Determinants of Head and Neck Injuries among Commercial Motorcyclists in Kisumu County, Kenya

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ABSTRACT

Motorcycle-related injuries remain a significant public health concern in low- and middle-income countries. This study assessed factors associated with head and neck injuries among commercial motorcyclists in Kisumu County, Kenya.A community-based analytical cross-sectional study assessed socio-demographic, behavioral and cognitive determinants of head and neck injuries among 375 commercial motorcyclists in Kisumu County selected through cluster sampling. The lifetime prevalence of head and neck injuries was 5.9%. Most respondents were male (95.7%), aged 25–34 years (44.2%), and had secondary education (51.3%). Inconsistent helmet use was significantly associated with injury at bivariate level ($\chi^2 = 10.88$, $p = 0.012$), with riders who never wore helmets having higher crude odds of injury (OR = 4.18; 95% CI: 1.27–13.79). However, this association did not remain statistically significant in the multivariate model, likely due to confounding by riding experience and small cell sizes in the never-use category, as reflected by the wide confidence interval. Multivariate logistic regression showed that riders with more than 6 years of riding experience had significantly increased odds of injury (AOR = 6.39, 95% CI: 1.75–23.37, $p = 0.005$), suggesting cumulative occupational exposure and possible risk normalization. Overall, riding experience emerged as the only independent predictor of head and neck injuries, while socio-demographic variables and overall knowledge scores were not significant. The findings suggest that behavior-focused interventions and strengthened helmet law enforcement remain important, but prolonged occupational exposure should be prioritized in injury prevention strategies.

Keywords: motorcycle injuries, helmet use, riding experience, Kisumu County, Kenya

INTRODUCTION

Head and neck injuries among commercial motorcyclists include trauma to the skull, brain, face, jaw, cervical spine, and surrounding neck tissues, ranging from minor abrasions to severe traumatic brain injuries, skull fractures, and cervical spine damage (Adeoye et al., 2020; World Health Organization, 2021). These injuries remain a major public health concern globally because motorcyclists are highly exposed to direct crash impact and traffic-related risks (Alam et al., 2020; Sornkarn et al., 2021). Evidence from Asia and Europe has consistently shown that helmet non-use, speeding, alcohol consumption, and risky riding behaviors are major contributors, while helmets reduce head injuries by up to 69% and deaths by 42% (Liu et al., 2008)

In Africa, the burden of head and neck injuries has risen with the rapid expansion of motorcycles as a convenient mode of transport, compounded by weak road safety enforcement and poor road infrastructure (Muthoni et al., 2021; Kigera & Naddumba, 2020). In Kenya, studies have similarly reported that young male riders, risky behaviors, low helmet use, and inadequate safety knowledge significantly increase vulnerability to severe injuries (Odero et al., 2018; Wambua et al., 2020). In Kisumu County, motorcycle crashes contribute between 41% and 62% of all traffic injuries, while head and neck injuries account for 42.5% of motorcycle injury cases, with 55.2% requiring hospitalization (Cholo et al., 2023; KNBS, 2022).

Despite this burden, previous studies have mainly focused on general road traffic injuries, with limited attention to the specific behavioral, knowledge, attitudinal, socio-demographic, and contextual factors associated with head and neck injuries among commercial motorcyclists.

The problem is further compounded by the long-term consequences of these injuries, including disability, chronic pain, loss of productivity, and increased healthcare costs. However, there is still insufficient localized and context-specific evidence on how rider behaviors, safety perceptions, environmental conditions, and health system factors interact to influence head and neck injuries in Kisumu County. This gap limits the design of targeted prevention and management strategies, hence the need for this study.

