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**EXTENT OF MUSCULOSKELETAL AND
POSTURAL DISCOMFORT EXPERIENCED BY
THE AUTO RICKSHAW DRIVERS OF
VADODARA CITY**

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**EXTENT OF MUSCULOSKELETAL AND POSTURAL
DISCOMFORT EXPERIENCED BY THE AUTO RICKSHAW
DRIVERS OF VADODARA CITY**

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By

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Institutional Ethics
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FACULTY OF FAMILY AND COMMUNITY SCIENCES
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Ethical Compliance Certificate 2024-2025

This is to certify Ms. Rinusha Rajan study titled; "Extent of Musculoskeletal and Postural Discomfort Experienced by the Auto Rickshaw Drivers of Vadodara City." from Department of Family and Community Resource Management has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number IECHR/FCS/M.Sc./10/2024/19.

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CERTIFICATE

This is to certify that the thesis entitled "**EXTENT OF MUSCULOSKELETAL AND POSTURAL DISCOMFORT EXPERIENCED BY THE AUTO RICKSHAW DRIVERS OF THE VADODARA CITY**" submitted for partial fulfilment of the requirement for the degree of Masters in the Faculty of Family and Community Sciences (Family and Community Resource Management) to the Maharaja Sayajirao University of Baroda, carried out by Ms. Rinusha Rajan, is her original bonafide work.

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INTRODUCTION



CHAPTER I

INTRODUCTION

In the bustling streets of urban landscapes and the winding roads of suburban areas, Auto Rickshaw stands as universal symbol of convenient and affordable transportation for millions of people around the world. While these three-wheeled vehicles serve as lifelines for daily commuters by connecting them to their destinations with speed and agility. The Auto Rickshaw Drivers spend prolonged hours navigating through congested roads and constantly adjusting their posture to adapt to the demands of their dynamic environment (Kumar & Varghese, 2018). Despite such indispensable role played by the Auto Rickshaw Drivers in urban mobility, the set of challenges they face often go unnoticed (Harding et al., 2016).

According to Singh (2018), one of the critical aspects affecting their comfort and health is the design and ergonomics of the driver's seat, which has been associated with the development of Musculoskeletal and Postural Discomfort among this hardworking demographic. The driver's seat of an Auto Rickshaw is not merely a physical space for the operator; it is the cockpit from which they navigate congested streets, contend with unpredictable traffic, and ensure the safety and comfort of their passengers and it also influences the driver's comfort, well-being, and overall efficiency during long hours on the road (Islam et al., 2020).

The repetitive nature of their work, combined with poor seating ergonomics, is often characterized by a lack of proper lumbar support, inadequate cushioning, and limited adjustability, contributing to a heightened risk of developing prolonged discomfort and, over time, potential musculoskeletal issues encompassing conditions like lower back pain, neck stiffness, and joint problems (Gupta & Sharma, 2019). According to Mattu et al., (2021), the longer the years of driving experience the greater the chances of developing Musculoskeletal Discomfort. Moreover, the constant need to maintain a fixed driving posture further exacerbates the strain on their bodies, potentially leading to long-term health issues that not only affect the driver's quality of life but also have implications for public safety (Islam et al., 2020).

As the backbone of the city's transportation network, addressing the ergonomic challenges faced by the Auto Rickshaw Drivers is not only a matter of improving their working conditions but also essential for the overall well-being (Deoke et al., 2018).

1.1. The Auto Rickshaw Drivers: An Overview

The Auto Rickshaw Drivers, often the unsung heroes of urban transportation in many developing cities, navigate bustling city streets with skill and resilience. These drivers, settle on the front seat of their three-wheeled vehicles, possess an intimate knowledge of the roadways that wind through crowded markets and narrow lanes (Kumar & Verma, 2020). Beyond their driving skills, the Auto Rickshaw Drivers often serve as informal tour guides, sharing local insights and stories with passengers who become temporary companions on the journey (Singh, 2019).

The nature of their work requires adaptability, patience, and strong communication skills. The Auto Rickshaw Drivers interact with a diverse range of passengers throughout the day, from hurried office-goers to leisurely tourists (Patel et al., 2022). Additionally, a case study by Lalnunmawia et al., (2023) revealed that the Auto Rickshaw Drivers face the challenges of varying weather conditions, fluctuating fuel prices, traffic congestion, and competition with other drivers, making their job physically and mentally demanding and requiring long hours behind the wheel (Kumar & Das, 2020). The income they generate is typically tied to the number of passengers they transport and the distance travelled (Rao & Joshi, 2019).

