

Assessment of Occupational Health Hazards and Safety Needs of Commercial Motorcyclists in, Uasin Gishu County, Kenya

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ABSTRACT

In Kenya, the commercial motorcycle (*boda boda*) industry is one of the largest informal sector employing over 2 million riders and is a source of livelihood to 5 million Kenyans. Unprecedented levels of youth unemployment in Uasin Gishu County have driven novice riders to venture into the *boda boda* business with minimal recourse of the occupational hazards and risks they will be exposed to. The objective of the study was to generate data on predominant occupational health hazards among commercial motorcyclists in Uasin Gishu County, Kenya. The study used a cross-sectional research design. A two-stage cluster sampling technique was used to select study participants to the desired sample size of 368. Qualitative and quantitative data was collected using questionnaires and the Hazard Identification, Risk Assessment and Control measures (HIRAC), tool. The data was analyzed using descriptive and inferential statistics. From the findings, psychosocial, physical and ergonomic hazards featured as the predominant occupational hazards among commercial riders in Uasin Gishu County. The results revealed that stress is a significant psychosocial health hazard affecting the wellbeing and safety of *boda boda* riders in the County. Additionally, the study established that the prolonged static sitting posture adopted by riders is a key ergonomic risk factor thus predisposes riders to the risk of developing work-related musculoskeletal disorders. This study recommends for interventions aimed at enhancing capacity and behavior change in the *boda boda* sector through refinement of the training curriculum, concerted sensitization on statutory requirements and strict enforcement of safety laws to enhance occupational safety in the *boda boda* industry during the 2nd UN Decade of Action for Road Safety 2021-2030.

Keywords: Occupational health, Hazards, Risk factor, Occupational safety, *Boda boda*

INTRODUCTION

Occupational hazards refer to long-term and short immediate risks associated with a specific work environment subsequently affecting the health and safety of workers and can be categorized as ergonomic stressors, physical, biological, psychosocial and chemical hazards (Mehrdad, 2020). Motorcyclists are among the most vulnerable road users (VRUs) globally, accounting for nearly a quarter of global road traffic mortality annually (WHO, 2018). In Kenya, the severe economic hardship in the country coupled with high rate of unemployment has necessitated continuous increase in the number of people riding commercial motor-cycles for their livelihood with minimal recourse of the occupational hazards and risks they will be exposed to. The increased popularity of *boda boda* as a mode of transport in Uasin Gishu County has resulted in escalating cases of occupational injuries and fatalities and has thus put an enormous burden on the health care sector.

Motorcyclists are often exposed to the following physical hazards excessive heat, deafening noise levels, vibrations, lacerations and cuts resulting from physical injuries (ILO, 2019). A study revealed that modern helmets sound attenuation properties are quite poor offering low frequency attenuation which is not effective considering that at 60 km/h the noise resulting from wind around the helmet is reported to be at about 90 dB(A) (McCombe, 2003). Subsequently, riders often experience hearing impairment due to prolonged exposure to

traffic noise prompting countries like US to make external structural modifications on aerodynamic features of helmets but it only resulted in a 5 dB gain (NHTSA, 2017). Prolonged exposure to Whole-Body Vibration (WBV) among commercial motorcyclists often results in lower back pain and shoulder stiffness. WBV is often as a factor of rider experience, speed levels, motor vehicle maintenance, weight of the rider, age of the motorcyclist and cushion seat design (Mehrdad, 2020).

Chemical hazards are risks resulting from exposure to chemicals in the work environment often resulting in acute toxicity, carcinogenicity, aspiration toxicity, skin corrosion and irritation, reproductive toxicity and eye effects. There is minimal emphasis and awareness of risks with regards to exposure to toxic chemicals in the *boda boda* industry. Motorcyclists are often exposed to chemical hazards like compressed gases, combustible liquids like diesel, organic peroxides and flammable products. In Brazil, a study by Boek *et al.* (2018) found that genetic damage and oxidative stress factors is significantly high among professional motorcyclists as an effect of exposure to NO₂ and O₃ and other trace elements ($p < 0.05$).

Psychosocial hazards are elements of the work environment which can impact on the mental health and well-being of a worker. Common psychosocial hazards in the *boda boda* industry include violence, stress, fatigue, aggression, bullying, harassment, job strain as an effect of long working hours and customer aggression (Haworth *et al.*, 2005). Prolonged exposure to work stressors often results in debilitating effects resulting in extensive “burnout” and subsequent health complications like psychological disorders, cardiovascular diseases, musculoskeletal disorders and ulcers. A study in Pakistan, revealed that psychosocial variables like work stressors, aggressive behavior and mood fluctuation exacerbates risky driving behavior among motorcyclists; 80 % of the patients admitted that their speed of driving fluctuated with emotional moods (Syeda *et al.*, 2019).

