuals and society (18).

In this study, it was observed that annual suicide rates have fluctuated over the last decade; while rates were quite low in 2014 and 2015, there was a significant increase in 2017 and 2022. Suicide is a public health problem with legal, medical, economic, social and individual consequences. It is also a multidimensional phenomenon that needs to be analyzed in the context of cause-and-effect relationships from the perspective of psychology and sociology. (29). For this reason, it is important that it is handled carefully from every angle. When analyzed in terms of Turkey's sociopolitical and economic structure, the findings are quite striking. In July 2016, an anti-government attempt took place in Turkey. Hundreds of thousands of people were dismissed and prosecuted as a result of this event (30). During this period, the media frequently covered the suicides of many individuals who were dismissed from their jobs and were on trial. In these news reports, various expressions such as "the dismissed person, the accused person, the person on trial committed suicide" were used for the individuals who committed suicide. In other words, 2017 was a period of intense economic and political instability in Turkey following the coup attempt (30). This situation may have increased feelings of hopelessness and helplessness in society, which may have been reflected in suicide rates. In addition, existing economic problems have been exacerbated by the pandemic. The economic fluctuations that emerged in 2022 after the pandemic, especially the currency crises after 2018 and the increase in unemployment rates have created financial and moral pressure on individuals (31,32). It is thought that these conditions may be related to the increase in suicide rates.

In this study, it was determined that the highest rates of suicides occurred in the months of July, October, August and May, and most frequently at 23:00, 01:00, 17:00 and 11:00. The fact that suicide rates in the last decade peaked in July, October, August and May coincides with the seasonal suicide trends reported in the general literature (33). The increase in temperature, especially in summer and fall, can increase biological and psychological pressures on individuals. Although not investigated in previous studies, seasonal changes can lead to an increase in mental health problems such as restlessness, depression and anxiety, especially in hot weather (3, 6-10). This effect may be even more pronounced in a city like Şanlıurfa, which is located in the Southeastern Anatolia Region of Turkey and has very hot climatic conditions. In addition, in this city, which has an agriculture-based economy, these months are the planting and harvest months (34). Therefore, economic stress, livelihood problems, unemployment and easy access to chemical pesticides may have increased suicide rates. In addition, circadian rhythms are the 24-hour cycles of our biological clock that regulate our physical, mental and behavioral processes during the day. These rhythms affect many functions such as the sleep-wake cycle, hormone release and body temperature (35). Research shows that circadian rhythms play an important role in mental health. Depression and suicide attempts have been found to occur more frequently, especially early in the morning and late at night. This suggests that disruptions in circadian rhythms may have negative effects on mood and cognitive functioning and may lead to increased suicidal thoughts or behaviors. Thus, the role of circadian rhythms on mental health and suicidal behavior is considered to be an important factor contributing to the concentration of suicide attempts at certain hours (36).

Seasonal fluctuations in deaths by suicide have been widely studied, but much less is known about patterns related

to time of day. A less extensively studied area of research concerns the effects of time of day on suicides. According to Freichel and O'Shea (2023), both attempted and completed suicides are influenced by daily and circadian rhythms (33). Several studies on suicide attempts in various populations have shown that suicide attempts occur most frequently in the evening and at night, while the number of completed suicides peaks in the morning (35-39). On the other hand, the interpersonal-psychological theory of suicide suggests that suicidality is associated with isolation and a sense of thwarted belonging, both of which may be exacerbated when individuals are awake and alone at night. Therefore, the high prevalence of suicides at night (23:00 and 01:00) is consistent with the time periods when individuals are alone and psychologically most vulnerable, indicating that feelings of depression, loneliness and helplessness may intensify during these hours.

### Study limitations

This study has several limitations. Firstly, as a retrospective descriptive study based on data from a single region, the findings may not be applicable to other areas with different socioeconomic, cultural, or healthcare contexts. The reliance on medical records for data collection may have led to missing or incomplete information, particularly regarding suicide causes, as many cases had unknown reasons. This could affect the accuracy of the findings. Additionally, the study focused only on patients admitted to intensive care units, potentially excluding those who did not require hospitalization. This limits the study's ability to capture the full spectrum of suicide attempts. The reliance on medical diagnoses may also overlook underlying psychosocial factors or the complexity of psychiatric comorbidities, as many patients' mental health histories were poorly documented. Finally, while seasonal and circadian rhythms were noted, the study did not consider other factors, such as social or economic policies, that might have contributed to the fluctuations in suicide rates. Future research should address these gaps.

### Conclusion

This retrospective descriptive study examines the sociodemographic and clinical characteristics of patients admitted to an intensive care unit in Turkey for suicide attempts over the last ten years and provides important findings on how suicides may be associated with country-specific socioeconomic and cultural factors. The study found that suicide attempts were common among young adults and women, but that men used more lethal methods. Comorbid conditions such as alcohol and substance abuse and drug intoxication were also found to play an important role in suicide attempts. The fact that most of the reasons for suicide were recorded as unknown draws attention to the deficiencies in record keeping and monitoring processes, while the most frequently reported reasons were family, economic and psychiatric problems. In addition, the easy accessibility of chemicals such as insecticides, pesticides, herbicides and pharmaceuticals have a significant impact on the preferred methods of suicide attempts. It was concluded that seasonal and circadian rhythms contribute to the increase in suicide cases, especially in hot summer and fall months and at night.

In light of these findings, it is important to develop a comprehensive strategy to prevent suicide attempts in the community. First of all, mental health education programs should be organized for young adults and women, and awareness should be raised to reduce suicide attempts in these groups. Rehabilitation services for alcohol and substance abuse should be strengthened to minimize the impact of these comorbid conditions. To better understand the causes of suicide, an effective registration system that encourages data sharing among health institutions should be established. Support mechanisms for family, economic and psychiatric problems should be developed to provide timely assistance to individuals. Furthermore, controlling access to insecticides and other chemicals would be a critical step in reducing the diversity of suicide methods. Finally, considering the impact of seasonal changes, the accessibility of mental health services should be increased during summer and autumn and special intervention programs should be implemented during these periods. Implementation of these recommendations will make a significant contribution to reducing suicide attempts.

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**Acknowledgements:** None.

**Ethical Approval:** This Study approval was obtained from the Harran University Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (number: 2023/13/02236. date: 24.07.2023).

