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Association between the maxillofacial injury severity score to helmet types, neutrophil lymphocyte ratio and length of stay

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Summary

Background: Traffic accidents are a major etiological factor in maxillofacial injuries, exhibiting a high incidence rate. The Maxillofacial Injury Severity Score (MFISS) is utilized to assess the severity of maxillofacial trauma. Helmet use is a preventive measure against more serious injuries. Patients with maxillofacial trauma are at risk of complications and infections. Elevated neutrophil to lymphocyte ratio (NLR) in hospitalized patients correlates with a longer length of stay (LOS). **Objectives:** This study aimed to evaluate the relationship between helmet types and MFISS scores, as well as the relationship between MFISS scores and both LOS and NLR values in patients. **Methods:** An analytical observational study with a prospective design was conducted at RSUP Prof. dr. I.G.N.G. Ngoerah, Denpasar, from March to December 2024. The study sample consisted of 66 trauma patients with maxillofacial injuries, selected based on inclusion and exclusion criteria. Data were analyzed using the Kruskal-Wallis and Spearman tests to assess the relationships between variables. **Results:** The Kruskal-Wallis test revealed a positive value of 39.825 with P = 0.000, indicating a significant relationship between helmet types and MFISS scores. Spearman analysis showed P = 0.027 (r = 0.273), demonstrating a significant positive correlation between MFISS scores and NLR values, and P = 0.000 (r = 0.505), indicating a significant positive correlation between MFISS scores and LOS. **Conclusion:** There is a significant relationship between MFISS scores and helmet types, as well as a significant relationship between MFISS scores and NLR values and LOS in maxillofacial injury patients at RSUP Prof. dr. I.G.N.G Ngoerah.

Key words
helmet type – length of stay – maxillofacial injury – MFISS score – NLR

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Introductions

Motorcycle riders are highly vulnerable in traffic accidents, often experiencing minor to severe injuries, including facial fractures and traumatic brain injury. Despite the crucial role of helmets in preventing such trauma, many riders remain unaware of the importance of wearing safety-standard helmets. In Indonesia, the government mandates the use of helmets with the Indonesian National Standard (SNI) to reduce the risk of serious head injuries. Facial injuries, especially maxillofacial fractures, can severely impact victims' quality of life and may result in death.

Globally, motorcycle crashes contribute to 23% of road traffic fatalities, particularly in regions where motorcycles dominate transportation [1]. In Bali, traffic accidents rose significantly between 2020 and 2022, with incidents increasing from 1,787 to 3,620 cases [2]. Traffic accidents are among the leading causes of maxillofacial injuries, accounting for 34.3–80.1% of facial bone and soft tissue trauma [3]. The use of full-face helmets has been shown to significantly reduce the risk of traumatic brain injury compared to open-face or no helmets [4,5]. Although both helmet types carry some risk of facial trauma, full-face helmets offer better protection.

Evidence consistently supports that helmet use decreases the head injury risk by 69% and mortality by 42% [1]. Facial regions, such as the chin, cheeks, nose, and lips, are the most commonly injured areas in crashes [6,7]. Helmets

are also associated with lower rates of maxillofacial fractures, skull fractures, and traumatic brain injury [7].

Few studies have explored the correlation between a helmet type and the severity of maxillofacial trauma. The Maxillofacial Injury Severity Score (MFISS) is a validated tool to assess trauma severity and guide management, prognosis, and post-trauma quality of life. Previous research highlights that complications such as prolonged hospitalization are linked with elevated neutrophil-to-lymphocyte ratios (NLR), a marker of systemic inflammation [7]. Average hospital stays for facial fractures vary from 1–28 days, and some cases, such as isolated mandibular fractures, can be managed on an outpatient basis to reduce post-operative inflammation [8].

Therefore, this study aims to investigate the relationship between MFISS, helmet types, NLR, and hospital length of stay (LOS).

Material and method

This study is analytic observational research using prospective study models. The samples were patients that were admitted to Prof. dr I.G.N.G Ngoerah Central Hospital, Denpasar, Bali, Indonesia with a maxillofacial fracture. The patients were then assessed for MFISS and then were asked about the helmet type equipped during accident. Admitted patients were then followed up before surgery regarding the NLR value and LOS until their recovery. The samples were taken at the period from March 2024 to December 2024.

The inclusion criteria included adult patients above 17 years old and with trauma accident that causes maxillofacial injuries. Exclusion criteria included declining CT scan examination, incomplete medical record, death of patient and not wearing a helmet during the accident.

The scores of MFISS and their criteria are summarized in Tab. 1 [9].

The types of helmets are classified into three groups: a full-face helmet, an open-face helmet with a cover and an open-face helmet without a cover.