The study aimed to identify determinants of head and neck injuries among commercial motorcyclists in Kisumu county,Kenya.Specifically,it assessed socio-demographic,behavioural,knowledge and attitudinal factors associated with such injuries.This study is significant because it provides context-specific evidence on the factors associated with head and neck injuries among commercial motorcyclists in Kisumu County, a population that is increasingly vulnerable due to the growing use of motorcycles as a means of transport. By identifying the role of behavioral practices, helmet use, riding experience, and safety knowledge, the findings contribute to the existing body of knowledge on motorcycle-related injuries in Kenya. The study is also important for policy and practice, as the evidence can guide the National Transport and Safety Authority, Kisumu County health authorities, and boda boda associations in designing targeted injury prevention strategies, including enforcement of helmet laws, behavior change interventions, and rider safety education. In addition, the findings may support health system planning by informing emergency response and trauma care strategies for motorcycle-related injuries. Academically, the study fills a local evidence gap by moving beyond general road traffic injuries to specifically examine head and neck injuries and their determinants. This makes it valuable for future researchers, public health practitioners, and policymakers interested in occupational safety and road traffic injury prevention.

METHODOLOGY

Study Design

This study employed a community-based, analytic cross-sectional mixed-methods design conducted in Kisumu County, Kenya, among registered and active commercial motorcyclists. The mixed-methods approach combined quantitative and qualitative techniques to provide both statistical associations and contextual explanations of head and neck injuries (Creswell & Clark, 2016).

Study duration and Period

The study spanned from March 2025 to January 2026 with data collection occurring between November 2025 and January 2026.

Study Area

The study was conducted in Kisumu County, located in western Kenya. According to the 2019 Kenya Population and Housing Census, the county has a population of approximately 1,155,551 people and covers an area of 2,085.9 km², with a population density of about 460 persons per square kilometer. The county is administratively divided into seven sub-counties: Kisumu East, Kisumu Central, Kisumu West, Seme, Muhoroni, Nyando, and Nyakach.Kisumu County was considered suitable for this study because motorcycles are a common means of transport, accounting for about 19% of transport use, and the county has experienced a rising burden of motorcycle-related crashes and injuries. It is a mix of urban, peri-urban, and rural settings providing a diverse risk environment for assessing the socio-demographic, behavioral, and contextual factors associated with head and neck injuries among commercial motorcyclists.

Study Population

The study population comprised registered and active commercial motorcyclists operating within Kisumu County. Eligible participants included riders who were actively engaged in commercial motorcycle operations for at least three months, were in good physical health, and were available during the study period. Riders were excluded if they had physical, cognitive, or medical conditions that impaired their ability to respond to study questions, were acutely ill or hospitalized, or had participated in the pilot study conducted in Nyakach Sub-

county, in order to minimize information bias.Good physical health in this context refers to ability to participate in the interview process and provide informed consent,not a clinical assessment.

Sample Size and Sampling Techniques

Sample Size Determination

The sample size was 375 respondents, determined using Fisher's formula for cross-sectional studies:

$$n = \frac{Z^2 pq}{d^2}$$

Where:

n =required sample size

Z = value at 95% confidence interval, usually 1.96

p =Estimated prevalence of head and neck injuries. (42.5%, Cholo *et al.*., 2023)

d = margin of error, usually 5% (0.05)

Substituting the values as;

n=1.96^2.0.425(1-0.425)/0.05^2 Gives **375** respondents.

Sampling Technique

The study used a cluster sampling approach, where the selected six sub-counties formed the sampling clusters, while Nyakach was excluded because it served as the pilot site. Within each cluster, respondents were allocated proportionately based on the observed distribution of riders and stage activity during reconnaissance and field mapping, applying principles similar to Probability Proportionate to Size (PPS), although exact rider population figures were unavailable. This ensured that sub-counties with visibly larger and busier motorcycle operations contributed more respondents. Thereafter, simple random sampling was used to select riders from identified boda boda stages within each cluster.This approach improved geographical spread, representativeness, and practical feasibility, while reflecting the real-world distribution of riders across the county.

