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The Impact of Admission Timing on Intensive Care Unit (ICU) Outcomes for Patients Transferred from Internal Medicine Wards – A Single Center Study

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Abstract

Aim: This study investigates the impact of admission timing on intensive care unit (ICU) outcomes for patients transferred from internal medicine wards to the ICU at a tertiary university hospital.

Study Design: A retrospective cohort study was conducted in a nine-bed medical ICU at Gazi University Hospital from January 2020 to November 2022. Patients aged 18 years and older admitted from internal medicine wards were included. Statistical analyses compared outcomes based on admission timing and ICU mortality.

Results: Of 316 patients, 59% were admitted during off-hours, with an overall ICU mortality of 56%. No difference in mortality was found between office-hour and off-hour admissions (52% vs. 59%, p=0.17). There were no differences in the length of ICU stay (5 [3-11] days vs. 5 [3-12] days, p=0.72), requirements for invasive (60% vs. 61%, p=0.47) or non-invasive mechanical ventilation (17% vs. 16%, p=0.44), intermittent (30% vs. 30%, p=0.54) or continuous renal replacement therapy (22% vs. 26%, p=0.24) requirement, and nosocomial infection rate (49% vs. 52%, p=0.35) based on admission timing. Independent mortality risk factors included the requirement for invasive mechanical ventilation (odds ratio (OR): 3.33 [95% confidence interval (CI): 1.49-7.29], p<0.01), the presence of circulatory shock (OR: 2.02 [95% CI: 1.29-2.89], p<0.01) solid cancer (OR: 1.98 [95% CI: 1.22-3.19], p<0.01), and the Acute Physiology and Chronic Health Evaluation II (APACHE II) score (OR: 1.08 [95% CI: 1.01-1.16], p=0.04).

Conclusions: Unlike some previous studies, we found no difference in ICU mortality between office-hour and off-hour admissions in patients admitted from internal medicine wards. This finding suggests that equal staffing distribution throughout the day may prevent adverse effects of out-of-hours admissions, and support better organization in specialized ICUs.

Keywords: Internal medicine; Wards; Admission time; Intensive care unit.

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Introduction

Intensive care units (ICUs) are critical care settings where patients with severe clinical presentations are closely monitored and treated.[1] These units are known for their high incidence of complications, particularly nosocomial infections and complications related to invasive procedures, contributing to elevated mortality and morbidity rates.[2,3] Improving survival rates in the ICUs remains a primary objective, leading to extensive academic research and hospital quality management initiatives. Consequently, numerous studies have focused on preventable and modifiable factors influencing ICU mortality.[4,5] Despite the heterogeneous nature of patient populations and conditions encountered within ICUs, organizational factors such as ICU infrastructure, staffing levels, and personnel expertise play essential roles in patient outcomes.[6] Although there is an expectation for ICUs to provide consistent quality care every day, around the clock, emerging evidence indicates variations in care quality. The data particularly emphasize factors like staffing levels across various timeframes, such as weekdays versus weekends and office hours versus off-hour periods.[7] Studies have demonstrated that reduced staffing or less experienced personnel during off-hours can cause delays in recognizing deteriorating patients and delay timely diagnosis, treatment, and care, adversely affecting patient care and prognosis.[8] Conversely, conflicting findings exist regarding the association between ICU admission timing and mortality. While some studies have failed to establish a correlation between admission time and patient outcomes, the diverse outcomes reported in these studies highlight the complexity of this relationship.[9]

On the other hand, while many studies investigate influence of ICU admission timing across diverse patient populations, a small part focuses on specific medical disciplines, such as internal medicine wards. This study investigates the influence of admission timing on ICU outcomes within internal medicine wards at a single university hospital. We examine patient characteristics following admission to a tertiary medical ICU over a specific period to determine whether admission timing during office hours versus off-hour periods impacts ICU outcomes. Additionally, we compare outcomes across different internal medicine subspecialties to identify potential variations in the relationship between admission timing and patient outcomes.