Tab. 1. The Maxillofacial Injury Severity Score criteria.

AIS-90 for facial trauma		Functional maxillofacial trauma scale		
Injury description	**AIS-90**	**Functional decline**	**Injury description**	**Score**
• face soft tissue laceration < 10 cm and avulsion < 25 cm^2	1	MO	involves < 6 teeth in one part of jaw	1
• external carotid artery branches rupture			external carotid artery branches rupture	2
• mouth and tongue mucous – superficial injury			involves > 6 teeth in one part of jaw	3
• dento-alveolar fracture, subluxation or teeth displacement				
• face skeletal fracture, ramus mandibula or nasal bone				
• temporo-mandibular joint occlusion				
• face soft tissue laceration >10 cm and avulsion >25 cm^2	2	FD	soft tissue injury < 4 cm	1
• mouth and tongue laceration – deep or wide laceration			non-displaced facial bone fracture	2
• dento-alveolar fracture			• soft tissue injury > 4 cm with tissue defect < 2 cm^2 • facial nerve branches injury • unilateral fracture in one part of the bone • soft tissue injury > 4 cm with tissue defect > 2 cm^2 • injury of facial nerve trunk • bilateral fracture at one part of the jaw or bone fracture involving both jaws	3
• face skeletal – mandibular body, coronoid fracture and condyle/ Lefort I–II mid-face fracture / zygomatico-maxillary complex				
• nasal bone fracture – open, displacement or comminuted/ orbital				
• fracture/closed				
• temporo-mandibular joint luxation				
• injury to face's nerve system				
• Lefort III fracture of mid-face part with blood loss < 20%	3	LMO	• mouth opening between 2 cm and 3.7 cm	1
• orbital fracture – open displaced or comminuted				
• fracture Lefort III mid-face part with blood loss > 20%	4		mouth opening > 2 cm	2

AIS – Abbreviated Injury Scale, FD – functional deformity, LMO – limited mouth opening, MO – malocclusion

The full-face helmet covers the whole portion of the head and face, while the open-face helmet with a cover covers the head part but leaves the face part open. This type also uses a transparent cover at the front side of the helmet. The open-face helmet without a cover means a helmet with an open-face design without a transparent cover. We will also classify the helmet type according to the certified helmet using SNI or uncertified helmet.

NLR was recorded as numerical variables and was taken when the patient was getting laboratory examination before surgery. Hospital LOS is also used as a numeric scale and was counted since patient's admission to hospital until the patient was discharged.

The data obtained in this study were processed using computer software. Initially, all collected data were entered into Microsoft Excel for sample characteristic entry and subsequently transferred to SPSS, version 26.0 for Windows for statistical analysis. Normality testing was conducted to assess the distribution pattern of numerical variables, including MFISS, LOS and NLR, using the Kolmogorov-Smirnov test. Descriptive analysis was performed to characterize the research subjects and study variables. Numerical variables were presented as means and standard deviations, while categorical variables were described using relative frequencies and summarized in univariate distribution tables. To evaluate the association between helmet types (categorical variables) and trauma severity scores (numerical variables), mean comparisons were carried out. One-way ANOVA was applied when the data were normally distributed across all helmet categories; otherwise, the Kruskal-Wallis test was used. Correlation analysis was also conducted to explore the relationship between MFISS scores and both NLR and LOS. Pearson correlation was employed for normally distributed data, while Spearman correlation was applied for non-normally distributed data. All statistical analyses were performed using SPSS version 26.0, with significance set at $P < 0.05$ and a 95% confidence interval (CI).

Tab. 2. Subjects' characteristics.

Variable	Classification	Numbers	Percentage (%)	Total
sex	male	53	80.3	66
	female	13	19.7	
age	< 20 years old	19	28.9	66
	21–30 years old	27	40.8	
	31–40 years old	6	9.0	
	41–50 years old	6	9.0	
	51–60 years old	4	6.0	
	> 60 years old	4	6.0	
education	uneducated	2	3.0	66
	elementary school	2	3.0	
	junior high school	13	19.7	
	senior high school	34	51.5	
	graduates and above	15	22.7	
occupation	unemployed	14	21.2	66
	working at private sector	14	21.2	
	civil servant / military / police	5	7.6	
	contract worker	16	24.2	
	health worker	6	9.1	
	farmer / fisherman	11	16.7	
marriage	married	32	48.5	66
	unmarried	34	51.5	

Results

There are 66 subjects that were taken during the study period. The patients' characteristics can be observed in Tab. 2. The demographic profile of maxillofacial injury patients at Prof. Dr. I.G.N.G Ngoerah General Hospital reveals that the majority were aged 21–30 years, accounting for 40.8% of the sample. In terms of educational background, most respondents (51.5%) had completed senior high school, while the lowest proportion (3%) consisted of individuals with no formal education or only primary school education. Regarding employment, the highest percentage (24.2%) were private sector employees or contractual workers, whereas civil servants, military, and police personnel represented the lowest proportion (7.6%). Marital status distribution showed that 51.5% of respondents were unmarried, while 48.5% were married. These findings suggest that the typical maxillofacial trauma patient in this setting is a young adult, educated at the high school level, working in the private sector, and predominantly unmarried.