Biological hazards often result from exposure to biological elements posing a significant threat to the health and well-being of humans at the work place and include viruses, bacteria, infectious plant materials, stinging insects and other airborne pathogens. During the global COVID-19 pandemic, adhering to a 2-metre physical social distance emerged as a crucial safety guideline aimed at mitigating the spread of the virus. A study in Nairobi revealed that commercial motorcyclists believed that they were highly susceptible to Covid-19 and that the government should have availed free sanitizers and face masks to the riders (Kigatiira, 2020). Ergonomics refer to optimizing human safety and appropriate system interactions in the design of a tool or engineering of the work environment to eliminate discomfort and meet the needs of the worker. The seated posture adopted by motorcyclists is an important ergonomic risk factor often increasing the risk of musculoskeletal disorders. Varied brands of motorcycles used by commercial riders often impose awkward sitting postures resulting in significant body strain and the problem is compounded by long riding hours which exposes the riders to frequent postural damage and subsequent back pains (Kourouma, 2020).

Escalating cases of *boda boda* related accidents contributing to 40% of the fatal crashes in the country compelled the NTSA to stipulate stiffer penalties in 2017. These measures aim to streamline the industry by curbing reckless behaviours; Notably, strong emphasis is placed use of protective gears including helmets and reflective jackets (NTSA, 2020). The high prevalence of occupational injuries and adverse health complications make *boda boda* riding an inherently risky occupation. However, despite several studies on occupational hazards related to commercial motorcyclists, there is insufficient information on factors associated with psychosocial, biological, chemical and ergonomic hazards among *boda boda* riders in Kenya. Previous research by varied United Nations Road Safety Collaboration Partners during the Decade of Action for Road Safety (2011-2020) focused on exposure to physical hazards which is mainly related to environmental factors with minimal consideration to human and machine factors.

The scarcity of existing data on occupational health hazards and safety habits among commercial motorcyclists in Kenya necessitated a further look into the predominant hazards and causative factors influencing the occurrence of such hazards. The extensive hazard assessment of occupational hazards among *boda boda* riders in Uasin Gishu County-Kenya was inclusive of psychological determinants, psychosocial problems; substance abuse and design failure. The findings from this research provides additional insight to help researchers, authorities and policy makers figure out predominant occupational hazard among *boda boda* riders in Uasin Gishu County and appropriate target actions that should be adopted in order to caution the most VRUs categories (motorcyclists). The government of Kenya recognizes the *boda boda* informal sector as a significant labour

market and a critical enabler in achieving the Vision 2030 development blueprint. Understanding the aforementioned influences on rider intentions and behaviour may facilitate the refinement of training interventions and would inform proper policy formulation in the informal sector, which will in turn improve road safety performance during the 2nd UN Decade of Action for Road Safety (2021-2030).

1.1 Objective of the Study

To generate data on predominant occupational health hazards among commercial motorcyclists in Uasin Gishu County -Kenya.

1.2 Research Question

The study sought to answer the question: Which are the predominant occupational hazards among commercial motorcyclists in Uasin Gishu County -Kenya?

METHODOLOGY

2.1 Study Area

The study was carried out in Uasin Gishu County, located in the Rift Valley region and is one of the 47 counties in Kenya. The County hosts Eldoret town which is the largest administrative, commercial and population centre in the County and the fifth densely populated urban area in Kenya as per the 2019 census with a population of 475,716. The poverty rates and unemployment rates in the County are estimated to be at 38.2 % and 14.5% respectively (UNDP, 2017). Subsequently, the *boda boda* enterprise has become a popular source of informal self-employment among the youth significantly impacting rural-urban transportation in the region.

2.2 Research Design

The study adopted the use of a cross-sectional research design that involved describing the nature and characteristics of the demographic segment without manipulating the behavior of subjects and variables in the study. The design was relevant to the study since it had the potency to elicit a large amount of quantifiable data from the study population.

2.3 Target Population

The target population for this research were *boda boda* riders who charge a fee to ferry passengers in Uasin Gishu County-Kenya. Commercial motorcyclists were sampled from selected *boda boda* assembly points (clusters) within the County since it was impractical to compile an exhaustive list of *boda boda* riders given the riders level of mobility. The population of interest was inclusive of all age groups, gender, levels of income and accommodated diverse religious denominations.