Table 1 Population Distribution of the sample riders with respect to each cluster

Ser. No.	**Sub-county (Cluster)**	**Main Town**	**Sample size**
1	Kisumu East	Kasagam	40
2	Kisumu West	Ojola	172
3	Kisumu Central	Kondele	57
4	Nyando	Awasi	35
5	Muhoroni	Chemelil	21
6	Seme	Kombewa	50
7	Nyakach	Pap Onditi (**Pretest**)	**30**

Data Collection Tools and Procedures

Data Collection Tools

A structured questionnaire was used to collect quantitative data on socio-demographics, behavioural practices and knowledge and attitude factors.An observation checklist was used to assess actual riding behaviours including helmet use, traffic use and law enforcement presence.12 Key Informant Interviews: 2 KIIs were done in each town. The respondents were the chairmen of the *boda boda* association and the traffic police officers. The KI interviews aimed at understanding their views regarding use of helmets as well as knowledge of traffic rules and attitudes towards using them.

Data Collection Procedure

Data were collected using a combination of structured questionnaires, observation checklists, and key informant interviews. Trained research assistants conducted non-participant observations first at selected sites such as boda boda stages, road junctions, and market centers to capture real-time riding behaviors (e.g., helmet use, traffic compliance). Riders were then approached, the study explained, and informed consent obtained before conducting face-to-face interviews using a semi-structured questionnaire. KIIs were conducted with chairpersons of the boda boda associations and traffic police officers to understand their views regarding use of helmets as well as knowledge of traffic rules and attitudes towards using them and contextual factors influencing safety practices. Data collection was done during the day across multiple time periods to capture variation in behavior.

Validity and Reliability

Validity was ensured through expert review of data collection tools to assess content relevance and comprehensiveness and pilot testing in Nyakach Sub-county, which helped refine the tools for clarity and relevance.Reliability was strengthened through training of research assistants, use of standardized procedures, and application of test-retest methods during the pilot phase to assess consistency of responses over time.

Data Management

Collected data was handled with strict confidentiality. Completed questionnaires were checked daily for completeness, consistency, and accuracy, then coded and entered into STATA version 18 for analysis. Quantitative data were analyzed using descriptive statistics (frequencies and percentages) to summarize respondent characteristics and injury patterns. Chi-square tests were used to determine associations between independent variables and head and neck injuries, while binary and multivariate logistic regression analyses were performed to estimate crude and adjusted odds ratios with 95% confidence intervals. Statistical significance was set at $p < 0.05$. Qualitative data from KIIs were audio-recorded, transcribed verbatim, and organized into themes using thematic analysis, allowing triangulation with quantitative findings. All electronic data were stored in password-protected files, while hard copies were securely kept under restricted access. Data will be retained for five years before secure destruction.

Ethical Considerations

Ethical approval was obtained from Maseno University Ethics Review Committee and National Commission for Science, Technology and Innovation. The study adhered to key ethical principles of autonomy, beneficence, and justice. Participation was voluntary, and informed consent was obtained from all respondents after explaining the study purpose, procedures, risks, and benefits. Confidentiality and anonymity were maintained, and participants were informed of their right to withdraw at any time without penalty.

RESULTS

Socio-Demographic Characteristics

From Table 2a,373 respondents completed the questionnaire yielding 99.5% response rate.91.67% were male with a Majority (54.16%) aged 25-34 years,47.72% had attained primary education and More than half (51.47%) had 1-3 years riding experience Motorcycle riding in Kisumu county is predominantly undertaken by young males.

Table 2a; Distribution of participants by Socio-demographic Characteristics

Age	Freq.	Percent
18-24 years	46	12.33
25-34 years	202	54.16
35-44 years	105	28.15
45-54 years	20	5.36
Gender		
Female	30	8.06
Male	341	91.67
Other	1	0.27
Level of Education		
College/ university	34	9.12
No formal education	35	9.38
Primary school	178	47.72
Secondary school	126	33.78
Riding experience		
1-3 years	192	51.47
4-6 years	119	31.9
Less than one year	40	10.72
More than 6 years	22	5.9

From table 2b,Overall life-time prevalence of head and neck injuries from this study was 5.9%, indicating a notable burden.89 respondents reported ever being involved in motorcycle accident,22 of them reported having sustained head and neck injuries (5.9% of the total).There was a significant association between previous accident involvement and occurrence of head and neck injuries ($\chi^2 = 74.60$, $p < 0.001$).