**Author Contributions:** Concept: Ö.K, M.K.E. Literature Review: Ö.K, M.K.E. Design: Ö.K, M.K.E. Data acquisition: Ö.K, M.K.E. Analysis and interpretation: Ö.K, M.E.D, M.K.E. Writing manuscript: Ö.K, M.E.D, M.K.E. Critical revision of manuscript: Ö.K, M.K.E.

**Conflict of Interest:** The author(s) do not have any potential conflict of interest regarding the research. authorship and/or publication of this article.








**Financial Disclosure:** No financial support was received for this study.

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**Diagnosis and treatment approaches in gallstone ileus: a case series from a high-volume clinic***Safra Taşı İleuslarında Tanı ve Tedavi Yaklaşımları: Yüksek Volümlü Klinikten bir Vaka Serisi*Hasan Elkan<sup>1</sup> , Mehmet Sait Berhuni<sup>1</sup> , Hüseyin Yönder<sup>1</sup> , Vedat Kaplan<sup>1</sup> , Faik Tatlı<sup>1</sup> , Abdullah Özgönül<sup>1</sup> , Ali Uzunköy<sup>1</sup> <sup>1</sup>Department of General Surgery, Harran University, Faculty of Medicine, Sanliurfa /Türkiye**Abstract****Background:** This study aims to present the patients who underwent surgery for gallstone ileus in our clinic in the light of literature information.**Materials and Methods:** We collected data from patients who had surgery for gallstone ileus in our clinic between January 2016 and January 2024. Demographic data, preoperative symptoms, comorbidities, diagnostic method, surgical method, location of the stones causing the ileus, and postoperative findings were recorded.**Results:** Eight patients underwent surgery for gallstone ileus in our clinic on the specified dates. The average age was 64.1 (55–81) years. All patients experienced nausea, vomiting, and abdominal pain, and six had comorbidities. While the diagnosis was made by computed tomography in six patients, it was made during surgery in two. Seven patients had only enterolithotomy, and one underwent enterolithotomy, fistula repair, and cholecystectomy. The stones were located in the ileum in five patients and in the jejunum in three. No postoperative mortality was observed in our patients.**Conclusions:** Gallstone ileus should be considered in elderly patients with comorbidities and no history of abdominal surgery who present with ileus. While enterolithotomy is the main treatment, we believe that cholecystectomy and fistula repair can also be performed in a single session in patients whose general condition is not critical.**Keywords:** Gallstone, Ileus, Diagnosis and treatment**ÖZ****Amaç:** Bu çalışmada kliniğimizde safra taşı ileusu nedeniyle opere edilen hastaları literatür bilgileri ışığında sunmayı amaçladık**Gereç ve Yöntem:** Veriler, Ocak 2016–Ocak 2024 tarihleri arasında kliniğimizde safra taşı ileusu nedeniyle opere edilen hastalardan toplandı. Demografik veriler, preoperatif semptomlar, komorbiditeler, tanı yöntemi, cerrahi yöntem, ileusa neden olan taşların yerleşimi ve postoperatif bulgular kaydedildi.**Bulgular:** Belirtilen tarihlerde kliniğimizde 8 hasta safra taşı ileusu nedeniyle opere edildi. Ortalama yaş 64.1 (55-81) yılı. Hastaların tamamında bulantı, kusma ve karın ağrısı görüldü ve 6'sında ek hastalık mevcuttu. Altı hastada tanı bilgisayarlı tomografi ile konulurken iki hastada tanı ameliyat esnasında konuldu. Yedi hastaya sadece enterolitotomi ve bir hastaya enterolitotomi, fistül onarımı ve kolesistektomi uygulandı. Taşlar beş hastada ileumda üç hastada jejunumda yerleşmişti, Hastalarımızda ameliyat sonrası mortalite gözlenmedi.**Sonuç:** Safra taşı ileusu; komorbiditeleri bulunan, abdominal cerrahi öyküsü olmayan ve ileus tablosuyla başvuran yaşlı hastalarda düşünülmelidir. Esas tedavi enterolitotomi olmakla birlikte genel durumu kritik olmayan hastalarda kolesistektomi ve fistül onarımının da tek seansta yapılabileceğini düşünüyoruz.**Anahtar kelimeler:** Safra taşı, ileus, tanı ve tedavi**Highlights**

- Gallstone ileus should be suspected in elderly patients with ileus, comorbidities, and no prior abdominal surgery.
- Enterolithotomy is the preferred surgical method for its speed and suitability for critically ill patients.
- Early diagnosis and prompt treatment are essential for better outcomes.

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## Introduction

Gallstone ileus occurs when gallstones enter the gastrointestinal tract through bilioenteric fistulas (1-2). First described by Erasmus Bartholin in 1654, it is a type of mechanical obstruction in the gastrointestinal (GI) system caused by gallstones (3). It accounts for 1–4% of all intestinal obstructions and approximately 25% of obstructions in people over 65 years old (4).

Most gallstones that enter the intestines through a bilioenteric fistula do not induce problems, but larger stones >2.5 cm in diameter can lead to an obstruction (1-2). The most common areas of obstruction are the ileum, jejunum, and colon. Key symptoms include cramp-like pain, nausea, and vomiting (5).

Clinical suspicion is key to diagnosing gallstone ileus. Signs include air-fluid levels on direct abdominal X-rays and air and stone images in the intrahepatic bile ducts on computed tomography (CT) (5-6). Surgery is the preferred treatment for gallstone ileus. Three different approaches have been defined for surgical treatment so far. The patient can only receive enterolithotomy and be followed up, or enterolithotomy, cholecystectomy, and fistula repair procedures can be conducted in the same session. The third approach involves cholecystectomy and fistula repair for at least 4–6 weeks post-enterolithotomy (2,6). The present study aimed to present data from patients who underwent surgery for gallstone ileus in our clinic in the last 8 years, in the light of a review of relevant literature.

## Material and Methods

We reviewed data from eight patients who had surgery for gallstone ileus between January 2016 and January 2024. We recorded information on their symptom duration before presentation, preoperative radiological evaluation, previous surgical history, surgery risk assessment based on the physical classification degree by the American Society of Anesthesiologists (ASA), concomitant chronic diseases, surgery duration, surgery method, intraoperative findings, postoperative complications, and 30-day mortality, as well as patient demographics. The study was approved by Harran Clinical Research Ethics Committee (HRÜ/24.06.35. date: 13.05.2024) prior to the commencement of the study.

