ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering | e–ISSN: 2067 – 3809
Tome XVII [2024] | Fascicule 1 [January – March]

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OPTIMIZING TRICYCLE WORKSTATIONS: A STUDY ON RIDER COMFORT AND ERGONOMIC SOLUTIONS

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Abstract: This study thoroughly examined the ergonomic challenges faced by tricycle riders, shedding light on the discomforts prevalent during tricycle usage. The research involved a population of 125 male tricycle riders. It investigated their daily routines, revealing that a significant portion spent up to 13hours daily on tricycles. Data collection methods included the Nordic Musculoskeletal Questionnaire and other surveys to assess musculoskeletal disorders and related risk factors. The analysis revealed that many riders experienced discomfort, including wrist, neck, shoulder, upper back, and lower back pain, attributed to factors like insufficient leg space, rigid steering, and inconvenient seating positions. The study proposed important design modifications, such as optimizing leg space, introducing a headrest, and enhancing seating comfort. It emphasized the need for regular ergonomic evaluations and collaboration with stakeholders, including manufacturers and policymakers, to enhance the tricycle riding experience for safety and satisfaction.

Keywords: Tricycle, riders, musculoskeletal disorders, comfort, discomfort

INTRODUCTION

Ergonomics involves studying how workers interact with their work environment, emphasizing the need for employees to be aware of potential risks within their workplace. These risks, including repetitive movements, static postures, heavy lifting, excessive force, and vibrations, can lead to severe outcomes like accidents or disabilities (Hyer et al., 2015). Ergonomics was defined as the designing of workplaces, products, and systems tailored to individuals, focusing on enhancing productivity, minimizing discomfort, and reducing work–related hazards (Zhenjing et al., 2022; Hembecker et al., 2012). Ergonomics aims to understand human capabilities and limitations to optimize the design of elements, ensuring efficiency, safety, and user satisfaction (Bubb, et al., 2021).

Tricycles, a versatile mode of transportation, have been integral to various aspects of daily life, from leisurely rides in parks to last–mile delivery services (Smith and Johnson, 2020). In recent years, tricycles have gained prominence as a sustainable and cost–effective solution for urban mobility and goods delivery (Anderson, 2018). As their utilization continues to expand, it becomes paramount to consider the well–being of tricycle riders who often spend extended periods operating these vehicles (Zhang and Wang, 2019).

This study delves into the optimization of tricycle workstations, focusing on two key aspects: rider comfort and ergonomic solutions (International Tricycle Manufacturers Association, 2021). Rider comfort is essential not only for improving the overall riding experience but also for minimizing the risk of musculoskeletal disorders associated with prolonged tricycle operation (OSHA, 2020). Ergonomic solutions play a pivotal role in enhancing rider performance and reducing physical strain, thereby increasing efficiency and safety.

The Department of Occupational Safety and Health (DOSH) in Malaysia strives to protect individuals in workplaces from occupational hazards, yet the number of reported accidents has been consistently rising (Kitzmann et al., 2012). Musculoskeletal Disorders (MSDs) are prevalent due to poor ergonomics awareness, leading to pain and discomfort in various body parts. Recognizing the importance of addressing ergonomics is vital to prevent and mitigate MSD risks (Fazi et al., 2017).

Evaluating ergonomics is crucial to identify risk factors and assess ergonomic risks. This article reviews two widely used methods: Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA). RULA focuses on upper limbs, evaluating factors like posture and movement to determine risk levels, while REBA assesses the entire body, considering multiple body regions to identify hazards and prioritize interventions (Hignett et al., 2022). Studies utilizing RULA and REBA have highlighted ergonomic risks in various industries. For instance, in the Indian Electronics Industry, workers faced medium to high

ergonomic risks, emphasizing the need for interventions (Singh et al., 2013).