Based on Tab. 3, most patients with maxillofacial injuries were classified as having moderate injury severity, accounting for 54.5% of respondents. Minor injuries were reported in 27.3% of cases, while 15.2% experienced serious injuries, and only 3% were categorized

Tab. 3. Maxillofacial trauma severity.

Variable	Classification	Count	Percentage (%)
severity	minor (score 1–10)	18	27.3
	moderate (score 11–20)	36	54.5
	severe (score 21–30)	10	15.2
	very severe (score ≥ 31)	2	3.0
	total	66	100.00

Tab. 4. Subjects' helmet types equipped.

Variable	Classification	Count	Percentage (%)
helm equipped	equipping helmet	66	100.0
	not equipping helmet	0	0.0
	total	66	100.00
helmed type	full face	19	28.8
	open face with cover	24	36.4
	open face without cover	23	34.8
	total	66	100.00
Indonesian standardized helmet	certified	40	60.6
	not certified	26	39.4
	total	66	100.00

as having severe maxillofacial trauma. These findings indicate that most patients presented with moderate levels of maxillofacial injury severity.

As shown in Tab. 4, all patients with maxillofacial fractures at Prof. Dr. I.G.N.G Ngoerah General Hospital reported wearing helmets at the time of the incident. Based on helmet design, 36.4% used open-face helmets with a cover, 34.8% used open-face helmets without a cover, and 28.8% wore full-face helmets. This indicates that most patients were using open-face helmets with a cover. When classified according to safety standards, 60.6% of the respondents wore helmets with the SNI certification mark, while 39.4% wore non-certified helmets.

Tab. 5 shows that the MFISS ranged from 3 to 33, with a median of 15.0 and a range of 30.0. The LOS variable had a minimum value of 2 and a maximum of 10 days, with a median of 4.0 and a range of 8.0. Meanwhile, the NLR ranged from 0.54 to 55.5, with a median value of 3.5 and a range of 54.96.

The analysis in Tab. 6 using the Kruskal-Wallis H test was conducted to examine the relationship between a helmet type and the severity of maxillofacial injuries as measured by the MFISS. The non-parametric test was used due to the non-normal distribution of MFISS scores across helmet categories. The test revealed a statistically significant difference in MFISS scores among the different helmet types, $\chi^2(2) = 39.83$, $P < 0.001$. This finding suggests that a helmet type is significantly associated with injury severity among maxillofacial trauma patients.

In Tab. 7, Spearman's rank correlation was used to examine associations between MFISS and clinical variables, including NLR and LOS. There was a significant positive correlation between MFISS and NLR ($\rho = 0.273$, $P = 0.027$), indicating that greater injury severity was moderately associated with higher systemic inflammatory response. Additionally, MFISS was positively correlated with LOS ($\rho = 0.505$, $P < 0.001$), suggesting that patients with more severe maxillofacial injuries had longer hospital stays.

Discussion

This study analyzed 66 patients with maxillofacial fractures due to motorcycle accidents, focusing on the relationship between a helmet type and MFISS, while also considering demographic factors, LOS, and NLR.

Tab. 5. Descriptive data for each variable.

	N	Minimum	Maximum	Mean	Standard deviation	Median	Range
MFISS	66	3.00	33.00	15.51	6.57	15.00	30.00
length of stay (days)	66	2.00	10.00	4.70	1.54	4.00	8.00
NLR value	66	0.54	55.50	7.086	8.795	3.515	54.96

MFIS – Maxillofacial Injury Severity Score, NLR – neutrophil to lymphocyte ratio

Tab. 6. Spearman's correlation between MFISS and clinical variables.

Variables	Spearman's P	P-value
MFISS vs. NLR	0.273	0.027
MFISS vs. LOS	0.505	< 0.001

LOS – length of stay, MFISS – Maxillofacial Injury Severity Score, NLR – neutrophil to lymphocyte ratio

Tab. 7. Kruskal-Wallis test results for MFISS based on a helmet type.