## Results

Of the eight patients in the study, three (37.5%) were female and five (62.5%) were male, with an average age of 64.1 (55–81) years. Two patients had other diseases, four had diabetes mellitus (DM), one had hypertension (HT), and one had DM, HT, and heart failure. None had previous surgeries. All the patients had an ASA score of III. Two (25%) patients were operated on before the COVID-19 pandemic and six (75%) were operated on after. All the patients presented with symptoms of ileus, abdominal swelling, nausea, vomiting, and colicky abdominal pain. The average time from when symptoms started and to when patients came to the hospital was 5.4 (1–9) days. Only three patients had a history of gallstones. All patients had air-fluid levels upon direct abdominal X-rays. Gallstones were identified as the cause of ileus on preoperative CT scans (**Figure 1A**) in six (75%) patients, while two (25%) were diagnosed during laparotomy. Free air image was observed in the bile ducts (pneumobilia) in six patients (75%) diagnosed using CT (**Figure 1B**).

All the patients required emergency surgery. Seven had only enterolithotomy (**Figure 3**), while one patient had enterolithotomy, fistula repair, and cholecystectomy. During surgery, stones causing the obstruction were found in the ileum in five patients and the jejunum in three patients. The average stone size causing the blockage was 5.1 (4–6) cm (**Figure 4**). One patient who had enterolithotomy only received elective surgery 8 weeks later, including cholecystectomy and fistula repair.

Patients' demographic data, comorbidities, complaints at presentation, preoperative CT findings, surgical procedure, localization of the obstruction, and gallstone size operated on due to gallstone ileus are given in **Table 1**. There were no deaths after surgery. A patient was monitored in the intensive care unit due to pleural effusion, and drainage was performed with a catheter. Two patients had wound infections treated with antibiotics. The average hospital stay was 11.4 (5–28) days, and there were no deaths during the 30-day follow-up.

**Table 1 Clinical, diagnostic, and treatment characteristics of the patients**

N/Age/sex	Application complaint	Computed tomography	Operation	Concomitant medical illnesses	Stone localization	Diameter of stone (cm)
1- 81/F	Nausea, vomiting, inability to pass gas and stool, and abdominal pain.	Intestinal obstruction, pneumobilia, aberrantly located gallstone	Enterolithotomy	DM, HT, CVD	Terminal ileum	6
2-61/M	Nausea, vomiting, and abdominal pain.	Intestinal obstruction, aberrantly located gallstone	Enterolithotomy	DM	Terminal ileum	4
3-66/M	Nausea, vomiting, inability to pass gas and stool, and abdominal pain.	Intestinal obstruction, pneumobilia, aberrantly located gallstone	Enterolithotomy	-	Jejunum	5
4-63/F	Nausea, vomiting, and abdominal pain.	Intestinal obstruction, pneumobilia, aberrantly located gallstone	Enterolithotomy	DM	Terminal ileum	5
5-62/M	Nausea, vomiting, inability to pass gas and stool, and abdominal pain.	Intestinal obstruction,	Enterolithotomy	HT	Terminal ileum	6
6-57/M	Nausea, vomiting, and abdominal pain.	Intestinal obstruction,	Enterolithotomy	-	Jejunum	6
7-55/M	Nausea, vomiting, and abdominal pain.	Intestinal obstruction, aberrantly located gallstone	Enterolithotomy Fistula repair + cholecystectomy after 8 weeks	DM	Jejunum	4
8-68/F	Nausea, vomiting, and abdominal pain.	Intestinal obstruction, pneumobilia, aberrantly located gallstone	Enterolithotomy + fistula repair + cholecystectomy	DM	Terminal ileum	5

**Abberivariations:** N: Number, F:Female, M:Male, DM:Diabetes mellitus, HT:Hypertension, CVD: Cerebrovascular disease



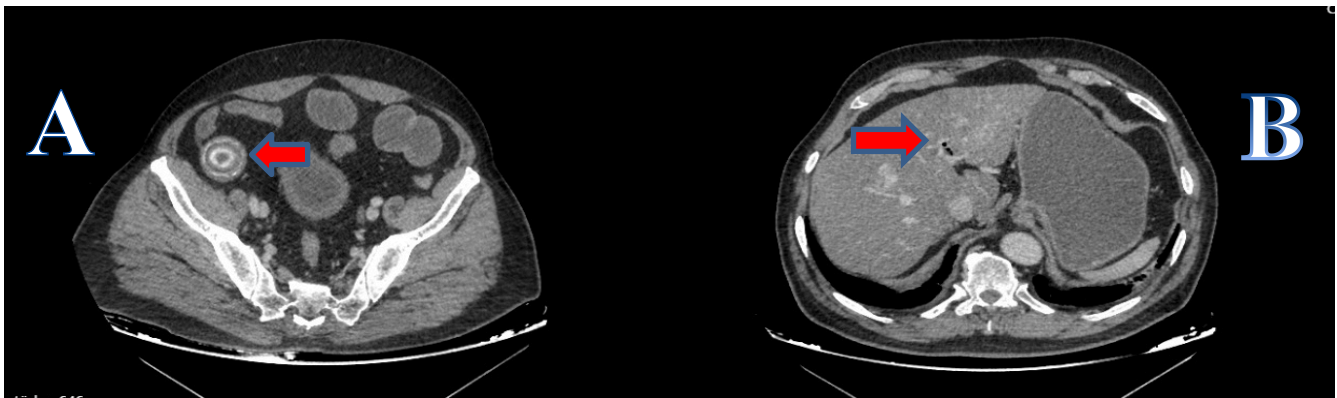


Figure 1 A. Computed tomography image of stones, which caused ileus B. Pneumobilia image on computed tomography (shown with red arrows)