Additionally, studies showed that improper tricycle designs in Nigeria led to discomfort and strain among riders. Addressing these design flaws, considering anthropometric data, can enhance rider comfort and prevent musculoskeletal disorders (Okunribido et al., 2007). Awareness about ergonomics, implementing effective assessment methods like RULA and REBA, and prioritizing ergonomic design are essential steps toward creating safer and healthier workplaces for employees. In this study, we explored the various dimensions of this topic. This includes an analysis of the existing ergonomic challenges faced by tricycle riders, a review of innovative solutions implemented in the industry, and an evaluation of their impact on rider comfort.

Furthermore, this study also shed light on the potential benefits of optimizing tricycle workstations, such as increased rider satisfaction, higher productivity, and reduced operational costs (Zhang and Wang, 2019). By enhancing rider comfort and implementing ergonomic solutions in tricycle workstations, not only can we improve the quality of life for tricycle operators, but we can also contribute to the broader goals of sustainable and efficient urban transportation. This research also provides valuable insights for manufacturers, policy makers, and anyone interested in the multifaceted world of tricycles.

RESEARCH METHODOLOGY

This study employed a descriptive research design, utilizing surveys to describe ergonomic evaluation and musculoskeletal disorder prevalence among tricycle riders in Ifo, Ogun State.

The study was conducted in Ifo Local Government Area, Ogun State, Southwestern Nigeria, and involved 125 male tricycle riders. Data collection methods included the Nordic Musculoskeletal Questionnaire and other surveys, interviews, and observations. Statistical analysis included descriptive measures, such as frequency counts and percentage distribution, to summarize the data.

SPSS was used to analyze rider responses, anthropometric measurements, and seat pressure mapping data, offering insights into seat design shortcomings in terms of ergonomics.

RESULTS AND DISCUSSION

This section presents quantitative outcomes from the study, analyzing data obtained from the questionnaire. The questionnaire focused on participants' riding habits, comfort levels, discomfort points regarding the tricycle seat, and existing musculoskeletal issues exacerbated by prolonged sitting.

Out of 130 riders involved, 125 (83.3%) completed the questionnaire, providing valuable insights. Participants confirmed their use of tricycles for transportation for a minimum of three years. Socio–demographic information is detailed in Table 1, outlining the percentage of participants' responses.

Table 1. Socio–Demographic Information

S/N	Items	Options	Frequency	Percent (%)
1.	Age	20–30 years	29	23.2
		31–40 years	58	46.4
		41–50 years	21	16.8
		More than 50 years	17	13.6
2	Marital status	Single	29	23.2
		Married	88	70.4
		Divorced	8	6.4
3	Religion	Christianity	62	49.6
		Muslim	50	40.0
		Traditional	13	10.4
4	Ethnic group	Yoruba	108	86.4
		Igbo	17	13.6
5	Level of Education	Primary	38	30.4
		Secondary	71	56.8
		Tertiary	16	12.8

Table 1 provides an overview of the socio–demographic characteristics of the respondents. Age distribution shows that 29 participants (23.2%) fall in the 20–30 years age group, 58 riders (46.4%) are in the 31–40 years age category, 21 respondents (16.8%) belong to the 41–50 years age group, and 17 riders (13.6%) are 51 years old or above. Regarding marital status, the majority, 70.4% (88), are married, while 23.2% are single, and eight respondents (6.4%) reported being divorced.

In terms of religion, the majority of respondents (49.6%) identified as Christians, 40% (50) as Muslims, and 10.4% (13) as traditionalists practicing various beliefs. Ethnicity data shows that the majority, 86.4% (108), are from the Yoruba tribe, while 13.6% (17) belong to the Igbo tribe of Eastern Nigeria.

Education levels vary, with 30.4% (38) having primary or elementary education, 56.8% (71) having secondary school (post–primary education), and 12.8% (16) holding tertiary education qualifications.