Tests	P-value
Kruskal-Wallis H	39.825
Degrees of freedom	2
P-value	< 0.001

Most patients were aged 21–30 years, a productive age group with higher exposure to traffic-related trauma due to more frequent use of motorcycles and possible engagement in riskier behaviors. Most patients had completed senior high school or vocational school education, consistent with studies by Akhigbe and Kraftet et al., who highlighted that young adults are the primary users of motorcycles and are therefore more vulnerable to injury [10,11]. These findings are further supported by Aires et al. and Yasir, who report that young adults are the most affected demographic in motorcycle-related injuries [1,12].

Male patients dominated the cohort (80.3%), aligning with studies by Kamath et al. and Chalya et al., which emphasized that men are more likely to engage in high-risk activities and thus are more frequently involved in traffic accidents [13,14]. The most common occupation was private or contract employees (24.2%), although this contrasts with Sattar et al., who found a higher prevalence among construction workers. In this study, occupation was not significantly associated with accident incidence or injury severity [15].

The most frequently used helmet was the open-face type with a cover (36.4%), followed by full-face helmets. Despite most helmets bearing the SNI logo (60.6%), a substantial portion of patients experienced moderate to severe maxillofacial injuries, with the majority having MFISS scores in the range of 21–30 (54.5%).

Statistical analysis using the Kruskal-Wallis test demonstrated a significant association between helmet type and MFISS score ($P < 0.001$). These results are supported by Aires et al. , who found that open-face helmet users were more likely to sustain facial trauma [1]. Similarly, Peek-Asa, Yu, and Amirjamshidi et al. reported that full-face helmets offer superior protection for the midface and mandible regions compared to open-face helmets [16–18].

However, some studies such as those by Yokoyama et al. and Cini et al. reported no statistically significant differences between helmet types, though full-face helmet users tended to have lower facial injury scores [19,20]. These discrepancies may be due to various confounding factors such as the prioritization of other injuries during initial treatment, or the influence of helmet comfort and design on user compliance. Tabary et al. noted that reduced peripheral vision and discomfort associated with full-face helmets might lead to improper use or preference for open-face helmets despite the reduced protection [21].

A meta-analysis by Cavalcante et al. confirmed that helmet use reduces the incidence of mid- and upper-face fractures; however, literature remains inconsistent regarding the specific protective differences between full-face and open-face helmets, indicating a need for further research with controlled variables [22].

The mean LOS was 4.70 ± 1.54 days, with most patients hospitalized for four days. This is in line with the findings of Siddiqui et al., who reported that hospital stay is often extended in patients requiring complex management, such as bone plating [23]. Tambayong et al. further established that patients with higher facial injury scores tend to have longer hospital stays (≥ 5 days). In this study, although most patients had moderate injury scores, other factors like comorbidities may have contributed to variations in LOS [24].

The mean NLR was 7.08 ± 8.80, with the most frequently recorded value being 1.6. NLR is a recognized biomarker for systemic inflammation and has been associated with trauma severity and poor outcomes [25,26]. An NLR > 5 on day 5 of hospitalization has been linked to increased mortality risk. Although specific correlations between MFISS and NLR in maxillofacial trauma are limited, studies by Forget et al. and Wang et al. support the use of NLR as an indicator of injury severity and prognosis [25,27].

Conclusion

This study highlights a significant association between a helmet type and MFISS, with open-face helmets linked to higher facial injury severity. Young adult males, particularly private employees, were the most affected group. Despite many using SNI-certified helmets, moderate to severe injuries remained common. Full-face helmets provided better protection, though user compliance may be influenced by comfort. Mean LOS and elevated NLR values reflected moderate trauma severity, with NLR serving as a useful inflammation and prognosis marker. These findings underscore the importance of promoting full-face helmet use and further research on helmet

design, compliance, and inflammatory markers in facial trauma outcomes.

Disclosure

The authors have no conflicts of interest to disclose. The authors declare that this study has received no financial support. All procedures performed in this study involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards.

Roles of the authors

Kiagus Handrian Parikesit contributed to the conception and design of the study, data collection, data analysis, interpretation of results, and drafting of the manuscript. I Gusti Putu Hendra Sanjaya provided overall supervision, methodological guidance, and critical revision of the manuscript for important intellectual content. Agus Roy Rusly Hariantana Hamid contributed to study supervision, validation of data, and final approval of the manuscript. Gede Wara Samsarga assisted in data acquisition and coordination of clinical documentation. I Gusti Ayu Sri Mahendra Dewi contributed to literature review, verification of datasets, and editing support. Putu Anda Tusta Adiputra assisted in clinical data organization, preparation of tables and figures, and technical editing. Shita Diwyani Sudarsa provided input on clinical interpretation and editorial review of the manuscript. Astrinita Lestari Suyata contributed to project coordination, proofreading, and management of the submission process.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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