Despite these challenges, their indispensable role in urban transportation makes them an integral part of the vibrant tapestry of city life and even any the Auto Rickshaw Drivers take pride in their ability to contribute to the accessibility of transportation in urban areas, playing a vital role in the daily lives of city dwellers (Badami et al., 2018).

1.2. Musculoskeletal Discomfort among the Auto Rickshaw Drivers

Musculoskeletal Discomfort (MSD) refers to pain, discomfort, or impairment in the muscles, bones, joints, tendons, ligaments, or other structures that support body movement (Afridi et al., 2024). It affects various body parts, including the lower back, neck, shoulders, wrists, hands, and lower legs, as evidenced by studies across different professions in India (Idrees et al., 2023).

Musculoskeletal Discomfort (MSD) is a significant occupational health concern among the Auto Rickshaw Drivers due to the nature of their work, which involves long hours of driving in a seated position, exposure to whole body vibrations, and poor ergonomic design of vehicles (Ali et al., 2023). Additional risk factors include adverse workstyle, intensive manual work, prolonged sitting, bending and twisting of the waist, repetitive movements, irregular meal intake, poor posture, and occupational stress (Asma et al., 2019). Moreover, lifestyle choices such as tobacco use, alcohol consumption, smoking and physical inactivity contribute to the high prevalence of Musculoskeletal Discomfort (V et al., 2019).

The multifactorial nature of Musculoskeletal Discomfort highlights the interplay between occupational and lifestyle factors affecting musculoskeletal health. Prevention and management strategies include ergonomic interventions, modifying work practices, promoting breaks, managing workloads, and adopting healthy lifestyles (Murugan et al., 2021).

1.3. Postural Discomfort among the Auto Rickshaw Drivers

Postural Discomfort among the Auto Rickshaw Drivers refers to the pain or discomfort experienced in various body parts due to sustained or awkward postures during their work. It is caused by positions that deviate from the neutral alignment of the body, leading to increased stress on musculoskeletal structures (Aghilinejad et al., 2016). According to Indra (2020) the nature of their work involves long hours of sitting in a confined space with limited movement, making them highly susceptible to Postural Discomfort. The human body is designed for movement, and when forced into static positions for extended durations, it can lead to muscle stiffness, joint pain, and overall discomfort (Waongenngarm et al., 2020).

The severity of discomfort can be influenced by several factors, including the duration and frequency of non-neutral postures, individual characteristics such as age and weight, and occupational factors like extended working hours (Azmi & Aziz, 2022). Economic pressures force many the Auto Rickshaw Drivers to prioritize earning over health, often working long hours without adequate breaks, further exacerbating their discomfort (Ojha, 2024). The lack of awareness about proper ergonomics and the absence of health initiatives contribute to a cycle of discomfort and potential long-term health issues (Suryavanshi et al., 2020).

Spending significant hours in sitting posture can result in discomfort in the neck, shoulders, and lower back, along with poor posture, muscle imbalances, and strain. Tension in the neck and shoulders can lead to headaches and stiffness, while inadequate lumbar support and a sedentary lifestyle may cause lower back pain and compromise the natural curve of the spine, resulting in stress on intervertebral discs and chronic pain (Choobineh et al., 2017). Beyond musculoskeletal concerns, prolonged sitting is linked to broader health issues such as a higher risk of cardiovascular problems, obesity, and metabolic syndrome, as it can impact blood circulation and lead to complications like swollen ankles and deep vein thrombosis (Kett et al., 2021).

1.4. Problems experienced by the Auto Rickshaw Drivers

The Auto Rickshaw Drivers often struggle with financial instability due to inconsistent daily earnings, substantial running expenses, and limited access to financial services. The unpredictable nature of their income makes it challenging to cover costs such as vehicle upkeep, fuel, and personal necessities. Moreover, the lack of social security benefits or insurance coverage further intensifies their financial insecurity (Lalnunmawia et al., 2023).

Beyond financial struggles, the Auto Rickshaw Drivers are exposed to various physical health risks, particularly Musculoskeletal Discomfort (MSD). Prolonged hours of sitting, coupled with continuous vibrations and jolts from uneven roads, contribute to lower back pain, wrist strain, and ankle pain. The frequent use of clutch and brake pedals can further aggravate these conditions, leading to long-term health implications if not addressed (Shrivastava et al., 2020; Kett et al., 2021).