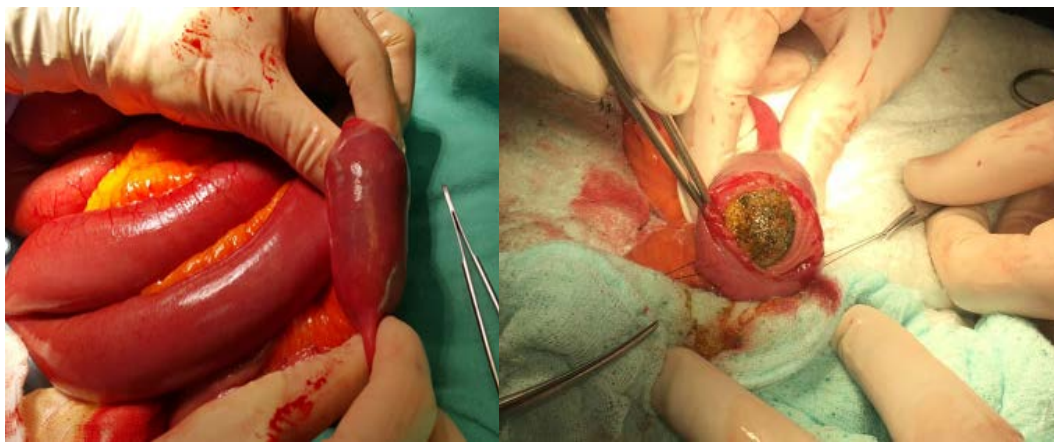


Figure 2. Gallstone removed by enterolithotomy



Figure 3. Gallstones, which caused ileus

### Discussion

Gallstone ileus occurs when gallstones pass into the gastrointestinal tract. The most common type is the bilioenteric fistulas (8-9). Bilioenteric fistulas most prevalently develop as cholecysto-duodenal (76%). This is followed by cholecysto-colic (11%), cholecysto-gastric (6%), choledocho-duodenal (4%), and cholecysto-choledochal (3%) fistulas (1,3).

The age of patients in our study aligns with previous research but not sex distribution. Kumar et al. found that the

average age was 83 (61–96) years; female patients constituted 90% of the participants. Lassandro et al. reported an average age of 71.5 (58–96) years, with 85.2% female patients. Yakan et al. had an average age of 63.6 (50–80) years, with 75% female patients (1,9,10). The average age in the present study was 64.1 (55–81) years, and the female sex ratio was 37.5%.

In previous studies, the time between the onset of symptoms and hospital presentation was 3–4 days (3,5,7). In our study, it was an average of 5.4 (1–9) days. The average diameter of biliary stones, which caused ileus, was 5.1 (4–6) cm in this study. As regards the obstructed GI segments, these stones caused obstruction in the ileum in five patients (62.5%) and the jejunum in three patients (37.8%). Kumar et al. found stones averaged 3.3 (2.5–4) cm in their series of ten patients; the obstruction was in the ileum in nine patients and the sigmoid colon in one patient (1). In their series of 12 cases, Yakan et al. reported that obstruction was seen at the ileum level in nine patients and at the jejunum level in three patients (9).

Nonspecific symptoms, difficulty accessing healthcare, and comorbidities, including DM, make diagnosing gallstone ileus challenging. Additionally, most patients with gallstone ileus generally do not have history of cholelithiasis (11). Only 3 (37.5%) of our patients had a history of cholelithiasis. The most common symptoms of gallstone ileus are nausea, vomiting, abdominal distension, and epigastric pain. Previous studies reported abdominal pain and vomiting in approximately 90% of patients with this condition (12-13). In ileus cases detected in the emergency department, more common causes (such as brid, cancer, hernia) should be excluded first. Gallstone ileus should then be suspected and diagnosis approaches such as contrast-enhanced CT should be performed (9-10). All the patients included in our study had abdominal pain and vomiting. Notably, six (75%) of the patients had surgery after the COVID-19 pandemic, while two (25%) had surgery before. To our knowledge, there is no relationship reported in the literature between gallstone ileus and Covid -19 disease. This suggests that patients may have been reluctant to seek hospital care during the pandemic.

Therefore, approximately half gallstone ileus cases are diagnosed intraoperatively (14). The first imaging method for patients with ileus clinic is a direct abdominal X-ray. X-ray is quite insufficient to determine the etiology. Furthermore, stones in the gallbladder may be discovered by ultrasonography (USG). USG is mostly used to evaluate the biliary tract in cases where gallstone ileus is suspected. Another imaging method used for diagnosis purposes is CT, which can detect large stones, intestinal obstruction, and the level of obstruction. The gold standart imaging method for diagnosis of gallstone ileus is contrast-enhanced CT with 90-93% sensitivity and nearly 100% specificity (9). Even CT may sometimes be insufficient in diagnosis due to the structure and composition of the gallstone. Radiologically, the detection of obstruction findings, air bubbles in the biliary system, and ectopic stone images is called "Rigler's Triad," which can be detected in 14.8% of gallstone ileus cases through direct X-rays, 11.1% through USG, and 77.8% through CT. Based on the data from previous studies, CT is the most effective method for diagnosing gallstone ileus (10,14). The diagnosis of gallstone ileus is made intraoperatively in approximately half of the patients despite preoperative imaging methods. In the present study, gallstone ileus diagnosis was made during laparotomy in two (25%) patients and preoperatively using CT in six (75%).

Emergency treatment of gallstone ileus aims to remove the stone and intestinal obstruction. There is debate over the best surgical method (7,15-17). The surgical method to be chosen is closely related to the general condition of the patient. The general approach is to perform enterolithotomy quickly if the surgical risk of the patient is high in the preoperative evaluation. It is more appropriate to add restorative repair to enterolithotomy in patients with low surgical risks (16). Studies suggest that enterolithotomy is the most frequently used method (1,8-9). It is often preferred in emergencies to remove intestinal obstruction and in high-risk patients because it is safer and quicker. In the present study, seven (87.5%) patients had only enterolithotomy. The main purpose of performing enterolithotomy, cholecystectomy, and bile fistula repair in the same session is to prevent the risk of future recurrence of gallstone ileus, cholangitis, and cholecystitis (9,17-19). This procedure is generally associated with significant morbidity and causes mortality in patients at high risk (9,16). One of the patients in our study underwent enterolithotomy, cholecystectomy, and fistula repair during a single-stage operation. Only one of our seven patients, who underwent enterolithotomy, received cholecystectomy and fistula repair 8 weeks later. Previous studies show that surgical morbidities range from 25 to 80% as patient age increases (1,3,7). In the present study, surgical morbidity was seen in a total of three patients (37.5%), including surgical site infection in two patients and pleurisy in one patient.