2.4 Sampling Techniques and Sample Size

Sample size is the number of observation or replicate to include in the statistical population (sample unit drawn from sample frame). A multistage sampling technique was used to recruit the study participants. First, Uasin Gishu County was purposefully selected because of the significant increase in fatalities and injuries related to commercial motorcycle accidents in the region. Secondly, *boda boda* assembly points, herein called clusters in the County were selected at random. A total of 21 clusters (N) were chosen. Out of these, a Probability Proportional to Size cluster sampling technique was used to select the final study sample which comprised of 12 clusters(n). A simple random sampling technique was then used to select study participants from the 12 clusters using sample weight or proportion per cluster population. Individual *boda boda* riders who consented to the study were thus recruited until desired sample size of 368 was achieved.

2.5 Data Collection Tools

Data were collected using a face-to-face questionnaire. The questionnaire utilized both open and close ended questions in order to collect adequate qualitative and quantitative data on hazards and road safety issues among *boda boda* riders. The Hazard Identification, Risk Assessment and Control measures (HIRAC) was the standard

data collection tool that was used to identify predominant occupational hazards among *boda boda* riders. The HIRAC tool was vital in evaluating the risks arising from exposure to psychosocial factors, physical, chemical, biological and ergonomic hazards and appropriate risk rating taking into account the adequacy of any existing controls.

2.6 Ethical Consideration

Ethical approval was sought and obtained from Egerton University Institutional Scientific and Ethics Review Committee (EUISERC) (*Approval No. EUISERC/APP/216/2023*) under Division of research and Extension, before embarking on the study. Additionally, a research permit was obtained from the National Commission for Science Technology and Innovation (NACOSTI) (*License No: NACOSTI/P/23/23904*). Permission was also sought from *boda boda* Sacco leaders in Uasin Gishu County prior to commencing the study. Consent was obtained from each of the riders before the questionnaires were administered.

2.7 Data Analysis

Descriptive statistics such as frequencies, percentage and measures of central tendency were used to analyze quantitative data generated from the study. The findings were presented using frequency distribution tables, graphs, pie and bar charts to enhance visualization and data interpretation. The qualitative information obtained from the study was subjected to thematic analysis, which involved discovering, exploring, and reporting overarching ideas or concepts. For extensive analysis, the data collected was cleaned, coded and analyzed using Statistical Package for Social Sciences (SPSS) version 24.

RESULTS AND DISCUSSION

3.1. Socio-Demographic Characteristics of the Respondents

This section presents the socio-economic attributes of the respondents, and they include; age, gender, level of education, daily income and off days in a week.

3.1.1 Gender of the respondents

Majority of the riders in the study were male 348 (94.6%) with females accounting for only 5.4% of the respondents (table 3.1). The study findings largely concur with that of Okonda *et al.* (2015) where 98 % of the respondents in the study area were found to be male. This implies that the *boda boda* transport business is largely male-dominated. The reasons for the gender discrepancies found in this study is not known, however, it could be, as expounded by Mkutu and Mkutu (2019), due to the escalating incidences of accidents, violence, socio-cultural norms, increased morbidity and mortality, and, the demanding nature of the occupation.

Table 3.1: Gender distribution

Gender		N (%)	Cumulative Percent
Valid	Male	348 (94.6%)	94.6
	Female	20 (5.4%)	100.0
	Total	368 (100%)	

3.1.2 Age of the respondents

Figure 3.1 provides a visual presentation of the respondents' age. From the study results, majority of the riders (57.1 %) were from the age bracket of 18-35 years and only 6.3% were above 55 years. This is an indication that the commercial motorcycle industry is largely youth-driven. The findings are in line with Luchidio (2013) who found out that majority (71%) of the *boda boda* riders in Kakamega County were young aged between 18-35. This affirmed Amone (2021) who stated that the unprecedented levels of unemployment have driven youths to venture into the *boda-boda* business in a bid to improve their living standards.