In addition to physical health concerns, the Auto Rickshaw Drivers face broader health challenges. Irregular eating habits, limited access to nutritious food, and exposure to environmental pollutants negatively impact their overall well-being. Mental health issues such as stress, anxiety, and depression are also common, driven by demanding work conditions, financial pressures, and social stigma associated with their profession (Kaul et al., 2019).

1.5 Coping Strategies for the Auto Rickshaw Drivers

Auto rickshaw drivers may adopt various coping strategies to alleviate musculoskeletal and postural discomfort resulting from prolonged driving hours and poor ergonomics. These strategies can be categorized into physical, behavioral, and ergonomic interventions:

1.5.1 Physical Coping Strategies

Performing stretching exercises before and after work can help reduce muscle stiffness and improve flexibility (Sharma & Singh, 2019). Additionally, engaging in periodic breaks during driving shifts to stand, walk, and relieve postural strain is essential in minimizing discomfort. The use of self-massage techniques or over-the-counter pain relief balms can further aid in alleviating muscle pain, promoting better physical well-being.

1.5.2 Behavioral Coping Strategies

Regularly adjusting driving posture can help reduce prolonged strain on specific body parts, while practicing relaxation techniques such as deep breathing may assist in managing stress-induced muscle tension. Additionally, limiting excessive driving hours and maintaining a balanced work-rest schedule can prevent fatigue-related musculoskeletal issues (Verma et al., 2022).

1.5.3 Ergonomic Coping Strategies

Using seat cushions or lumbar support can enhance seating comfort and reduce lower back strain, while modifying seat positioning helps achieve better posture and minimizes pressure on the spine. Additionally, wearing wrist braces or padded gloves can help reduce discomfort from repetitive hand movements, thereby preventing strain-related injuries (Kumar & Sharma, 2021).

Despite these coping mechanisms, many auto rickshaw drivers continue to experience persistent discomfort due to the lack of awareness and accessibility to ergonomic solutions.

Justification of the Study

Vadodara, also known as Baroda, is a city in the Indian state of Gujarat that boasts a vibrant cultural heritage and a rapidly growing urban landscape. Auto Rickshaw serve as a vital mode of transportation, offering a convenient and affordable option for both locals and tourists. However, the demanding nature of this profession exposes the Auto Rickshaw Drivers to significant occupational hazards, particularly Musculoskeletal and Postural Discomfort. As key contributors to urban mobility, these drivers spend long hours on the road, facing ergonomic challenges that lead to discomfort, fatigue, and long-term health issues. This study aims to analyze the prevalence of Musculoskeletal and Postural discomfort among the Auto Rickshaw Drivers, identifying the specific anatomical areas affected and the factors contributing to their discomfort.

The review of literature highlighted that several studies were found within and outside India focusing on areas such as “Musculoskeletal Disorders Among the Auto Rickshaw Drivers: A cross-sectional study” by (Shaik et al., 2014), “Occupational Health Problems of the Auto Rickshaw Drivers: A study in metropolitan cities” by (Devi et al., 2022), “Occupational Characteristics and economic conditions of Auto Rickshaw Drivers” by (Lalnunmawia et al., 2023). Related studies on work-related Musculoskeletal Disorders/ Occupational Disorders have been investigated and reported for drivers of Truck, Bus and Taxi within and outside India. (Rathod et al., 2023; Lalit, 2015; Abledu et al., 2014; Yap et al., 2023; Fatima et al., 2020).

Similar studies were conducted in the Department of Family and Community Resource Management in the Faculty of Family and Community Sciences, focusing on various Occupational and Musculoskeletal Discomforts. For instance, “Extent of Discomfort Experienced Among Manual Wheelchair Users of Vadodara City” by (Joshi & Shah, 2014), and “Assessment of Musculoskeletal Discomforts Experienced by the Rose Farm Workers of Vadodara District” by (Mishra & Upadhyaya, 2020). Other studies include “Ergonomic Assessment of Cashiers at Checkout Counters of Selected Retail Stores in Vadodara City” by (Saraswat & Saikia, 2020), and “Assessment of Musculoskeletal Discomfort and Occupational Stress Among Banking Employees in Assam” by (Phukan et al., 2021). Additionally, “Musculoskeletal Pain and Postural Discomfort Experienced by the Marble Cutting Workers in the Marble Industry” was conducted by (Jaiswal & Veerkumar, 2020).