Recent studies show that laparoscopy surgery for gallstone ileus can achieve similar success rates, while significantly reducing hospital stays (8,13). Kumar et al. reported the average duration of hospital stay was 10 days after surgical treatments involving laparotomy, while the same duration was 5 days in patients who underwent

laparoscopic surgery (1). All our cases were operated by laparotomy method, and the average hospital stay was 11.4 (5–28) days. Shorter hospital stays can help prevent nosocomial infections, especially since it is more prevalent in the elderly population.

### Study limitations

The limitations of our study include the fact that it was designed as a retrospective study, there was a relatively smaller number of cases, and the fact that it was a single-center study

### Conclusion

In conclusion, the “gallstone ileus” diagnosis should be kept in mind when elderly female patients with comorbidities and without a previous history of abdominal surgery present with ileus. Although enterolithotomy is the primary treatment, we believe that cholecystectomy and fistula repair can be performed in the same session if the patient’s condition allows.

**Acknowledgements:** None.

**Ethical Approval:** This Study approval was obtained from the Harran University Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (number: HRÜ/24.06.35. date: 13.05.2024).

**Author Contributions:** Concept: H.E, M.S.B. Literature Review: H.E, V.K, F.T. Design: A.U, H.Y, A.Ö. Data acquisition: H.E, M.S.B. Analysis and interpretation: H.Y, M.S.B, V.K. Writing manuscript: F.T, A.U, A.Ö. Critical revision of manuscript: A.U, A.Ö, F.T, V.K.

**Conflict of Interest:** The author(s) do not have any potential conflict of interest regarding the research. authorship and/or publication of this article.

**Financial Disclosure:** No financial support was received for this study.

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## The Association of Demographic Data and Hematological Parameters with Causes of Death in Patients Following Cardiopulmonary Resuscitation in the Emergency Department

*Acil Serviste Kardiyopulmoner Resüsitasyon Sonrası Kaybedilen Hastaların Demografik Verileri ve Hematolojik Parametrelerinin Ölüm Nedenleri ile İlişkisi*

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### Abstract

**Background:** Cardiopulmonary arrest, marked by the cessation of breathing and circulation, has high mortality rates. Cardiopulmonary resuscitation (CPR) outcomes are influenced by factors like arrest duration and underlying conditions. Inflammatory markers such as platelet-lymphocyte ratio (PLR), lymphocyte-monocyte ratio (LMR), and red cell distribution width (RDW) may predict mortality.

**Materials and Methods:** This retrospective study analyzed 142 patients who died after CPR in the Emergency Department of Harran University Training and Research Hospital (between January 1, 2018, and December 31, 2020) and 150 healthy controls. Hematological indices (WBC, PLR, LMR, RDW) and clinical data were compared using statistical tests, including ROC analysis.

**Results:** The patient group had a mean age of  $58.99 \pm 19.28$  years. Heart failure (7.5%) and acute myocardial infarction (6.8%) were the leading causes of death. WBC, LMR, and RDW were significantly higher in the patient group, while PLR and platelet counts were lower ( $p < 0.05$ ). ROC analysis identified RDW (AUC: 0.670) and LMR (AUC: 0.707) as significant prognostic markers.

**Conclusions:** Elevated LMR and RDW values and reduced PLR and platelet counts may predict mortality in CPR patients.

**Keywords:** Cardiopulmonary Resuscitation, Mortality Inflammatory Markers, Lymphocyte-Monocyte Ratio, Red Cell Distribution Width

### ÖZ

**Amaç:** Kardiyopulmoner arrest, solunum ve dolaşımın durmasıyla karakterize olup yüksek mortalite oranlarına sahiptir. Kardiyopulmoner resüsitasyon sonuçları, arrest süresi ve altta yatan hastalıklar gibi faktörlerden etkilenir. Trombosit-lenfosit oranı, lenfosit-monosit oranı ve eritrosit dağılım genişliği gibi inflamatuvar belirteçlerin mortaliteyi öngörmede etkili olabileceği düşünülmektedir.

**Gereç ve Yöntem:** Bu retrospektif çalışmada, Harran Üniversitesi Eğitim ve Araştırma Hastanesi Acil Servisi'nde CPR sonrası hayatını kaybeden 142 hasta (1 Ocak 2018 ile 31 Aralık 2020 arasında) ile 150 sağlıklı kontrol grubu karşılaştırılmıştır. Hematolojik parametreler (WBC, PLR, LMR, RDW) ve klinik veriler istatistiksel testler ve ROC analizi kullanılarak değerlendirilmiştir.

**Bulgular:** Hasta grubunun ortalama yaşı  $58,99 \pm 19,28$  yıl olarak tespit edilmiştir. En sık ölüm nedenleri %7,5 ile kalp yetmezliği ve %6,8 ile akut miyokard enfarktüsü olmuştur. Hasta grubunda WBC, LMR ve RDW değerleri anlamlı derecede yüksek, PLR ve trombosit değerleri ise düşüktür ( $p < 0,05$ ). ROC analizinde RDW (AUC: 0,670) ve LMR (AUC: 0,707) önemli prognostik belirteçler olarak bulunmuştur.

**Sonuç:** Yüksek LMR ve RDW değerleri ile düşük PLR ve trombosit değerleri, CPR hastalarında mortaliteyi öngörmede kullanılabilir.

**Anahtar kelimeler:** Kardiyopulmoner Resüsitasyon, Mortalite, İnflamatuvar Belirteçler, Lenfosit-Monosit Oranı, Eritrosit Dağılım Genişliği

### Highlights

- The role of inflammatory markers in predicting post-CPR mortality was examined
- Elevated RDW and LMR, along with decreased PLR and platelet counts, were identified as significant prognostic indicators.
- These markers may aid in improving post-CPR patient management.

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Received: 25 April 2024

Accepted: 11 December 2024

Cite as: BUYUKASLAN.H et al. The Association of Demographic Data and Hematological Parameters with Causes of Death in Patients Following Cardiopulmonary Resuscitation in the Emergency Department. IJCMBMS 2024;4(3): 144-50 doi.org/ 10.5281/zenodo.14296493

## Introduction

Cardiopulmonary arrest is characterized by the cessation of the patient's breathing and circulation and is among the medical emergencies with a high mortality rate. Cardiopulmonary resuscitation (CPR) refers to a series of interventions aimed at restoring these vital functions (1). Sudden cardiac death accounts for 15-20% of all deaths and represents a significant public health issue (2). The success of CPR depends on various factors, including the duration of arrest, the patient's age, cardiac rhythm, and underlying conditions (3,4).