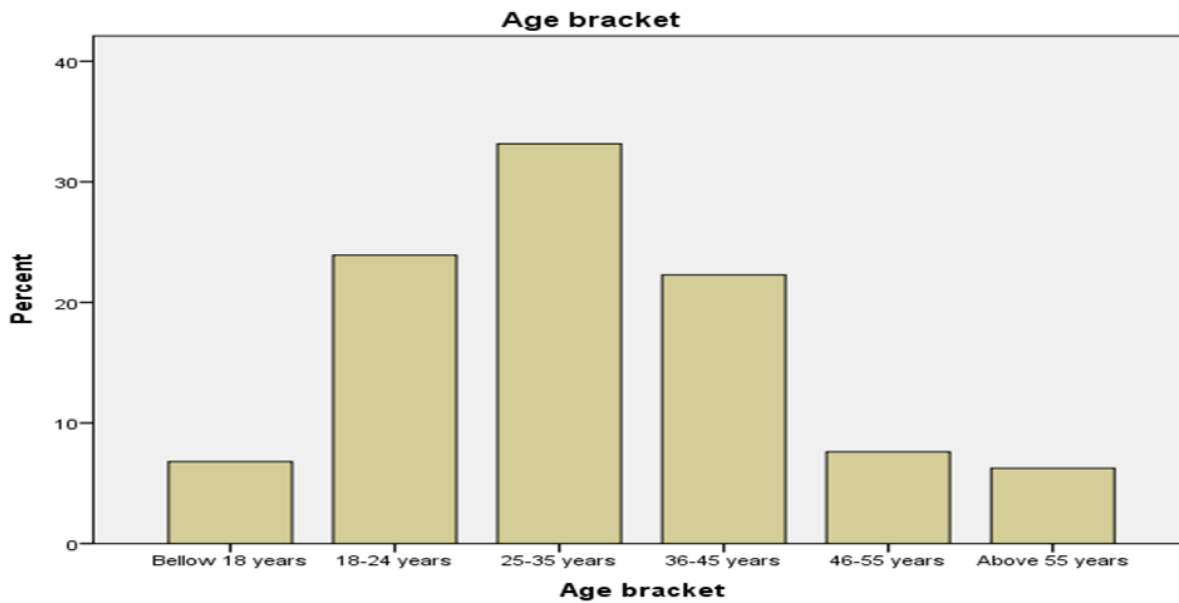


Figure 3.1: Age of the respondent

3.1.3 Respondents level of education

Previous studies have declared education a critical social factor to consider when examining factors that influence safety of commercial riders. This study examined literacy diversity of the riders. As shown in table 3.2, a greater number of the respondents (51.4%) had secondary education, 35.6% attained primary education and only 13% had tertiary education. Therefore, majority of riders in Uasin Gishu County have some form of formal education, however, very few are skilled crafts men. Previous research undertaken in Turkana County showed that the level of education of commercial riders has a positive and significant effect on behavior and adherence to road safety regulations (Okebiro *et al.*,2022). Additionally, educational levels of *boda boda* riders have also been correlated with high prevalence of traffic accidents (Nyachieo,2020).

Table 3.2: Education level of respondents

		N (%)	Cumulative Percent
Valid	Primary	131 (35.6%)	35.6
	Secondary	189 (51.4%)	87.0
	Tertiary education	48 (13.0%)	100.0
	Total	368 (100%)	

3.1.4 Income

In order to understand how sustainable, the *boda boda* industry is, respondents were asked to provide their average income per day. Majority of the respondents (41.3%) daily income ranges between KES 501-800, 32.6 % receive between 300-500 KES per day while 21.7 % earn between KES 801-1500 on average from daily operations as represented in table 3.3. The findings of this study clearly indicate that the *boda boda* industry is lucrative and is a source of livelihood for the local population, thus alleviating poverty levels in Uasin Gishu County. The income levels found in this study agrees with that of Gitonga (2014) which revealed that the average daily earning of commercial riders in Embu West Sub-County ranges from KES 300-800. A study by Car and General (2022), avers that the *boda boda* sector in Kenya is a key driver of the economy earning a rider about KES 1000 from 15 trips translating to KES 1Billion daily and KES 365 billion in a year for the 1 million riders working in the industry.

Table 3.3: Daily Income in KES

Response	N (%)	Cumulative Percent
0-300	16 (4.3%)	4.3
301-500	120 (32.6%)	37.0
501-800	152 (41.3%)	78.3
801-1000	67 (18.2%)	96.5
1001-1300	10 (2.7%)	99.2
1301-1500	3 (0.8%)	100.0
Total	368 (100%)	

3.1.5 Resting days for *boda boda* riders in Uasin Gishu County

Estimating the number of off-days in the *boda boda* industry which is classified as an informal sector is critical since overworking can lead to fatigue which can impair the cognitive performance of a rider and consequently increase the risk of a crash. The study revealed that majority of the riders (54 %) had only 1 off day in a week, 148 (40%) did not have any off day while 6 % took 2 off days in a week. These results concur with those of Senda (2023) who found that majority of riders (56.49 %) in Nakawa Division, Kampala work for 6 days in a week while 27.27 % operate daily. According to a report by the International Labor Organization, with regards to work duration and intensity, dependent self-employed persons usually experience worse work –time quality and intensity in comparison to all other categories of employment (Williams & Lapeyre, 2017). In accordance with the Employment Act (2007) which recommends for at least one or two off days per week to prevent burnout, a considerable portion of the riders in this study fall short of the recommended standards thus influencing safety outcomes.