Table 2b; Life-time Prevalence of Head and Neck injuries

Have you previously been involved in an accident?	**head_neck**		
	0	**1**	**Total**
no	**284**	**0**	**284**

	80.91	**0.00**	**76.14**
yes	**67**	**22**	**89**
	19.09	**100.00**	**23.86**
Total	**351**	**22**	**373**
	100.00	**100.00**	**100.00**
Pearson Chi2 = 74.60 Prob = 0.0000			

Association between socio-demographic characteristics and head and neck injuries among commercial motorcyclists

From table 3, Most socio-demographic variables did not show statistically stable associations with injury occurrence, although interpretation of gender effects was limited by the overwhelmingly male sample distribution.Years of riding experience showed a significant association with head and neck injuries ($\chi^2 = 15.36$, $p = 0.001$).Riders with more than six years' experience were significantly more likely to experience head-neck injuries compared to those with less years' experience (OR = 6.7, p = 0.002, 95% CI: 1.991–22.978).

Table 3; Association Between socio-demographic characteristics and the occurrence of head and neck injuries

Variable		**Head_neck injury**		**Chi2**	**P value**
		Yes	**No**		
Age	**18-24 years**	**2**	**44**	**0.99**	**0.81**
	25-34 years	**11**	**191**		
	35-44 years	**7**	**98**		
	45-54 years	**2**	**18**		
Gender	**Female**	**0**	**30**	**2.13**	**0.35**
	Male	**22**	**319**		
	Other	**0**	**1**		
Level of Education	**College/ university**	**4**	**30**	**3.22**	**0.36**
	No formal education	**3**	**32**		
	Primary school	**8**	**170**		
	Secondary school	**7**	**119**		
Riding experience	**1-3 years**	**8**	**184**	**15.36**	**<0.01**
	4-6 years	9	110		
	Less than one year	0	40		
	More than 6 years	5	17		

Association Between Behavioural characteristics and head and neck injuries

Riders who reported never wearing helmets had 4.2 times higher odds of head/neck injuries (OR = 4.18, p = 0.019).40.8% always used helmets while 44.8% used them only sometimes.To validate self-reported helmet use practices, non-participant roadside observations were conducted at selected boda boda stages across the study sites. The observation checklist showed that 24.13% of riders were observed wearing helmets, compared to 40.8% who reported always wearing helmets in the survey.The observed helmet use rate was lower than the self-reported rate, suggesting possible social desirability bias in questionnaire responses, where riders may have overstated compliance with helmet regulations.87.4% reported using other protective gear(reflective jackets,gloves,knee guard) But only 53.5% use them consistently.No significant association found for other risky behaviours such as use of other protective gear,riding speed,overtaking behavior,carrying more passengers,weaving through traffic,sudden braking,phone use, listening to music and alcohol/drug use.

Motorcyclists Knowledge and attitude on head and neck injuries

From table 4,There was no significant association between composite knowledge score and the occurrence of head and neck injuries ($\chi^2 = 1.63$, p = 0.202).Knowledge was generally high and was distributed as follows,risk awareness: 81.45%,helmet importance: 87.37%,traffic law knowledge: 87.87% and helmet legal requirements: 67.30%Understanding the potential consequences of head and neck injuries was significantly associated with injury occurrence ($\chi^2 = 7.74$, p = 0.005). This may reflect reverse causation where riders who had previously been involved in accidents acquired knowledge through experience.Attitudinal factors among commercial motorcyclists had no significant association with the occurrence of head and neck injuries.Most riders had positive attitudes,97.03% felt vulnerable and 87.63% believed helmets are effective.