Materials and Methods

Study Design and Setting

This retrospective cohort study was conducted in the nine-bed tertiary medical ICU of Gazi University Hospital from January 2020 to November 2022. The research protocol adhered to the Declaration of Helsinki and received approval from the Gazi University Ethics Committee (Approval Number: 2023 – 1473, Date: 21.11.2023). Due to the study's retrospective nature, informed consent was not applicable and was not requested by the ethics committee. Our medical ICU is a closed, tertiary care unit managed in compliance with the Turkish Ministry of Health's regulations regarding operations, personnel, equipment, and registration. During office hours, the ICU staff includes one responsible intensivist (faculty member), one intensive care fellow, one senior (3rd-4th year) internal medicine resident, and three first-year internal medicine residents. Given all specialties in our hospital, necessary consultations can be requested at any time. Outside office hours (off-hours), the ICU is staffed by one senior internal medicine resident and one first-year internal medicine resident, with the intensivist and fellow on call. The responsible faculty member also conducts bedside ICU visits at least once on non-working days. Radiology and operating room duties are managed by on-call teams during off-hours, and other units such as the coronary angiography unit, interventional radiology unit, gastroenterology endoscopy unit, and apheresis unit operate on an on-call basis. Our medical ICU is part of the Internal Medicine Department at Gazi University Faculty of Medicine, where all internal medicine residents participate in a monthly rotation within both the medical ICU and internal medicine wards as part of their training in the Educational Programme of Internal Medicine at Gazi University Faculty of Medicine. The other ICU personnel are under the supervision of a head nurse with intensive care certification. One nurse for every two patients and one nurse's aide for every four to five patients work in the ICU during and outside working hours.

Participants

Patients eligible for inclusion were those aged 18 years and older who had stayed more than 24 hours in one of the internal medicine subspecialty clinic wards prior to ICU admission. Exclusion criteria included patients who stayed less than 48 hours in the ICU, were transferred from other ICUs, hospitals, wards, or emergency departments, as well as postoperative and terminally ill patients.

Data Collection

We collected demographic data, and scores from the Acute Physiology and Chronic Health Evaluation II (APACHE II), Glasgow Coma Scale (GCS), Sequential Organ Failure Assessment (SOFA), and Risk, Injury, Failure, Loss, and End-Stage Kidney Disease (RIFLE). We also documented the type of ward prior to ICU admission—medical oncology, nephrology, geriatrics, gastroenterology, general internal medicine, hematology, endocrinology, and rheumatology—along with diagnoses at ICU admission, comorbidities, and clinical conditions that developed during the ICU stay. Additional data included the day and time of ICU admission (weekday, weekend, or public holidays; within or outside working hours), length of ICU stay, and outcomes in the ICU. Patients were divided into two groups based on the timing of ICU admission: during office hours (Monday to Friday, 08:00 AM to 04:59 PM) or off hours (Monday to Friday, 05:00 PM to 07:59 AM, weekends, and all public holidays). These two groups were then compared in terms of patient characteristics and ICU outcomes. Weekends encompass Saturdays and Sundays, while national holidays, including April 23rd (National Sovereignty and Children's Day), May 1st (Labor and Solidarity Day), May 19th (Commemoration of Atatürk, Youth and Sports Day), July 15th (Democracy and National Unity Day), August 30th (Victory Day), October 29th (Republic Day), New Year's Day, and religious holidays (Ramadan and Eid al-Adha) are also included.

Statistical Analysis

Continuous variables were reported as either mean ± standard deviation or median with interquartile range, based on their distribution. Categorical variables were presented as frequencies and percentages. Patients were categorized into two groups based on the time of ICU admission: office hours or off hours, and their data were analyzed accordingly. Additionally, patients were divided and compared based on ICU mortality, categorized as survivors or non-survivors. The Mann-Whitney U test was employed for comparing medians of continuous variables, while the chi-squared test was utilized for categorical variables. Logistic regression analysis was conducted to identify independent risk factors for off-hours admission and ICU mortality. A p-value of less than 0.05 was considered statistically significant. The analyses were performed using IBM SPSS Statistics 22 (version 22.0, IBM Corp., New York, NY, USA).