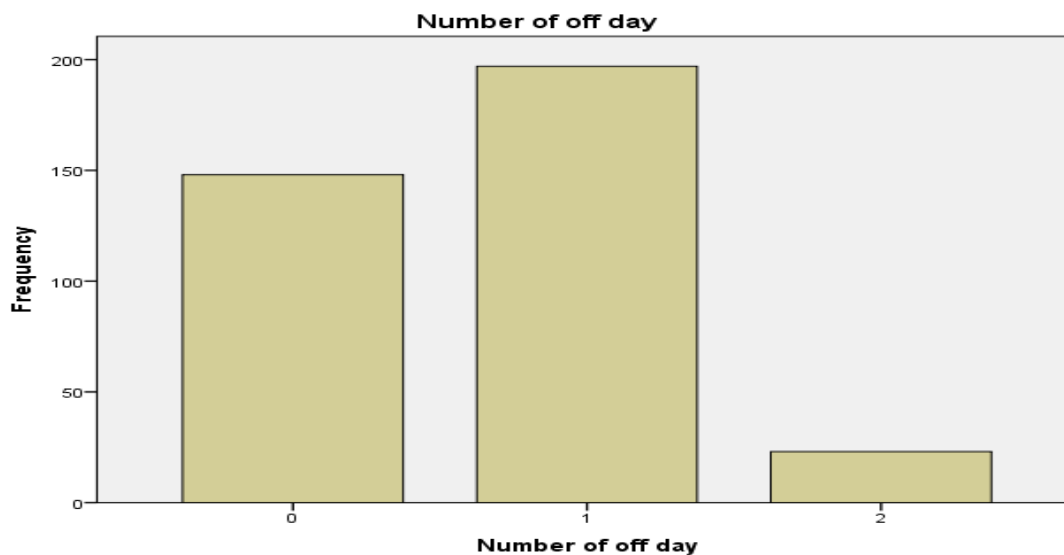


Figure 3.2: Number of off days in a week

3.2 Occupational Hazards in the Boda Boda Industry

The study sought to determine predominant occupational hazards among commercial motorcyclists in Uasin Gishu County-Kenya. Occupational hazards are essentially risks affiliated with working in a particular work environment and encompasses; physical hazards, chemical, biological, psychosocial hazards and ergonomic/machine risk factors (ILO,2019). This study examined rider’s vulnerability to hazards inherent in the *boda boda* industry and the associated occupational health risks.

3.2.1 Risk Rating of predominant occupational hazards in the *boda boda* industry.

The study utilized a Hazard Identification, Risk Assessment, and Control Measures (HIRAC) tool to determine the risk rating of occupational hazards in the *boda boda* industry. The likelihood to exposure was assessed using scales as (very likely, likely, unlikely and highly Unlikely) and the possible adverse consequence were scored as either (life threatening, detrimental, harmful and negligible). The risk rating for each hazard (high, medium or low) was thereafter determined using a risk matrix. A high risk rating implies that for a *boda boda* rider, the identified hazard, if not mitigated is likely to result in substantial injury or loss; a medium risk signifies that the recognized hazard is likely to cause the rider minor injury or loss while a low risk rating infers that without mitigation, the recognized hazard could potentially lead to harm, however, the risk to rider is not immediate. Figure 3.3 provides a visual presentation of the risk rating ranking across the five major categories of occupational hazards.