The Department of Family and Community Resource Management within the Faculty of Family and Community Sciences at The Maharaja Sayajirao University of Baroda offers advanced courses focusing on “Basics of Ergonomics” at the Bachelor’s level, and “Ergonomics in the Hospitality Industry” and “Ergonomics in Interiors” at the Master's level. This study aims to enrich the existing knowledge base and enhancing the curriculum's strength. Additionally, it seeks to provide valuable insights for students in Family and Community Resource Management into ergonomics, particularly concerning Musculoskeletal and Postural Discomfort, and work-related issues prevalent among the Auto Rickshaw Drivers due to prolonged sitting, repetitive tasks, and awkward postures.

The findings of this research are anticipated to make significant contributions not only to the field of Family and Community Resource Management but also to society as a whole by addressing ergonomic challenges faced by the Auto Rickshaw Drivers and offering potential solutions. The significance of this research lies not only in understanding the health implications for the Auto Rickshaw Drivers but also in proposing effective solutions. This present study seeks to identify modifications that can alleviate Musculoskeletal strain, enhance driving comfort, and ultimately improve the overall occupational environment for these drivers. The literature review indicated a dearth of research focusing on finding out the Extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city. Hence, this present study seeks to analyse Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city.

Statement of the problem

The present study aims to analyse the Extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city.

Objectives of the Study

1. To assess the Extent of Musculoskeletal Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city.
2. To assess the Extent of Postural Discomfort experienced by the respondents.
3. To design and develop an Ergonomic seat for reducing Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers

Hypotheses of the Study

1. The extent of Musculoskeletal Discomfort experienced by the respondents varies with their Personal Variables (Age in years and Body Mass Index) and Situational Variables (Duration of Driving per day and Driving experience in years).
2. The extent of Postural Discomfort experienced by the respondents varies with their Personal Variables (Age in years and Body Mass Index) and Situational Variables (Duration of Driving per day and Driving experience in years).
3. There exists a relationship between Extent of Musculoskeletal and Postural Discomfort experienced by the respondents.

Delimitations of the Study

1. The present study was limited to those Auto Rickshaw Drivers, who had driving experience of atleast 2 years.
2. The present research was limited to the Auto Rickshaw Drivers, who were not suffering from any chronic disease.
3. The present study was limited to the Auto Rickshaw Drivers of Vadodara city only.
4. The present study was limited to the CNG operated Auto Rickshaw Drivers of Vadodara city.

REVIEW OF LITERATURE



CHAPTER II

REVIEW OF LITERATURE

According to Snyder (2019), a literature review is a systematic way of collecting and synthesizing previous researches. The reviewed literature provides the basis to understand the importance of undertaking research in the chosen area to obtain knowledge on the methodology used in past researches and to identify the need for future research (Kothari, 2012). The main aim of the present research is to find out the extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city. The major areas of related literature, survey, scholarly articles, books and other sources relevant to particular issues, area of research, or theory, providing a description, summary and critical evolution of each work are presented here. In order to make the review clear and understanding, the present chapter is divided into the following section:

2.1 Theoretical Orientation

For the presentation the theoretical literature was divided into following three subheads namely:

2.1.1. Musculoskeletal Discomfort experienced by the Auto Rickshaw Drivers

2.1.2. Postural Discomfort experienced by the Auto Rickshaw Drivers

2.1.3. Types of Auto Rickshaws

2.1.4. Operational Mechanisms of the Auto Rickshaw

2.2 Empirical Studies

2.2.1. Researches conducted outside India

2.2.2. Researches conducted within India

2.3 Conclusion

2.1 Theoretical Orientation

Theoretical Orientation refers to the section that outlines the theoretical concepts relevant to the research topic. In this section, the theories related to the study are discussed individually in the subsequent descriptions.

2.1.1. Musculoskeletal Discomfort experienced by the Auto Rickshaw Drivers

Musculoskeletal Discomfort among the Auto Rickshaw Drivers is a significant concern, as indicated by studies investigating various aspects of their occupational health (Adhikari & Gupta, 2018). The prevalence of Musculoskeletal problems, particularly in the neck, shoulders, lower back, and wrists, is attributed to the overuse and inadequate support of muscles in these areas, often exacerbated by poor posture (Krishna et al., 2021). The neck and shoulders are especially vulnerable due to the constant turning and twisting required while navigating traffic, leading to strain and discomfort (Kett et al., 2021). The lower back endures considerable stress from prolonged sitting and vibrations caused by driving on uneven roads, which can result in chronic back pain and other related issues (Asma et al., 2019).