During cardiac arrest, ischemia triggers a systemic inflammatory response in tissues. With the onset of reperfusion, this inflammation intensifies, leading to extensive tissue damage. This process, known as 'reperfusion injury,' significantly impacts patient prognosis (3). Platelets play a critical role in this inflammatory process. By secreting mediators such as adenosine diphosphate, thromboxane, and von Willebrand Factor, platelets act as initiators and regulators of vascular inflammation. These properties highlight the central role of platelets in understanding the interaction between inflammation and reperfusion injury (3).

The inflammatory effects of platelets can be assessed through hematological parameters. The literature identifies key inflammatory markers, including platelet-lymphocyte ratio (PLR), lymphocyte-monocyte ratio (LMR), and red cell distribution width (RDW), which reflect the severity and systemic impact of inflammation. These markers have also been reported to be associated with sudden cardiac death and other causes of mortality (5-9).

This study aims to evaluate the historical records of patients who died after CPR in the Emergency Department of Harran University Training and Research Hospital to identify the causes of death and demographic characteristics. Furthermore, the study seeks to investigate the association of inflammatory markers such as PLR, LMR, and RDW with mortality in resuscitated patients.

## Material and Methods

This retrospective study included 142 patients who died between January 1, 2018, and December 31, 2020, in the Emergency Department of Harran University Training and Research Hospital, forming the patient group. Inclusion criteria consisted of adult, in-hospital cardiac arrest cases with available laboratory data. Data collected included age, gender, province of residence, date of death, and primary and secondary diseases contributing to death, recorded systematically in a standardized data collection form.

The control group comprised 150 healthy individuals who visited the emergency clinic during the same period for non-cardiac and non-inflammatory complaints. Hematological indices including NLR, PLR, LMR, and RDW were compared retrospectively between the patient and control groups. NLR was calculated as the absolute neutrophil count divided by the absolute lymphocyte count. PLR was calculated as the absolute platelet count divided by the absolute lymphocyte count, and LMR was determined by dividing the absolute lymphocyte count by the absolute monocyte count. RDW, a measure of red blood cell size variation expressed as a percentage, was obtained from complete blood count results.

Patients aged <18 years, those with traumatic cardiac arrest, cases lacking sufficient laboratory data, and individuals with prior diagnoses of leukemia, myelodysplastic syndrome, or myelofibrosis were excluded. Laboratory data for the patient group were collected during their hospital stay, while data for the control group were obtained under standard health check protocols. The study was approved by the Ethics Committee of Harran University Training and Research Hospital (Number: HRU/21.04.03 Date: 15.02.2024). All data were anonymized, and the study was conducted in compliance with the Declaration of Helsinki.

## Statistical Analysis

All statistical analyses performed using the SPSS 21.0 software package (SPSS Inc., Chicago, IL, USA). Numerical variables expressed as mean  $\pm$  standard deviation for normally distributed data. Qualitative variables presented as frequencies and percentages. To evaluate the differences between groups for qualitative variables, the chi-square test employed. For numerical variables, differences between the two groups assessed using the independent student t-test. The predictive ability of significant parameters for mortality was assessed using receiver operating characteristic (ROC) analysis, and the area under the curve (AUC) was calculated. The threshold for statistical significance will be set at  $p < 0.05$ .

## Results

The patient group included 142 individuals who underwent CPR in the emergency department, and the control group consisted of 150 healthy individuals. Of the patient group, 63.4% were male and 36.6% female, while the

control group had 60% male and 40% female participants. The mean age of the patient group was  $58.99 \pm 19.28$  years, significantly higher than the control group's mean age of  $58.65 \pm 7.12$  years ( $p=0.001$ ) (Table 1).

**Table 1. Distribution of Patient and Control Groups by Age**

Parameter	Patient Group n=142	Control Group n=150	p
Age, years / Mean $\pm$ SD	$58.99 \pm 19.278$	$58.65 \pm 7.124$	0.001

Among the causes of death in the patient group, heart failure (7.5%) and acute myocardial infarction (6.8%) were the most common, followed by trauma-related causes, including traffic accidents and gunshot wounds (Table 2). Respiratory arrest and cardiac arrest were also frequently presenting complaints, with rates of 39.4% and 26.8%, respectively (Table 3). Comorbidities such as hypertension (61.7%) and coronary artery disease (55.6%) were prevalent in the patient group (Table 4).

**Table 2: Causes of Death of Patients**

Cause of Death	n	%	Cause of Death	n	%
Traumatic Subarachnoid Hemorrhage	1	0.3	Fall from Height	2	0.7
Heart Failure	22	7.5	Electric Shock	2	0.7
Acute Myocardial Infarction	20	6.8	Gastrointestinal Bleeding	2	0.7
Traffic Accident	16	5.5	Mixed-Type Acidosis	2	0.7
Sudden Cardiac Death	16	5.5	Kidney Failure	1	0.3
Cardiac Arrest	13	4.5	Multiple Organ Failure	1	0.3
Gunshot Wound	8	2.7	Epidural Bleeding	1	0.3
Diabetic Coma	8	2.7	Cardiogenic Shock	1	0.3
Respiratory Arrest	7	2.4	Sharp Object Injury	1	0.3
Pulmonary Embolism	6	2.1	Pneumothorax	1	0.3
General Condition Disorder	3	1.0	Sepsis	1	0.3
Liver Failure	3	1.0	Stroke	1	0.3
Pneumonia	3	1.0			

**Table 3: Complaints of Patients Presenting to the Emergency Department**

Complaint	n	%	Complaint	n	%
Respiratory Arrest	55	39.4	General Condition Disorder	5	3.5
Cardiac Arrest	38	26.8	Abdominal Pain	4	2.8
Chest Pain	10	7.0	Traffic Accident	3	2.1
Shortness of Breath	10	7.0	Nausea and Vomiting	2	1.4
Blurred Consciousness	7	4.9	Fall from Height	1	0.7
Syncope	6	4.2			