Results

Three hundred sixteen patients were admitted from internal medicine wards to the ICU. Fifty-nine percent (188 patients) were admitted during off hours, and the ICU mortality rate was 56% (177 patients) (Table 1). Detailed information regarding the comparison of clinical characteristics of patients according to admission time is available in Table 1. There was no difference in mortality rates between patients admitted to the ICU during office hours and those admitted during off hours (52% vs. 59%, p=0.17) (Table 1). There was no difference in the length of ICU stay (5 [3-11] days vs. 5 [3-12] days, p=0.72), the requirement for invasive (60% vs. 61%, p=0.47) or non-invasive mechanical ventilation (17% vs. 16%, p=0.44), intermittent (30% vs. 30%, p=0.54) or continuous renal replacement therapy (22% vs. 26%, p=0.24), and the nosocomial infection rate (49% vs. 52%, p=0.35) between patients admitted to the ICU during office or off-hours (Table 1). The presence of circulatory shock at ICU admission was the only independent risk factor for off-hour admissions (Odds Ratio [OR]: 1.67 [95% Confidence Interval [CI]: 1.1-2.9], p=0.04). A comparison of ICU mortality according to ICU admission time across different internal medicine wards is presented in Table 2. When comparing mortality rates across various subspecialties, Rheumatology was the only admission ward with significantly different mortality rates between off-hours and office hours (Table 2). Detailed information regarding the comparison of clinical characteristics of patients according to ICU mortality is available in Table 3. Independent risk factors for ICU mortality included the requirement for invasive mechanical ventilation (OR: 3.33 [95% CI: 1.49-7.29], p<0.01), the presence of circulatory shock (OR: 2.02 [95% CI: 1.29-2.89], p<0.01), solid cancer (OR: 1.98 [95% CI: 1.22-3.19], p<0.01), and the APACHE II score (OR: 1.08 [95% CI: 1.01-1.16], p=0.04).

Discussion

In this study, we aimed to investigate the impact of admission time on patient outcomes from internal medicine wards to the ICU in a tertiary care hospital. We observed that a significant proportion of patients were admitted during off-hours, with no substantial difference in mortality rates between patients admitted during off-hours versus office hours. Additionally, there were no significant differences in the length of ICU stay, mechanical ventilation requirements, renal replacement

Table 1. Comparison of baseline characteristics, intensive care unit (ICU) admission, and follow-up data according to ICU admission timing in medical ICU patients admitted from internal medicine wards

	All Patients (n=316)	Office Hours (n=128, 41%)	Off-Hours (n=188, 59%)	p
Baseline Characteristics and ICU Admission Data				
Age	71 [62-81]	73 [61-79]	71 [62-83]	0.59
Gender				
Female	174 (55.1%)	70 (55%)	104 (55%)	0.50
Male	142 (44.9%)	58 (45%)	84 (45%)	
APACHE II Score	22 [16-29]	23 [16-30]	21 [16-29]	0.43
SOFA Score	8 [4-11]	7 [4-11]	8 [5-11]	0.42
Glasgow Coma Scale	12 [6-15]	11 [6-15]	12 [6-15]	0.54
Admission Ward				
Medical Oncology	75 (23.7%)	29 (23%)	46 (24%)	0.41
Nephrology	59 (18.7%)	25 (20%)	34 (18%)	0.43
Geriatrics	59 (18.7%)	21 (16%)	38 (20%)	0.16
Gastroenterology	57 (18%)	21 (16%)	36 (19%)	0.32
General Internal Medicine	39 (12.3%)	18 (14%)	21 (11%)	0.28
Hematology	14 (4.4%)	6 (5%)	8 (4%)	0.53
Endocrinology	9 (2.8%)	4 (3%)	5 (3%)	0.28
Rheumatology	4 (1.3%)	4 (3%)	0 (0%)	0.03
Comorbidities				
Hypertension	199 (63%)	86 (67%)	113 (60%)	0.12
Solid Cancers	126 (39.9%)	46 (36%)	80 (43%)	0.36
Diabetes Mellitus	115 (36.4%)	53 (41%)	62 (33%)	0.07
COPD, Asthma	92 (29.1%)	39 (30%)	53 (28%)	0.21
Cerebrovascular Disease	59 (18.7%)	25 (20%)	34 (18%)	0.56
Coronary Artery Disease	49 (15.5%)	20 (16%)	29 (15%)	0.41
Chronic Liver Disease	48 (15.2%)	12 (9%)	36 (19%)	0.03
Chronic Kidney Disease	33 (10.4%)	13 (10%)	20 (11%)	0.40
Hematological Malignancy	15 (4.7%)	7 (5%)	8 (4%)	0.11
Sepsis on ICU Admission	184 (58.2%)	67 (52%)	117 (62%)	0.04
Shock on ICU Admission	164 (51.9%)	60 (47%)	104 (55%)	0.01
ICU Follow-up				
Mortality	177 (56%)	67 (52%)	110 (59%)	0.17
Length of ICU Stay	5 [3-11]	5 [3-11]	5 [3-12]	0.72
Mechanical Ventilation (MV)				
Invasive MV	192 (60.8%)	77 (60%)	115 (61%)	0.47
Noninvasive MV	52 (16.5%)	22 (17%)	30 (16%)	0.44
Renal Replacement Therapy				
Intermittent	96 (30.4%)	39 (30%)	57 (30%)	0.54
Continuous	77 (24.4%)	28 (22%)	49 (26%)	0.24
Parenteral Nutrition	36 (11.4%)	13 (10%)	23 (12%)	0.35
Nosocomial Infection	161 (50.9%)	63 (49%)	98 (52%)	0.35
Blood Product Replacement	153 (48.4%)	54 (42%)	99 (53%)	0.09