This issue is further exacerbated by the sedentary nature of their jobs, which require long hours of sitting in confined spaces with limited opportunities for movement (Lalnunmawia et al., 2023). This lifestyle contributes to obesity and related musculoskeletal strain. In contrast, the physical demands of operating an Auto Rickshaw, coupled with the need for constant vigilance in congested traffic, can lead to increased muscle activation and cervical spine loading, resulting in discomfort and pain (Krishna et al., 2021).

Musculoskeletal Discomfort can lead to various disorders, including:

- a. Chronic Lower Back Pain
- b. Neck and Shoulder Pain
- c. Repetitive Strain Injuries (RSIs)
- d. Sciatica
- e. Herniated Discs
- f. Degenerative Disc Disease

- g. Carpal Tunnel Syndrome
- h. Thoracic Outlet Syndrome
- i. Kyphosis
- j. Joint Pain and Arthritis
- k. Tendonitis
- l. Job Dissatisfaction and Mental Health Issues

Table 1: Types of Musculoskeletal Disorders

Sr. No.	Types of Disorder	Description	Visual Reference
1	Chronic Lower Back Pain	Persistent lower back pain caused by various factors such as disc issues and muscle strain ^[1] .	 <p>Plate 1: Chronic Lower Back Pain ^[2]</p>
2	Repetitive Strain Injuries (RSIs)	Conditions affecting tendons, muscles, or joints due to repetitive tasks or awkward positions ^[3] .	 <p>Plate 2: Repetitive Strain Injuries ^[4]</p>
3	Neck and Shoulder Pain	Pain in the neck and shoulders due to sprains and strains from sports, overexertion, or incorrect posture. ^[5] .	 <p>Plate 3: Neck and Shoulder Pain ^[6]</p>
4	Sciatica	Pain radiating along the sciatic nerve from the lower back to the legs due to nerve compression ^[7] .	 <p>Plate 4: Sciatica ^[8]</p>
5	Herniated Discs	An injury to the intervertebral disc between two vertebrae, usually caused by excessive strain or trauma to the spine. ^[9] .	 <p>Plate 5: Herniated Discs ^[10]</p>

Furthermore, the socio-economic status of the Auto Rickshaw Drivers often compels them to work under stressful conditions with insufficient healthcare support, which can exacerbate Musculoskeletal Discomfort (Lalnunmawia & Malsawmtluanga, 2023). The lack of job satisfaction and the high prevalence of job-related morbidity, including Musculoskeletal issues, highlight the broader socio-economic challenges faced by this population (Mukherjee & Das, 2022).

An overview of Musculoskeletal Discomfort among the Auto Rickshaw Drivers highlights a multifaceted issue influenced by the ergonomic challenges of their work, the physical demands of driving, and the socio-economic context in which they operate (Krishna et al., 2021). Addressing these discomforts requires a holistic approach that considers the driver's work environment, health behaviors, and access to healthcare services (Devi et al., 2021).

2.1.2. Postural Discomfort experienced by the Auto Rickshaw Drivers

The Auto Rickshaw Drivers are exposed to various occupational hazards, one of which is Postural Discomfort resulting from prolonged driving and the design of their vehicles. Research indicates that the neck, shoulders, lower back, and hips are the most commonly affected body parts during driving, with inadequate support and poor posture contributing to pain and discomfort in these areas (Krishna et al., 2021). The design of the Auto Rickshaw, which often lacks proper ergonomic seating, forces drivers into awkward positions for extended periods, leading to significant postural strain (Devi et al., 2021).

Postural Discomfort can lead to various disorders, including:

- a. Chronic Lower Back Pain
- b. Neck and Shoulder Pain
- c. Hip Flexor Tendonitis
- d. Pelvic Misalignment
- e. Spondylolisthesis
- f. Cervical Spondylosis
- g. Lumbar Spondylosis
- h. Thoracic Outlet Syndrome

The overuse of the muscles responsible for scapular orientation can lead to altered scapular alignment, particularly in drivers who experience neck pain (Krishna et al., 2021). This misalignment often results in a variety of disorders, including thoracic outlet syndrome, where the nerves and blood vessels between the collarbone and the first rib are compressed, causing pain in the shoulders and neck, as well as numbness in the fingers (Kett et al., 2021). Furthermore, prolonged poor posture can contribute to conditions such as herniated discs, sciatica, and chronic lower back pain, as the lumbar spine is continuously subjected to stress without adequate support (Azmi & Aziz, 2022).