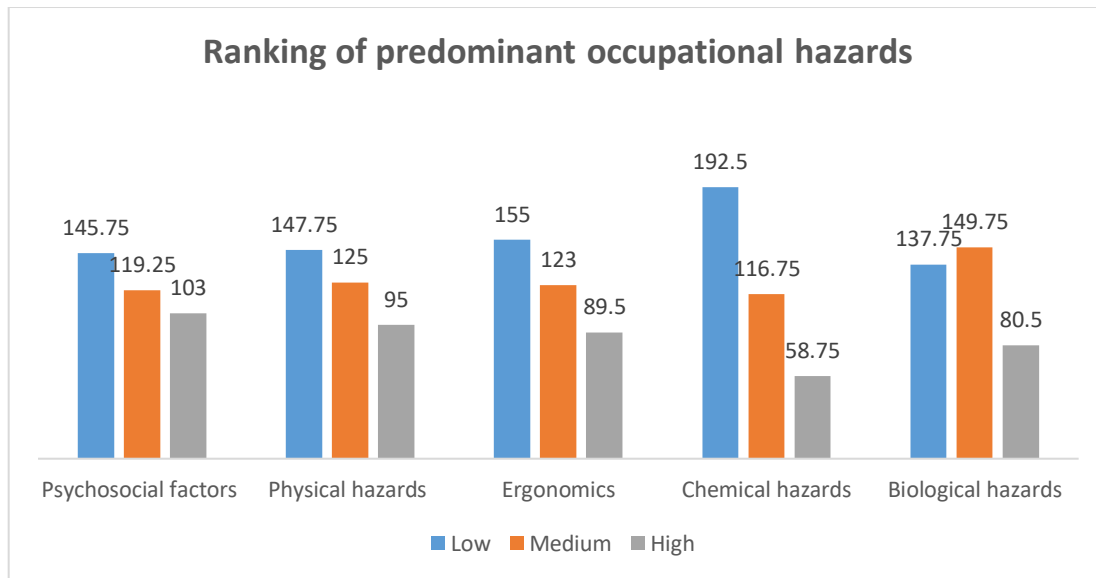


Figure 3.3: Ranking of predominant occupational hazards

From the study results, psychosocial factors emerged as the hazards with the highest risk rating with a frequency of 103; closely followed by the risk of exposure to physical and ergonomic hazards with a frequency of 95 and 89 respectively. The findings reveal that psychosocial, physical and ergonomic factors are predominant hazards impacting on the safety and occupational health of commercial riders in the study area. Of note is that chemical hazards had the lowest risk rating across the hazards with a frequency of 192, thus implying that concerns related to chemicals exposure are less prevalent within the *boda boda* industry.

Table 3.6: Risk Rating of predominant hazards in the *boda boda* Industry

HAZARDS		RISK RATING		
		Low N (%)	Medium N (%)	High N (%)
1. Psychosocial factors	Stress	73 (19.8%)	91 (24.7%)	204 (55.4%)
	Fatigue	151 (41%)	97 (26.4%)	120 (32.6%)
	Customer aggression	240 (65.2%)	109 (29.6%)	19 (5.2%)
	Violence	119 (32.3%)	180 (48.9%)	69 (18.8%)
2. Physical hazards	Excessive noise levels	238 (64.7%)	78 (21.2%)	52 (14.1%)
	Temperature extremes	79 (21.5%)	211 (57.3%)	78 (21.2%)
	Vibrations	211 (57.3%)	110 (29.9%)	47 (12.8%)

	Pot holes and slippery roads	64 (17.4%)	101 (27.4%)	203 (55.2%)
3. Ergonomics	Poor riding /Siting posture	37 (10.1%)	105 (28.5%)	225 (61.1%)
	Repetitive body movements	204 (55.4%)	131 (35.6%)	33 (9.0%)
	Body vibration	224 (60.9%)	105 (28.5%)	38 (10.3%)
	Visual discomfort/eye strain	155 (42.1%)	151 (41.0%)	62 (16.8%)
4. Chemical hazards	Carcinogens (Toxic fumes)	198 (53.8%)	125 (34.0%)	45 (12.2%)
	Irritants	98 (26.6%)	168 (45.7%)	102 (27.7%)
	Corrosives (brake fluids, diesel oil, oils)	265 (72.0%)	73 (19.8%)	30 (8.2%)
	Flammables (petrol and diesel spills)	209 (56.8%)	101 (27.4%)	58 (15.8%)
5. Biological hazards	Bacteria	148 (40.2%)	118 (32.1%)	102 (27.7%)
	Virus	98 (26.6%)	43 (11.7%)	227(61.7%)
	Parasites	147 (39.9%)	115 (31.3%)	106 (28.8%)
	Fungi	158 (42.9%)	139 (37.8%)	71 (19.3%)

3.3.2.1 Psychosocial hazards

With regards to exposure to psychosocial hazards, the research findings revealed that stress is a high risk factor in the *boda boda* industry (55.4%), customer aggression emerged as a low-risk concern while violence was identified as a medium psychosocial risk as outlined in table 3.6. This finding classifies stress as the most predominant psychosocial hazard affecting the well-being of *boda boda* riders in the County. A study by Senda (2023) found that majority (84.14 %) of *boda boda* riders in Kampala had severe distress, 13.92 % had middling distress and intriguingly only 19.4 % of the respondents in the study were psychologically well. Riding related stressors are mainly triggered by environmental and personal factors and usually brings about anxiety, affects attention, active memory and further impairs cognitive neuroscience of a rider.