ICU: Intensive Care Unit; APACHE: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential Organ Failure Assessment; COPD: Chronic Obstructive Pulmonary Disease.

Table 2. Comparison of intensive care unit (ICU) mortality in different internal medicine wards according to ICU admission timing

	ICU Non-Survivors (n=177)			
	Overall Mortality (n=67, 38%)	Office Hours (n=110, 62%)	Off-Hours	p
Medical Oncology (n=75)	51 (68%)	22 (33%)	29 (26.4%)	0.23
Nephrology (n=59)	31 (53%)	11 (16.5%)	20 (18.2%)	0.47
Geriatrics (n=59)	29 (49%)	10 (15%)	19 (17.3%)	0.42
Gastroenterology (n=57)	29 (51%)	8 (12%)	21 (19%)	0.15
General Internal Medicine (n=39)	18 (46%)	7 (10.5%)	11 (10%)	0.56
Hematology (n=14)	11 (78%)	3 (4.5%)	8 (7.3%)	0.34
Endocrinology (n=9)	4 (44%)	2 (3%)	2 (1.8%)	0.49
Rheumatology (n=4)	4 (100%)	4 (6%)	0 (0%)	0.02

ICU: Intensive Care Unit; n: Number.

therapy requirements, and nosocomial infection rates between patients admitted to the ICU during office and off-hours. The presence of shock at ICU admission was identified as the sole independent risk factor for off-hour admissions. Invasive mechanical ventilation, the presence of circulatory shock, solid cancer, and the APACHE II score were identified as independent risk factors for ICU mortality.

The impact of ICU admission time on ICU outcomes is controversial, with several studies from several countries producing differing results.[10,11] While some studies report no significant mortality differences in the literature, the majority indicate that off-hour ICU admissions may result in worse outcomes.[10-13] However, few studies focus on specific patient populations, and these data are predominantly derived from mixed ICU studies.[12,14,15] In a study by Gecegelen et al.,[16] conducted in our medical ICU from January 2017 to December 2018, it was found that admission to ICU during off hours increased ICU mortality compared to office hours (45% vs. 34%, respectively, p<0.01). This study followed 527 unselected patients in the same medical ICU. They mainly explained the difference in mortality with worse organ failure scores and different comorbidity spectra in the patients admitted to the ICU during off-hours. When comparing the patient populations of these two studies, there was no difference in disease severity scores (APACHE II score) between patients admitted to the ICU during working hours and those during off-hours in both studies. Although organ failure scores appeared to be higher in patients admitted during off-hours in the previous study, our current study also found the SOFA score to be similarly higher in off-hour admissions. While not statistically significant, this may be interpreted as clinically significant (6 (4-8.5) vs. 7 (4-10) in the previous study and 7 [4-11] vs. 8 [5-11] in the current study). The absence of a significant difference in mortality between off-hour and office-hour admissions in our study may be largely attributed to the unique organizational structure and educational framework within the internal medicine wards and our medical ICU. As a division of the internal medicine department, our ICU operates within the same academic program, ensuring all internal medicine residents undergo monthly rotations in both the medical ICU and internal medicine wards. This structured approach promotes a homogeneous level of education and clinical exposure among residents, fostering a culture of collaboration and interdisciplinary communication.