The prevalence of Musculoskeletal Disorders among the Auto Rickshaw Drivers is exacerbated by factors such as prolonged working hours and the physical demands of manoeuvring the vehicle, which necessitates frequent twisting and turning movements (Adhikari & Gupta, 2018). The hips and lower back are particularly vulnerable due to the sustained seated position, often resulting in hip flexor tightness and pelvic misalignment, which can contribute to lower back pain and discomfort (Azmi & Aziz, 2022).

The existing literature indicates that the Auto Rickshaw Drivers are at significant risk of experiencing Postural Discomfort due to the ergonomics of their work environment. This discomfort arises not only from the physical design of the Auto Rickshaw but also from the prolonged hours spent in a seated position, which can lead to Musculoskeletal issues such as kyphosis (an excessive outward curvature of the spine, resulting in a hunched posture), cervical spondylosis, and lumbar spondylosis (age-related wear and tear affecting the spinal discs in the neck and lower back, respectively) (Devi et al., 2021).

Addressing these ergonomic challenges through enhancements in vehicle design, awareness programs, and health interventions could potentially alleviate the Postural Discomfort experienced by drivers (Adhikari & Gupta, 2018).

2.1.3. Types of Auto Rickshaws

Auto Rickshaws, a vital mode of transportation in many developing countries, particularly in South Asia, come in various types based on their engine configurations and operational mechanisms. Understanding these variations is essential for addressing the ergonomic and environmental challenges associated with their use. According to Rajan (2024), Auto Rickshaws can be broadly classified into three categories:

- a. Fuel-powered Auto Rickshaws
- b. CNG/LPG-powered Auto Rickshaws
- c. Electric (battery-operated) Auto Rickshaws

a. Fuel-powered Auto Rickshaws

Petrol-powered Auto Rickshaws are the most traditional and widespread. They are known for their ease of maintenance and accessibility (Ahmed & Khan, 2021). However, their environmental impact due to higher emissions has led to a decline in preference, especially in areas where greener alternatives are available (Gupta & Sharma, 2019).



Plate 11: Petrol - powered Auto Rickshaw ^[21]

Diesel powered Auto Rickshaws are appreciated for their superior fuel efficiency and durability. They are typically used in regions where long-distance travel is more common, as they offer better mileage (Gupta & Sharma, 2019). However, diesel engines are often criticized for their higher emissions of pollutants such as NO_x and particulate matter, making them less favourable in areas with stringent environmental regulations (World Health Organization, 2020).



Plate 12: Diesel - powered Auto Rickshaw ^[22]

b. CNG -powered Auto Rickshaw

Compressed Natural Gas (CNG) engines have become a popular alternative to petrol and diesel engines due to their reduced emissions and lower operating costs (Jain & Patel, 2020). CNG Auto Rickshaws are particularly beneficial in urban areas where air quality is a significant concern, as they contribute less to pollution (Sharma & Singh, 2018). The lower price of CNG compared to petrol and diesel has also made it an increasingly favoured choice for many operators (Indian Ministry of Petroleum and Natural Gas, 2021).



Plate 13: CNG - powered Auto Rickshaw ^[23]

c. Electric (battery-operated) Auto Rickshaw

Electric Auto Rickshaws are emerging as a leading eco-friendly transportation option, with rechargeable batteries that produce zero tailpipe emissions, making them ideal for reducing urban air pollution (Kumar & Verma, 2022). Their popularity is on the rise, particularly in cities where charging infrastructure is available and government incentives support the adoption of electric vehicles (Singh & Mehta, 2021). The transition to electric rickshaws is considered a critical step towards sustainable transportation in South Asia (International Energy Agency [IEA], 2020).



Plate 14: Electric Auto Rickshaw [24]

2.1.4. Operational Mechanisms of the Auto Rickshaw

The operational mechanism of an Auto Rickshaw encompasses the system and processes that enable the vehicle to function. This includes the engine's power transmission to the wheels, the control of speed and direction, and the management of acceleration and braking. It ensures the vehicle's efficiency and responsiveness during operation (Patel & Joshi, 2020).