Table 4; Association Between Composite Knowledge score and head and neck injuries

Knowledge	**head_neck**		
	0	**1**	**Total**
0 (Poor)	**23**	**0**	**23**
	6.91	**0.00**	**6.53**
1 (Good)	**350**	**23**	**373**
	93.09	**100.00**	**93.47**
Total	**373**	**22**	**398**
	100.00	**100.00**	**100.00**
Pearson Chi2 = 1.63 Prob = 0.2020			

Independent Predictors of Head and Neck Injuries among commercial motorcyclists

Variables with p<0.20 in the bivariate analysis were included in the adjusted model to control for potential confounders.Variables eligible for multivariate analysis based on the p < 0.20 screening criterion included years of riding experience, helmet use frequency, helmet type, use of other protective gear, and knowledge of injury consequences. All candidate variables were first entered into the full adjusted model.During model diagnostics, knowledge of injury consequences showed conceptual overlap with general knowledge scores and was excluded from the final parsimonious model to minimize collinearity. In addition, some helmet-use categories had small cell counts, which contributed to unstable confidence intervals, particularly in the "never" category.After backward elimination, the final model retained years of riding experience, helmet use frequency, helmet type, and use of other protective gear. From table 5a,the overall model was statistically significant ($\chi^2 = 16.57$, p =

0.035),indicating that the variables included in the model jointly improved the prediction of head-neck injuries.After adjustment, years of riding experience remained the only statistically significant independent predictor of head and neck injuries. Riders with more than 6 years of riding experience were approximately 6.4 times more likely to experience head and neck injuries compared to those with 1–3 years of riding experience (AOR = 6.39, 95% CI: 1.75–23.37, p = 0.005).

Table 5a; Independent Predictors of Head and Neck Injuries among commercial motorcyclists

Variable		**AOR.**	**p-value**	**[95% Conf Interval]**
Years of riding experience	1-3 yrs	Ref	.	.
	4-6 years	1.878	0.235	0.663 - 5.319
	More than 6 years	6.39	0.005	1.747 - 23.366
Helmet use frequency	Always	Ref	.	.
	Never	2.626	0.481	0.179 - 38.463
	Rarely	0.644	0.709	0.064 - 6.498
	Sometimes	0.867	0.804	0.281 - 2.671
Type of helmet	Full Face	Ref	.	.
	No helmet	1.418	0.766	0.142 - 14.189
	Open face	0.678	0.544	0.193 - 2.379
Use of other gear	No	Ref	.	.
	Yes	0.38	0.092	0.123 - 1.171
Knowledge of injury consequences	Adequate	1.91	0.154	0.78–4.63

To assess the stability of the riding experience finding, stratum-specific injury rates were examined as shown in Table 5b. The results showed a progressive increase in injury rates from 4.2% among riders with 1–3 years' experience to 22.7% among those with more than 6 years, suggesting a cumulative exposure threshold effect. This trend supports a monotonic exposure-risk relationship and suggests that the observed association is unlikely to be driven by isolated cases alone.The absence of injuries in riders with less than one year of experience prevented its use as the regression reference category because it would generate an undefined odds ratio. The researcher therefore selected the 1–3 years category as the most statistically stable comparison group.

Table 5b: Stratum-Specific Injury Rates by Riding Experience

Riding Experience	Injured(n)%	Not Injured	Total
<1 year	0(0.0)	40(100)	40
1-3 years	8(4.2)	184(95.8)	192
4-6 years	9(7.4)	112(92.6)	121
>6 years	5(22.7)	17(77.3)	22

Although helmet non-use showed a significant association at bivariate level, this effect lost statistical significance after adjustment (AOR = 2.63, p = 0.481). In the researcher's interpretation, this attenuation likely reflects confounding by cumulative riding exposure, since riders with longer experience may also be less consistent in helmet use. In addition, the small number of injuries among riders who never wore helmets resulted in sparse cells and a wide confidence interval, limiting estimated precision and loss of statistical significance after controlling for riding experience and other covariates. The crosstabulation of helmet use by injury status is shown in table 5c.