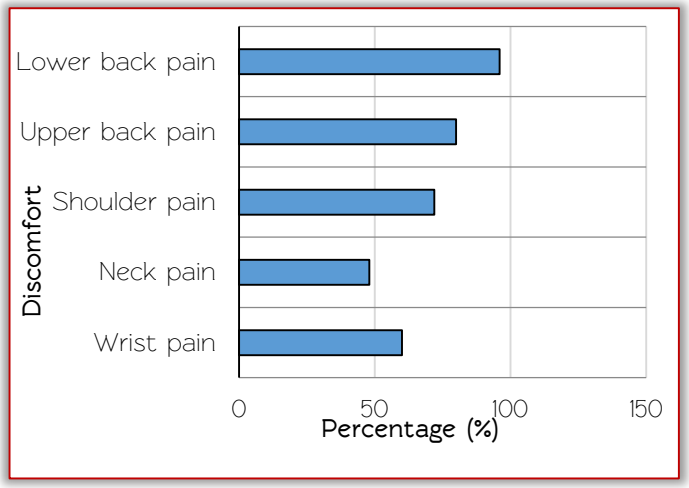

Figure 1: Discomfort level

Figure 1 presents the responses from the riders concerning their discomfort levels while using tricycles. The results indicate that: 60% (75) of the riders reported experiencing wrist pain, while 40% (50) did not have wrist pain. 48% (60) of the riders mentioned suffering from neck pain, with 52% (65) reporting no neck pain. In terms of shoulder pain, 72% (90) of the riders stated that they experienced it, while 28% (35) did not.

Furthermore, 80% (100) of the riders complained of upper back pain (UBP), while 20% (25) did not experience UBP. Additionally, 96% (120) of the riders reported lower back pain (LBP), with only 4% (5) of the riders not encountering LBP.

Table 2: Response of Riders Knowledge towards Riding of Tricycle

Questions	Hours	Frequency	Percentage (%)
How many hours per day do you spend riding the tricycle?	1–5 6–10 11–13	12 46 67	9.6 36.8 53.6
	Options	Frequency	Percentage (%)
Is the rider's seat convenient?	Yes No	54 71	43.2 56.8
Is the steering too rigid or flexible?	Rigid Flexible	71 54	56.8 43.2
Are you comfortable with the position of the side mirrors?	Yes No	125 000	100 0.00
Are you comfortable with the distance between your knee to the body frame of the tricycle while riding?	Yes No	58 67	46.7% 53.3%
How frequent do you change the tyres?	1 Year Six month	96 29	76.7% 23.3%
Would you sugest removing the manual start option?	Yes No	000 125	**0.00** 100%
Would you suggest an improvement on the manual start option?	Yes No	125 000	100% 0.00
Are you comfortable with the position of the handbrake?	Yes No	117 08	93.3% 6.7%
Do you carry beyond the no of passengers required?	Yes No	125 000	100% 0.00
Are you comfortable with the position of hand gear?	Yes No	125 000	100% 0.00

Table 2 provides an overview of the riders' tricycle usage patterns. It reveals that 9.6% (12) of riders use the tricycle for 5 hours daily, while 36.8% (46) use it for 10 hours daily. The majority, constituting 53.6% (67) utilizes the tricycle for 13 hours daily. Furthermore, the table presents the following findings based on the riders' responses: 43.2% (54) of riders find the seat convenient, while 56.8% (71) consider it inconvenient. 56.8% (71) of riders perceive the steering as rigid, contrasting with 43.2% (54) who find it flexible. All riders (100%) are comfortable with the side mirror positions. 46.7% (58) of riders find the distance between the knee and the tricycle workstation body frame comfortable, whereas 53.3% (67) find it inconvenient.

Regarding tire tyre replacement, 76.7% (96) of riders replace tricycle tyres yearly, while 23.3% (29) do so every six months. Every rider (100%) agrees that the manual start option should remain, with 100% of them suggesting improvements to it. Majority, 93.3% (117) of riders are comfortable with the handbrake position, while 6.7% (8) are not. All riders (100%) admit to carrying more passengers than the required number, and they are all comfortable with the hand gear position. Smith and Johnson (2020) conducted an extensive study on ergonomics in bicycles and tricycles, shedding light on the critical role of ergonomic design in enhancing rider performance and well–being. Their research emphasized the need for tailored solutions to address the specific requirements of tricycle riders.

Zhang and Wang (2019) contributed significantly to the understanding of rider comfort and ergonomics by focusing on last–mile delivery tricycles. Their study underscored the impact of workstation design on rider satisfaction and safety. It highlighted that ergonomic improvements can lead to a reduction in musculoskeletal disorders and contribute to higher productivity in last–mile delivery operations.