Additionally, the consistent rotation of internal medicine residents between the ICU and wards may facilitate continuity of care and enhance familiarity with the patient population across different settings. This familiarity and shared knowledge base may contribute to more effective communication and coordination among healthcare teams, regardless of the admission time. Consequently, patients admitted during off-hours may receive quality care equivalent to those admitted during office hours, leading to comparable outcomes in terms of mortality. These findings from two studies conducted in the same ICU at different times, comparing mixed ICU patients and only internal medicine ward patients, can be seen as evidence of better organization in specialized department ICUs.

Table 3. Comparison of baseline characteristics, intensive care unit (ICU) admission, and follow-up data according to ICU mortality in medical ICU patients admitted from internal medicine wards

	All Patients (n=316)	Non-Survivors (n=177, 56%)	Survivors (n=139, 44%)	p
Baseline Characteristics and ICU Admission Data				
Age	71 [62-81]	69 [62-81]	73 [62-82]	0.67
Gender				
Female	174 (55%)	108 (61%)	66 (47%)	0.01
Male	142 (45%)	69 (39%)	73 (53%)	
APACHE II Score	22 [16-29]	27 [19-32]	18 [14-23]	<0.01
SOFA Score	8 [4-11]	10 [7-14]	5 [3-7]	<0.01
Glasgow Coma Scale	12 [6-15]	8 [5-14]	14 [11-15]	<0.01
RIFLE Score				
Risk	73 (23%)	42 (24%)	31 (22%)	0.44
Injury	53 (17%)	36 (20%)	17 (12%)	0.04
Failure	70 (22%)	47 (27%)	23 (17%)	0.03
Loss	11 (4%)	5 (3%)	6 (4.3%)	0.40
End Stage	32 (10%)	20 (11%)	12 (9%)	0.39
ICU Admission Time				
Off Hours	188 (59%)	110 (62%)	78 (56%)	0.17
Admission Ward				
Medical Oncology	75 (23.7%)	52 (29%)	23 (16.5%)	<0.01
Nephrology	59 (18.7%)	32 (18%)	27 (19%)	0.44
Geriatrics	59 (18.7%)	28 (16%)	31 (22%)	0.09
Gastroenterology	57 (18%)	26 (15%)	31 (22%)	0.06
General Internal Medicine	39 (12.3%)	20 (11%)	19 (14%)	0.32
Hematology	14 (4.4%)	11 (6%)	3 (2%)	0.07
Endocrinology	9 (2.8%)	4 (2%)	5 (4%)	0.35
Rheumatology	4 (1.3%)	4 (2%)	0 (0%)	0.09
Comorbidities				
Hypertension	199 (63%)	118 (67%)	81 (58%)	0.08
Solid Cancers	126 (39.9%)	91 (51%)	35 (25%)	0.01
Diabetes Mellitus	115 (36.4%)	68 (38%)	47 (34%)	0.22
COPD, Asthma	92 (29.1%)	56 (32%)	36 (26%)	0.29
Cerebrovascular Disease	59 (18.7%)	28 (16%)	31 (22%)	0.17
Coronary Artery Disease	49 (15.5%)	25 (14%)	24 (17%)	0.44
Chronic Liver Disease	48 (15.2%)	31 (18%)	17 (12%)	0.28
Chronic Kidney Disease	33 (10.4%)	20 (11%)	13 (9%)	0.33
Hematological Malignancy	15 (4.7%)	12 (7%)	3 (2%)	0.01
Sepsis on ICU Admission	184 (58.2%)	131 (74%)	53 (38%)	<0.01
Shock on ICU Admission	164 (51.9%)	102 (58%)	62 (45%)	0.01
ICU Follow-up				
Length of ICU Stay	5 [3-11]	5 [2-14]	5 [3-9]	0.91
Mechanical Ventilation (MV)				
Noninvasive MV	52 (16.5%)	31 (18%)	21 (15%)	0.44
Invasive MV	192 (60.8%)	162 (92%)	30 (22%)	<0.01
Requirement of Hemodialysis				
Intermittent	96 (30.4%)	57 (32%)	39 (28%)	0.25
Continuous	77 (24.4%)	72 (41%)	5 (4%)	<0.01
Parenteral Nutrition	36 (11.4%)	20 (11%)	16 (12%)	0.55
Nosocomial Infection	161 (50.9%)	110 (62%)	51 (37%)	<0.01
Blood Product Replacement	153 (48.4%)	103 (58%)	50 (36%)	<0.01

ICU: Intensive Care Unit; APACHE: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential Organ Failure Assessment; COPD: Chronic Obstructive Pulmonary Disease.