**Table 4. Distribution of Comorbidities in the Patient Group**

Comorbidity	Present n, (%)	Absent n, (%)	Comorbidity	Present n, (%)	Absent n, (%)
Hypertension	87(61.7)	54(38.3)	ALS	1(0.7)	141(99.3)
CAD	79(55.6)	63(44.4)	Hepatitis B	1(0.7)	141(99.3)
Diabetes Mellitus	42(29.6)	100(70.4)	COPD	12(8.5)	130(91.5)
Myasthenia Gravis	1(0.7)	141(99.3)	Epilepsy	1(0.7)	141(99.3)
Venous Insufficiency	1(0.7)	141(99.3)	Heart Failure	10(7.0)	131(93.0)
Hyperlipidemia	6(4.2)	136(95.8)	Asthma	5(3.5)	137(96.5)
Acute Renal Failure	1(0.7)	141(99.3)	Stroke	7(4.9)	135(95.1)
CKD	1(0.7)	141(99.3)	Dysrhythmia	1(0.7)	141(99.3)
Schizophrenia	1(0.7)	141(99.3)	Osteoporosis	1(0.7)	141(99.3)
CLD	1(0.7)	141(99.3)	BPH	4(2.8)	138(97.2)

**Abbreviations:** COPD: Chronic Obstructive Pulmonary Disease ALS: Amyotrophic Lateral Sclerosis BPH: Benign Prostatic Hyperplasia, CAD: Coronary Artery Disease, CKD:Chronic Kidney Disease, CLD: Chronic Liver Disease

Laboratory comparisons revealed statistically significant elevations in neutrophil count ( $9.94 \pm 9.15$ ,  $p < 0.001$ ), lymphocyte count ( $4.91 \pm 3.41$ ,  $p < 0.001$ ), WBC count ( $16.92 \pm 17.42$ ,  $p < 0.001$ ), LMR ( $7.82 \pm 7.31$ ,  $p < 0.001$ ), NLR ( $4.31 \pm 8.23$ ,  $p < 0.001$ ), and RDW ( $14.25 \pm 2.84$ ,  $p < 0.001$ ) in the DG compared to the control group (Table 5). Conversely, PLT and PLR were significantly lower in the patient group than in the control group ( $p < 0.05$ ).

**Table 5. Comparison of Hematological Parameters Between Patient and Control Groups**

Parameters	Patient Group (Mean $\pm$ SD)	Control Group (Mean $\pm$ SD)	p
WBC ( $10^9/L$ )	$16.92 \pm 17.42$	$9.27 \pm 3.43$	$< 0.001$
Neutrophil ( $10^9/L$ )	$9.94 \pm 9.15$	$6.18 \pm 3.22$	$< 0.001$
Lymphocyte ( $10^9/L$ )	$4.91 \pm 3.41$	$2.22 \pm 0.94$	$< 0.001$
PLT ( $10^9/L$ )	$187.31 \pm 116.30$	$286.32 \pm 88.91$	0.017
MON ( $10^9/L$ )	$1.60 \pm 9.35$	$0.98 \pm 4.20$	0.269
LMR	$7.82 \pm 7.31$	$3.94 \pm 1.88$	$< 0.001$
PLR	$86.26 \pm 174.08$	$78.19 \pm 7.31$	0.097
NLR	$4.31 \pm 8.23$	$3.53 \pm 8.23$	$< 0.001$
MPV (fL)	$7.82 \pm 1.15$	$7.67 \pm 1.69$	0.020
RDW (%)	$14.25 \pm 2.84$	$12.77 \pm 2.84$	$< 0.001$

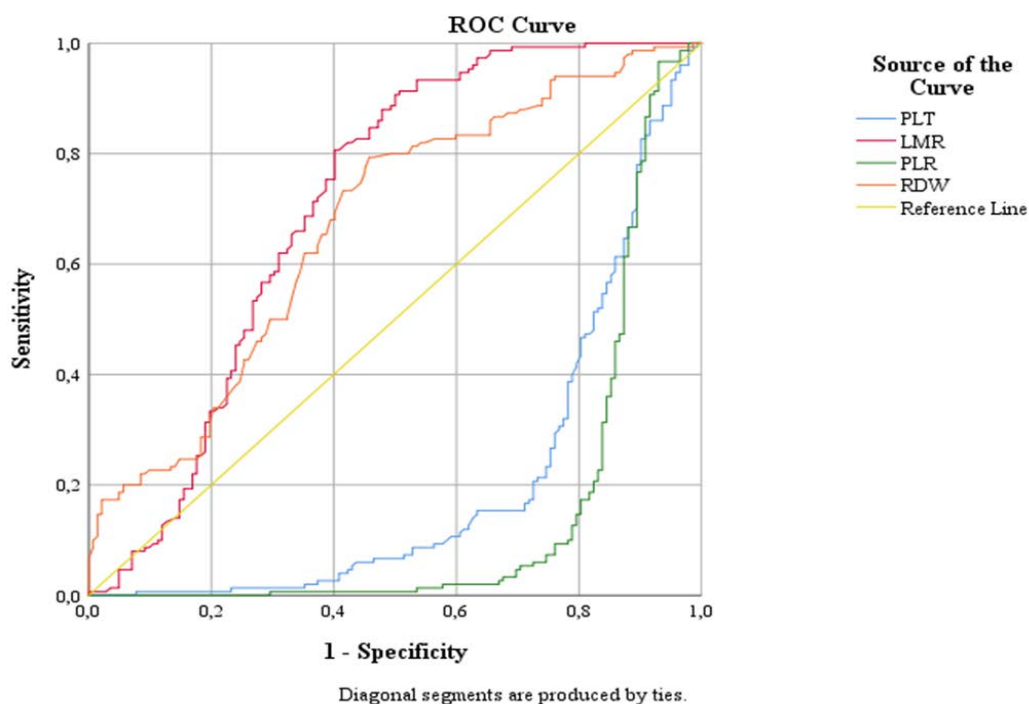
**Abbreviations:** WBC: White Blood Cell (total leukocyte count), PLT: Platelet count, MON: Monocyte count, LMR: Lymphocyte-Monocyte Ratio, PLR: Platelet-Lymphocyte Ratio, NLR: Neutrophil-Lymphocyte Ratio, MPV: Mean Platelet Volume, RDW: Red Cell Distribution Width

ROC analysis demonstrated that LMR, RDW, PLR, and PLT had significant predictive value for mortality, with AUC values indicating moderate to good discrimination (**Table 6, Figure 1**). Specifically, RDW and LMR were the most predictive markers, supporting their potential utility as prognostic indicators in patients undergoing CPR. This analysis highlights the role of hematological parameters, such as elevated RDW and LMR and reduced PLR and PLT, in reflecting systemic inflammation and predicting mortality in resuscitated patients. These findings underscore the importance of incorporating these parameters into the clinical assessment and follow-up of critically ill patients.