Table 5c; Helmet use frequency and head & neck injury status among commercial motorcyclists (n = 373)

Helmet Use Frequency	**No head-neck injuries**	**Head-neck injuries**	**Total**
Always	143	9	152
Never	19	5	24
Rarely	29	1	30
Sometimes	160	7	167
Total	351	22	373

Qualitative Themes on Behavioral Drivers of Head and Neck Injuries

The qualitative analysis generated four dominant themes that explained risky riding practices among commercial motorcyclists. The most frequently reported theme was economic pressure and income maximization, mentioned by 10 of the 12 key informants, making it the dominant behavioral driver. Participants consistently described how pressure to meet daily income targets encouraged speeding, overloading, and prolonged riding hours. In the researcher's interpretation, this theme strongly reinforces the quantitative finding that behavior is shaped less by knowledge deficits and more by structural livelihood demands.Weak enforcement of helmet regulations emerged as the second most prominent theme, cited by 9 respondents, who noted that compliance often improved only in the visible presence of law enforcement officers. Helmet discomfort, poor helmet quality, and passenger resistance to helmet sharing were also recurrent themes. These findings demonstrate that the qualitative data were not isolated quotations but converged into systematic explanatory patterns that deepen understanding of the observed quantitative associations as shown in table 6

Table 6;Major Themes Emerging from KIIs

Theme	**Respondents mentioning**	**Illustrative quotes**
Economic pressures and income maximization	10	"Sometimes they carry two or even more people because they need the cash"
Weak enforcement of helmet laws	9	"Most riders only wear the helmets when they see traffic police"
Helmet discomfort and poor quality	8	"Helmets become too hot during the day and some are heavy"
Passenger resistance to helmet sharing	6	"Passengers often resist shared helmets over hygiene concerns"

DISCUSSION

This study set out to examine factors associated with head and neck injuries among commercial motorcyclists in Kisumu County, and the findings reveal a complex interaction between experience, behaviour, knowledge, and contextual realities.

Prevalence of Head and Neck Injuries

The study found a 5.9% lifetime self-reported prevalence of head and neck injuries among commercial motorcyclists in Kisumu County. This estimate appears substantially lower than the 42.5% proportion reported by Cholo et al. (2023) in a hospital-based setting. In the researcher's interpretation, this marked difference is primarily explained by methodological and definitional variations rather than a true lower burden of risk. The current study measured self-reported lifetime occurrence of head and neck injuries among active community-based riders, whereas the comparison study was facility-based and largely captured riders presenting with more severe injuries requiring medical attention. As such, the two estimates reflect different epidemiological constructs: community prevalence of recognized injuries versus hospital-based proportions of severe injury cases.The researcher further acknowledges that the relatively lower prevalence observed in this study may also reflect underreporting of minor injuries, recall limitations, and failure to seek formal care for less severe crashes, which are common among commercial motorcyclists. Therefore, the findings should not be interpreted as evidence of low risk, but rather as a reflection of reported and recognized lifetime injuries within an active riding population. Importantly, the qualitative findings strongly reinforced that motorcycle crashes and head injuries are perceived as common occupational occurrences, supporting the conclusion that head and neck injuries remain a significant occupational and public health concern in Kisumu County.

Determinants Of Head and Neck Injuries

Socio-demographic factors: The findings showed that most riders were young adults aged 25–34 years and predominantly male, confirming that boda boda riding in Kisumu County is largely undertaken by individuals in their economically productive years.There was no statistically significant association between age,and level of education with the occurrence of head and neck injuries.The findings also did not demonstrate a statistically significant association between gender and head and neck injuries. However, the researcher interprets this result cautiously because the sample was overwhelmingly male, with female riders comprising a very small proportion of respondents and reporting no injury events. This limited variability substantially reduced the statistical power to detect meaningful gender differences. Therefore, the absence of significance in this study should not be interpreted as evidence that gender has no influence on injury risk, but rather as a reflection of sample imbalance within the commercial motorcycling workforce.This finding contrasts with studies by Odero et al. (2018) and Ngugi et al. (2019), which reported higher vulnerability among younger riders, as well as the WHO (2021) global evidence that young male riders face elevated road injury risk.