Table 4. Independent risk factors for intensive care unit (ICU) mortality

	OR (95% CI)	p
Invasive Mechanical Ventilation	3.33 [1.49-7.29]	<0.01
Circulatory Shock	2.02 [1.29-2.89]	<0.01
Solid Cancers	1.98 [1.22-3.19]	<0.01
APACHE II Score	1.08 [1.01-1.16]	0.04

OR: Odds Ratio; CI: Confidence Interval; APACHE: Acute Physiology and Chronic Health Evaluation.

Moreover, analyses of secondary outcomes, such as mechanical ventilation, length of ICU stay, renal replacement therapy requirements, and nosocomial infection rates, showed similar results regardless of admission timing. These findings suggest that overall management and outcomes within the ICU remain consistent irrespective of the admission timing, likely due to the unique organizational structure.

In a study by Naumann et al.,[12] a higher mortality rate was found in patients with cardiogenic shock admitted during off-hours. This was interpreted as being due to limited resources and staff underestimating the severity of cardiogenic shock during off-hours. Our study identified circulatory shock at ICU admission as independently associated with off-hour admissions. Although patients with shock did not exhibit higher mortality in our study, our findings suggest a similar interpretation: patients presenting during off-hours with hemodynamic instability may experience insufficient resuscitative efforts or delayed recognition of deteriorating conditions before ICU admission. Therefore, improved risk stratification should be applied for ward patients with hemodynamic instability during off-hours.

Further analysis revealed variations in mortality rates across different internal medicine subspecialties, with Rheumatology patients exhibiting higher mortality during office hour admissions compared to off-hour admissions. This discrepancy highlights the importance of considering specialty-specific factors influencing patient outcomes, such as ongoing combination immunosuppression therapy, which was noted in three of these patients. Given the small sample size of four patients admitted from Rheumatology wards and the lack of difference in mortality rates across other subspecialty clinics, these findings warrant cautious interpretation and emphasize the need for further investigation in larger cohorts to validate the findings and assess their clinical relevance.

Numerous studies have examined factors influencing mortality in intensive care units.[17-19] These studies indicate that various factors affect mortality, including patient age, severity of acute illnesses, pre-existing organ failures, comorbidities—particularly malignancies, reasons for ICU admission, procedures and treatments performed in the ICU, and events and complications during the ICU stay. Although identifying risk factors affecting ICU mortality was not the primary aim of our study, we identified several risk factors independently associated with mortality. Consistent with many other studies, the requirement for invasive mechanical ventilation, the presence of circulatory shock, the APACHE II score, and solid cancer were independently associated with ICU mortality.

When interpreting our findings, it is important to consider several limitations. Firstly, the retrospective nature of our study could lead to some data being missing during collection. Secondly, our single-center design may limit the generalizability of our results to other healthcare settings with different patient populations and resource availability. Additionally, this study was constrained by the need for more information on ICU bed availability when the patient was referred to the ICU, the duration between ICU consultation and ICU admission, and data regarding cases of unexpected ICU admissions.

Conclusion

In conclusion, our study contributes to the growing body of literature on ICU admission timing and patient outcomes by focusing specifically on the internal medicine patient population and comparing this data with that of unselected patients previously studied in the same ICU. Despite the challenges associated with off-hour admissions, our findings indicate that consistent staffing and resources can ensure optimal ICU care regardless of admission time, and provide supporting evidence of better organization in specialized department ICUs. Further research is needed to elucidate the underlying mechanisms driving differences in patient outcomes across various admission times and specialty areas, ultimately informing strategies to optimize ICU care delivery and improve patient outcomes.

Ethics Committee Approval: Ethics committee approval was obtained from Gazi University Ethics Committee (Approval Number: 2023 – 1473, Date: 21.11.2023).
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