**Table 6. Predictive Value of Hematological Parameters for Mortality**

Parameter	AUC (95% CI)	Cut-off	p	Sensitivity (%)	Specificity (%)
PLT ( $10^9/L$ )	0.207 (0.153-0.261)	3.3	0.001	78	89.4
LMR	0.707 (0.645-0.770)	5.4	0.001	80.7	40.1
RDW (%)	0.670 (0.608-0.732)	14.47	0.001	86	65.5
PLR	0.147 (0.096-0.197)	4.3	0.001	2.0	57.7

**Abbreviations:** PLT: Platelet count ( $10^9/L$ ), LMR: Lymphocyte-Monocyte Ratio, RDW: Red Cell Distribution Width (%), PLR: Platelet-Lymphocyte Ratio, AUC: Area Under the Curve, CI: Confidence Interval



**Figure 1. Distribution of laboratory results of the patient and control groups according to ROC analysis**

### Discussion

Cardiopulmonary resuscitation success is influenced by factors such as arrest duration, age, cardiac rhythm, and underlying conditions (3). Understanding the characteristics of patients undergoing CPR may improve resuscitation outcomes. However, despite these efforts, approximately 1 million people die annually from cardiac-related issues, with 350,000 of these attributed to cardiac causes (10,11).

In our study, most resuscitated patients were male, consistent with findings in the literature (12,13). This gender disparity may be explained by the higher prevalence of cardiovascular and respiratory diseases in men, increasing their likelihood of experiencing cardiac arrest (14).



The OPALS (Ontario Prehospital Advanced Life Support) study by Petrie et al. reported a mean age of 68 years for cardiac arrest cases (15). In contrast, the mean age in our study was 58.9 years for the patient group and 58.6 years for the control group. This lower age range may reflect the inclusion of younger trauma patients, as our hospital is a trauma center serving a region with high trauma incidence.

The most common causes of death in our study were heart failure (7.5%) and acute myocardial infarction (6.8%). These findings align with the study by Qingting Lin et al., which reported heart failure (41.5%) and AMI (24.7%) as the leading causes of death (16). The differences in rates may stem from variations in prehospital and in-hospital resuscitation protocols and the profile of resuscitated patients.

Trauma was also a significant cause of mortality in our study, reflecting its status as a major global public health issue with rising mortality rates (17). Karataş et al. identified trauma as the third leading cause of death (13.7%) (9), while Heymann et al. found trauma to be the second leading cause of death in their emergency department (18). Our hospital's proximity to the Syrian border and location along a busy trade route likely contributes to the high proportion of trauma cases.

Elevated white blood cell counts have been associated with poor CPR outcomes (16). In our study, WBC values were significantly higher in the patient group compared to controls, consistent with the literature. Platelets, as key mediators of vascular inflammation, play a critical role in prognosis (19). Endothelial damage and activation, common in cardiac arrest, lead to platelet adhesion and depletion, resulting in thrombocytopenia. Studies by Kim et al. and Bilge et al. have linked low platelet counts to higher mortality rates (20). In our study, platelet counts were significantly lower in the patient group, and ROC analysis indicated their potential as a prognostic marker.

Platelet-lymphocyte ratio values were also lower in deceased patients compared to controls, consistent with findings by Han SI et al. (21). PLR has been associated with inflammatory processes and excessive thrombus activity in conditions like heart failure and malignant tumors (22). Despite limited investigation into PLR's role in cardiac arrest, our results support its potential as a marker of microcirculatory dysfunction and systemic ischemia/reperfusion injury (23).

Lymphocyte-monocyte ratio has emerged as a simple and cost-effective marker in cardiovascular and inflammatory diseases. Increased monocyte and decreased lymphocyte counts have been linked to atherosclerosis and poor prognosis in coronary artery disease (24). In our study, LMR was significantly higher in the patient group, highlighting its association with mortality.

Red cell distribution width, reflecting heterogeneity in red blood cell size, is another marker of systemic inflammation and oxidative stress (25). Elevated RDW values have been associated with increased mortality in acute coronary syndrome and critically ill patients (26). Our study found significantly higher RDW levels in deceased patients, reinforcing its prognostic value.

In summary, patients who died after CPR had significantly higher WBC, lymphocyte, neutrophil, LMR, and RDW values, and significantly lower PLR and PLT values compared to controls. LMR, RDW, and PLR may reflect systemic inflammation and serve as useful markers in the follow-up of resuscitated patients.

### Study limitations

The limitation of this study is the retrospective design, which prevented access to prehospital data known to influence CPR outcomes. Additionally, missing data led to the exclusion of some patients, which, while not compromising statistical power, limits comprehensive analysis. Prospective studies would better address this issue by ensuring more complete data collection.

### Conclusion

In our emergency department, heart failure, acute myocardial infarction, and trauma were the leading causes of death. Elevated LMR and RDW values and reduced PLR and PLT values may guide the prognosis of resuscitated patients.

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**Acknowledgements:** None.

**Ethical Approval:** This Study approval was obtained from the Harran University Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (number: HRU/21.04.03. date: 15.02.2024).

**Author Contributions:** Concept: Y.E, B.SA, B.H. Literature Review: Y.E, B.SA, B.H.. Design: Y.E, B.SA, B.H.. Data acquisition: Y.E, B.SA, B.H. Analysis and interpretation: Y.E, B.SA, B.H. Writing manuscript: Y.E, B.SA, B.H. Critical revision of manuscript: Y.E, B.SA, B.H.

**Conflict of Interest:** The author(s) do not have any potential conflict of interest regarding the research. authorship and/or publication of this article.

**Financial Disclosure:** No financial support was received for this study.

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