Riders with more than six years of experience were significantly more likely to sustain injuries which contradicts conventional literature that associates injury risk with inexperience. This finding reflects cumulative exposure rather than skill deficiency. Riders who have spent longer in the occupation are more exposed to risk over time, increasing their likelihood of experiencing injuries. Additionally, prolonged engagement in riding may lead to risk normalization, complacency, or overconfidence, which could further increase vulnerability.This suggests that experience alone does not equate to safety, and long-term riders should be considered a priority group for targeted interventions, an area often overlooked in existing research.Further examination of stratum-specific injury rates showed a stepwise increase in injury prevalence across riding experience categories, suggesting a monotonic relationship between cumulative occupational exposure and injury occurrence. Although the >6 years category had a relatively small sample size, the increasing gradient across categories strengthens confidence that the observed effect reflects a true exposure-related risk pattern rather than instability from isolated cases.

Behavioural Factors : The findings demonstrated that helmet-wearing frequency was significantly associated with injury occurrence at bivariate level, where riders who never wore helmets were significantly more likely to sustain head and neck injuries compared to those who always wore helmetsThis finding is consistent with high-level global evidence showing that helmet use reduces the risk of head injury by approximately 69% and death

by 42% among motorcycle riders involved in crashes, as demonstrated in the Cochrane systematic review and reinforced by WHO road safety guidance. Other risky behaviors such as speeding, overtaking on the wrong side, carrying multiple passengers, mobile phone use, and riding under the influence were not statistically significant predictors, however,the descriptive and qualitative findings revealed that these practices were widespread.The lack of statistical significance may be attributable to self-report bias, underreporting due to social desirability, and the limitations of cross-sectional data in establishing temporal causality.The qualitative themes provided important contextual explanations for the quantitative findings. In particular, economic pressure emerged as the dominant driver of unsafe riding practices, suggesting that riders often prioritize daily income over safety compliance. The researcher interprets this as evidence that risky behavior is embedded within occupational and socioeconomic realities rather than merely individual attitudes. Similarly, observational findings indicating lower helmet compliance than self-reported responses suggest possible reporting bias, reinforcing the need for multi-method assessment approaches in future injury studies.

Knowledge and Attitude Factors : The study found high levels of knowledge regarding injury risks, helmet use, and traffic regulations. However, this knowledge was not significantly associated with injury occurrence.This highlights a critical knowledge–behaviour gap, where awareness does not translate into safer practices. This interpretation is supported by Glanz et al. (2015) and Chikere et al. (2020), who argue that awareness does not automatically translate into behavior change.This finding also supports behavioural theories such as the Health Belief Model, which emphasize that knowledge alone is insufficient to drive behaviour change without perceived barriers being addressed.Only one knowledge-related factor showed significant association; understanding the consequences of head and neck injuries. This likely reflects experiential learning, where riders who have previously sustained injuries or witnessed severe crashes become more aware of the consequences through lived experience.

attitude variables were not significantly associated with injury occurrence.This suggests that attitudes may be overridden by powerful contextual barriers, including the cost of quality helmets, discomfort during prolonged use, peer norms, passenger resistance, and inconsistent law enforcement.The qualitative findings strengthened this interpretation. Riders acknowledged the importance of helmets but cited heat, discomfort, poor helmet quality, and fear of losing passengers as major barriers to consistent use.