The aggregated low risk rating of fatigue found in this study differs significantly with the findings of a study conducted in India which found that the incidence of fatigue was significantly higher ($p < 0.05$) among commercial riders than drivers of other transport modes as an effect of non-uniform distribution of seat pressure and prolonged static sitting posture (Balasubramanian & Mani, 2014). The reasons for this discrepancy are currently unclear but differences in cultural and physical constitutions between Africans and Indians may explain the different findings. Additionally, the low risk rating of motorcycling mental and physical fatigue in this study may be attributed to rider biological factors such as age and health which influences physical and cognitive effort and subsequent fatigue levels. In Benin, Ghana, a study by Ahanhanzo *et al.* (2023) revealed a high prevalence of fatigue among motorized two –wheeler riders aged above 50 years, with a significant difference among riders aged below 30 years (14.29 % vs. 9.00 %, $p < 0.05$).

3.3.2.2 Physical hazards

On exposure to physical hazards, the findings in table 3.6 highlight potholes and slippery roads as high risk (55.2%) environmental elements within the occupation. Notably, temperature extreme is classified as a medium-risk concern while excessive noise and vibrations are rated as low risks physical hazards. This implies that poor road infrastructure in the County poses a vital occupational risk amongst *boda boda* riders. The findings are in line with Muguro *et al.* (2022) who found out that infrastructure development is not commensurate with motorization in Kenya as witnessed in unmarked bumps, lack of signage, malfunctioned traffic lights, poor road markings and lack of designated riding and cycling lanes thus posing a risk hazard.

The categorization of temperature extremes as a medium risk factor in the *boda boda* work setting denotes that there is a considerably elevated risk of exposure to extreme weather elements among commercial riders in the study area. A study conducted by Shabani and Mamuya (2020) found that commercial motorcyclists often operate in environments characterized by dusty roads and cold weather, heightening their susceptibility to health issues such as asthma, fever, chest pain, acute flu, pneumonia and respiratory diseases which is detrimental to their well-being. Additionally, weather elements have been recognized as risk factors for fatal motorcycle accidents. As outlined in a study by Hsu (2024), exposure to higher temperatures among motorcyclists is associated with increased risks of road traffic accidents as an effect of physiological response to heat stress resulting in fatigue, impaired cognitive function and elevated stress levels (95%CI: 1,041, 1.092).

3.3.2.3 Ergonomic hazards.

In regards to Ergonomic hazards, the study findings illuminate the static riding posture of *boda boda* riders as a substantial high risk factor (61.1%). It is thus deduced that the seated posture adopted by *boda boda* riders is a key ergonomic risk factor often predisposing riders to the risk of musculoskeletal disorders. More often than not, *boda boda* riders are exposed to whole-body vibration, cumbersome sitting posture, long riding time, routine muscular effort and seat discomfort as an effect of their workspace thus exposing riders to the risk of developing work-related musculoskeletal disorders (Jaiyesimi *et al.*, 2018). A similar study in Malaysia reported a high prevalence (82.3 %) of lower back pain among occupational motorcyclists in the country (Isa *et al.*, 2011)

Conversely, from the study findings, repetitive body movements and whole body vibration are rated as low risk factors within the *boda boda* work environment (table 3.6). This finding contradicts results reported by Chen *et al.* (2009) who found that more than 90% of the motorcycle riders in the study had a distinctively higher vibration dose value ($VDV_{(8)}$) (mean $23.5 \text{ m/s}^{1.75}$) exceeding the recommended ISO 2631-1 health guidance caution of ($17 \text{ m/s}^{1.75}$). The study therefore infers that there is limited knowledge on the adverse health impacts of whole-body vibration (WBV) exposure among commercial motorcyclists in the country. Previous studies have reported muscular fatigue, discomfort, lower back pain, vestibular and visual disturbances, musculoskeletal issues and impaired nervous system function as health effects of WBV exposure (Roseiro *et al.*, 2016, Moreno *et al.*, 2012, Ndimila *et al.*, 2015). According to Shivakumara and Sridhar (2010) the magnitude of exposure to WBV is dependent on ergonomic features of the motorcycle, age of the automobile, motorcycle specifications, sitting posture and age of the rider.