In line with these findings, the International Tricycle Manufacturers Association (2021) has outlined guidelines for tricycle workstation optimization. These guidelines serve as a valuable resource for manufacturers and designers, emphasizing the importance of ergonomic considerations in tricycle design. They stress that incorporating ergonomic principles can lead to more comfortable and efficient tricycle workstations.

Anderson's work (2018) explored the broader context of sustainable urban mobility and the role of tricycles in modern cities. While not solely focused on ergonomics, it acknowledged the significance of tricycles as a sustainable transportation solution. This broader perspective highlights the relevance of optimizing tricycle workstations to promote sustainable urban mobility.

The study results indicate that tricycle workstations must be redesigned to enhance riders' comfort. Most participants experienced discomfort and inconvenience both while entering and riding the tricycle, supported by extensive surveys and data collection. Therefore, it's strongly recommended to modify the workstation and overall structure to improve rider comfort and convenience (Neil et al., 2015). A significant number of riders reported discomfort during tricycle rides, citing issues like hip/upper leg strains, neck pains, and knee/lower leg problems due to insufficient leg space and the lack of headrests (Adeyemi and Yusuf, 2019). Addressing these discomforts requires design modifications considering riders' anthropometric measurements, such as adjusting the distance between the knee and the tricycle workstation body frame and enhancing seating convenience. Incorporating headrests and optimizing leg space are crucial steps toward improving rider experience. Regular ergonomic evaluations, collaboration with stakeholders and implementing these modifications will lead to a more enjoyable riding experience for tricycle users.

CONCLUSION

The study's findings underscore the pressing need to enhance tricycle workstations to ensure rider comfort. A significant majority of participants reported experiencing discomfort during various phases of tricycle usage, including entry, exit, and while riding. These discomforts commonly included hip and upper leg strains, neck pains, and knee or lower leg discomfort, often attributed to inadequate leg space and the absence of headrests. Such discomfort significantly impacts the appeal of tricycles as a mode of transportation. Extensive surveys and empirical data corroborate these findings, emphasizing the urgent necessity for design and structural adjustments to enhance the overall tricycle experience.

The findings underscore the importance of addressing rider discomfort by considering key factors such as the distance between the knee and the tricycle workstation body frame, sitting height, and overall sitting convenience. By incorporating these factors into design modifications, the overall comfort and convenience of tricycle workstations can be significantly improved. The Occupational Safety and Health Administration (OSHA, 2020) has emphasized the importance of ergonomics in various workplaces, including those involving tricycle operation. Their research provides insights into the link between ergonomic practices and the reduction of musculoskeletal disorders, underlining the need for ergonomic solutions in the tricycle industry.

Based on the comprehensive study and data analysis, it is strongly recommended to implement the following modifications to tricycle workstations: Optimize leg space: Adjust the tricycle workstation to provide ample space for riders to comfortably adjust their legs. Consider varying the distance between the knee and the tricycle workstation body frame to accommodate different leg lengths, reducing strains and discomfort. Incorporate headrest facility: Include a headrest feature in the tricycle workstation design to alleviate neck pains. This addition will provide necessary support for the neck, enhancing rider comfort during the ride. Enhance seating convenience: Re–evaluate seating ergonomics, cushioning, and backrest support to minimize discomfort and promote a more comfortable seating position for riders.

This study recommends regular ergonomic evaluations and continuous assessment of the ergonomic conditions of tricycle rider workstations. This will involves continues data collection, surveys, and feedback from riders to identify emerging issues and areas for further improvement. Collaboration with stakeholders and work closely with tricycle manufacturers, policymakers, and relevant stakeholders to integrate the recommended modifications into the tricycle workstation design is also vital. This collaborative effort ensures effective implementation and tangible changes for tricycle riders. By implementing these recommendations, it is anticipated that tricycle rider workstations will undergo significant enhancements, leading to a more satisfactory and enjoyable riding experience for all riders.

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ISSN: 2067–3809