Study Limitations

This study had several limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to establish temporal or causal relationships between behavioral factors and head and neck injuries. As such, observed associations should be interpreted as correlational rather than causal.Second, the study relied largely on self-reported behavioral practices, including helmet use, speeding, and mobile phone use while riding, which may be affected by social desirability and recall bias. However, the inclusion of non-participant observation data helped to partially validate self-reported helmet use patterns.Third, the small number of injury cases within some subgroups, particularly riders with more than six years of experience and female riders, may have resulted in unstable estimates and wide confidence intervals in multivariate analysis. This is particularly relevant for the gender analysis, where the overwhelmingly male sample limited meaningful comparison.Fourth, the prevalence estimate reflects self-reported lifetime head and neck injuries among active riders and may underestimate the true burden due to underreporting of minor injuries or exclusion of riders who had already left the profession following severe crashes.Finally, while the qualitative component provided important contextual insights, the relatively small number of KIIs may limit transferability of some themes beyond the selected study sites. Despite these limitations, the mixed-methods design strengthened interpretation through triangulation of quantitative and qualitative evidence.

CONCLUSION

The study concludes that head and neck injuries among commercial motorcyclists in Kisumu County remain an important public health and occupational safety concern. While socio-demographic characteristics such as age and education did not demonstrate significant independent associations with injury occurrence, the gender findings should be interpreted cautiously due to the overwhelmingly male composition of the sample, which

limited meaningful comparison.The findings identify riding experience as the most important independent predictor of head and neck injuries, with riders who had more than six years of experience experiencing substantially higher odds of injury. This suggests that cumulative occupational exposure, risk normalization, and possible complacency over time may outweigh the protective effects of acquired riding skills.Although inconsistent helmet use was associated with injury occurrence at the bivariate level, this relationship did not remain statistically significant after adjustment for exposure-related factors, suggesting that helmet use may interact with broader contextual and occupational determinants rather than acting as an isolated predictor in this population.The study further demonstrates that knowledge of road safety measures alone is insufficient to translate into safer riding practices, particularly in the presence of economic pressure, weak enforcement, and behavioral risk normalization. These findings underscore the need for context-specific, behavior-focused, and enforcement-supported interventions that address both protective practices and the livelihood realities of commercial motorcyclists.

RECOMMENDATIONS

There is a need to strengthen the implementation and routine enforcement of Kenya's existing helmet laws while ensuring strict adherence to approved helmet quality standards through continuous monitoring and market regulation. However, the researcher notes that enforcement alone may not yield sustainable injury reduction unless the contextual barriers identified in this study are simultaneously addressed. Qualitative findings highlighted weak enforcement consistency, affordability challenges for quality helmets, passenger resistance to shared helmet use, and economic pressures that compel riders to prioritize income over safety compliance.Therefore, county and national road safety stakeholders should adopt a balanced enforcement-support approach that combines regulation with affordable access to standard helmets, rider incentives, and stakeholder engagement with boda boda associations. This would reduce the risk of punitive enforcement measures disproportionately affecting riders' livelihoods without improving actual safety outcomes.

Road safety interventions should shift from knowledge-based education alone to behavior change communication strategies that specifically address risk normalization, complacency among experienced riders, and the socioeconomic drivers of unsafe riding practices. The researcher recommends targeted behavior-focused interventions for riders with longer riding experience, given their significantly higher cumulative exposure risk.In addition, intervention programs should integrate livelihood-sensitive approaches such as collaboration with rider associations, stage-based peer champions, and locally acceptable helmet-sharing hygiene solutions to improve both rider and passenger compliance.

Future studies should employ longitudinal or cohort designs to establish causal pathways between riding behaviors and head and neck injuries. Further intervention-based research is needed to evaluate the effectiveness of helmet promotion strategies, enforcement models, and rider-centered behavior change interventions in reducing injury occurrence.The researcher further recommends studies exploring the psychosocial, structural, and economic determinants of risky riding behaviors, including livelihood insecurity, peer norms, enforcement corruption, and passenger-related barriers, to inform more sustainable and contextually responsive prevention strategies.

Declarations

This work is original,with all the used sources cited and referenced properly .

There were no conflicts of interest in this work.

Consent For Publication

Not Applicable

Availability of Data and Materials

The data generated and analyzed from this study are available from the corresponding author upon request.

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