3.3.2.4 Chemical hazards

In the evaluation of predominant chemical hazards associated with commercial riding, insights from table 3.6 revealed that carcinogens, corrosives and flammables were collectively classified as low risks hazards with the risk associated with exposure to irritants categorized as moderate (45.7%). This implies that majority of *boda boda* industry sector players are oblivious to the risks associated with exposure to toxic chemicals in their work environment predisposing them to health problems like respiratory, skin and neurological disorders. Long-term occupational exposure to road traffic pollutants such as carbon monoxide, ground level ozone were reported to be statistically higher ($p < 0.05$) among professional motorcyclists in Porto Alegre, Brazil with O_3 levels showing a strong positive correlation with plasmatic lipid peroxidation ($(p < 0.001, 0.8995)$) (Carvalho *et al.*, 2018).

According to Gromadzińska and Wąsowicz (2019) riders in the transport industry are exposed to hazardous chemicals as an effect of incomplete combustion of fuels, fuel evaporation and motorcycle emissions which constitute a variety of chemical compositions; Polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and heavy metals. Research conducted in Hanoi, Vietnam on exposure to traffic pollutants revealed that motorcyclist had a mean black carbon concentration of $29.4 \mu\text{g}/\text{m}^3$ compared to $10.1 \mu\text{g}/\text{m}^3$ for bus passengers (Quang *et al.*, 2021). Consequently, commercial riders face heightened levels of long-term black carbon exposure, potentially increasing their vulnerability to cardiovascular diseases and respiratory mortality.

3.3.2.5 Biological Hazards

The findings on biological hazards highlight a significantly elevated risk (61.7 %) associated with exposure to viruses in the commercial riding setting while exposure to bacteria, parasites and fungi consistently received a

low risk rating. The high risk rating in relation to exposure to viruses can be attributed to the coronavirus (COVID-19) pandemic which posed a great health threat to riders in the *boda boda* industry. This reflection does not differ from findings reported in South-South Nigeria which pointed out that COVID-19 added another risk dimension to commercial riding as an effect of the operational setting of motorcycles which gave no room for social distancing (Avwioro *et al.*, 2022). Additionally, *boda boda* riders often come into close contact with pillion passengers and are thus prone to viral diseases such as influenza (flu) which is highly contagious and may result in life-threatening health complications including pneumonia. One study conducted in Sagamu, Nigeria found that the prevalence of cough was higher among commercial motorcyclists compared to the non-motorcyclist's controls (71% vs 21%) and the differences were statistically significant (P-value <0.001) (Adefuye *et al.*, 2015).

Boda boda operators are also highly susceptible to communicable diseases such as HIV (human immunodeficiency virus) and Tuberculosis (TB). A study done in Mbarara Municipality, Uganda revealed that commercial riders in the region had a high HIV prevalence at 9.9 % which was higher than the national HIV prevalence level (5.7%) (Tumwebaze *et al.*, 2020). With regards to the risk of TB (a bacterial infection), a study conducted by Karanja *et al.*, (2023) in Nairobi discovered that the TB prevalence rate among *boda boda* riders in the metropolis was 1972 per 100,000 people, which is more than twice the national prevalence rate of 558 per 100,000 people. The high prevalence of exposure to TB among commercial riders is attributed to close contact to infected persons and active cases particularly during passenger transportation.

CONCLUSION

Psychosocial, physical and ergonomic hazards featured as the predominant occupational hazards impacting on the safety and health of commercial riders in Uasin Gishu County-Kenya. Stress is the most predominant psychosocial hazard affecting the well-being of *boda boda* riders in Uasin Gishu County. Poor road infrastructure is a major physical hazard for commercial riders in the region. The sitting posture adopted by *boda boda* riders is a key ergonomic hazard and a risk factor for work-related musculoskeletal disorders. *Boda boda* riding professions carry a higher risk of viral infection. Further, majority of commercial riders are oblivious to the risks associated with exposure to toxic chemicals in their work environment. The study recommends for an overhaul of the *boda boda* sector policies to encompass occupational hazards and existing laws on occupational safety. In addition, the informal sector should be institutionalized in order to safeguard *boda boda* riders against work-cycle risks and guarantee their social protection. The findings from this research provides additional insight to help researchers, authorities and policy makers figure out which occupational hazard is most rampant in Uasin Gishu County and appropriate target actions that should be adopted in order to caution the most VRUs categories (motorcyclists). Establishing a dynamic, vibrant and sustainable *boda boda* industry that is responsive to the transport and safety needs of all road users will accelerate economic and social growth in Kenya as envisioned in Vision 2030.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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