According to Kumar & Desai (2019), Auto Rickshaws are classified based on their operational mechanisms into two categories:

1. Manual Transmission
2. Automatic Transmission

1. Manual Transmission

Traditional Auto Rickshaws typically use manual transmission systems, where the driver manually shifts gears using a lever and clutch, a system known for its reliability but also its potential to increase driver fatigue (Ahmed & Khan, 2021). Despite the rise of automatic alternatives, manual transmission vehicles remain widely used, particularly in regions where drivers are more familiar with traditional driving techniques (Gupta & Agarwal, 2020). Long hours of operation, especially in heavy traffic, can exacerbate fatigue, making manual systems less ideal for long-distance or high-frequency use (Sharma & Yadav, 2019).

2. Automatic Transmission

Modern advancements have introduced automatic transmission in auto rickshaws, significantly simplifying the driving process by eliminating manual gear shifting (Sharma & Patel, 2021). This feature helps reduce driver fatigue, particularly in stop-and-go urban traffic conditions, making

auto rickshaws more user-friendly (Kumar & Das, 2019). Although automatic transmission rickshaws are gaining popularity due to their convenience, they come with higher initial costs and maintenance requirements, which may affect their widespread adoption (Singh & Mehra, 2020).

2.2. Empirical Studies

2.2.1. Researches conducted outside India

Islam et al. (2014) investigated "Health Related Factors and Disability of the Auto Rickshaw Drivers" in Bangladesh through a descriptive cross-sectional study involving 220 drivers in Dhaka. It was conducted from January to December 2014. The study aimed to assess low back pain and disability levels among drivers. The data were collected via interview revealed that participant's ages ranged from 25 to 60 years, with a mean age of 34.95 years. The findings revealed that 62.7 per cent of drivers reported low back pain, with 75.4 per cent experiencing minimal disability and 24.6 per cent moderate disability, as measured by the Oswestry Disability Index. The factors significantly associated with low back pain included age, long working hours, improper sitting posture, long driving distances, and previous spinal conditions. Notably, sitting posture had a very strong association with low back pain ($p < 0.001$). The study concluded that drivers with proper sitting posture, comfortable seats, shorter working hours, and no spinal deformities had less frequent low back pain and related disabilities.

Ahmad et al. (2020) conducted a study on title "Prevalence of Musculoskeletal Disorders among Low to High Mileage Non- Occupational Car Drivers in city Faisalabad, Pakistan". The aim of the present study was to find out the musculoskeletal problems that could possibly arise among the common population of car drivers and among them the problem with the highest ratio, due to various contributing risk factors. A cross-sectional study was carried out in the city Faisalabad among non-occupational drivers, in which 192 drivers, including both males and females were enrolled with an age limit of 18 to 60 years. A Nordic musculoskeletal questionnaire was used to evaluate the pain in various areas of the body in non-occupational drivers.

The results showed that the most affected area was backache. There was 41 per cent back pain in the last twelve months and 38 per cent in the last seven days among non-occupational car drivers. The study concluded that low back pain was the highest to be discovered in the time period of the last 12 months and also in the last week as compared to other areas of the body.

Islam et al. (2020) conducted a study on the “Socio-demographic and Occupational Characteristics of Auto Rickshaw Drivers with Low Back Pain” in Dhaka, Bangladesh. Work-related musculoskeletal disorders, particularly low back pain, cause substantial economic losses to individuals and communities. This study aimed to determine the socio-demographic characteristics of autorickshaw drivers experiencing low back pain in Dhaka city. The study was conducted from January to December 2014 at various CNG stands and garages, the study included 220 drivers aged 25 and older. The study used descriptive, cross-sectional design, data were analyzed with SPSS version 19. The study found that 45.5 per cent of respondents were aged 31-40, 35.0 per cent were under 30, and 19.5 per cent were over 40. The level of education was limited, with 42.3 per cent only able to sign their name and 20.9 per cent completing primary education. The Income levels showed 48.2 per cent earned below 10,000 takas, and 47.7 per cent earned between 10,001 and 15,000 takas. The majority were married (92.3 per cent). Occupationally, 80.5 per cent of respondents found their seats comfortable and were satisfied with their job, while 19.5 per cent were dissatisfied due to risks, low income, or other reasons.

Tchounga et al. (2021) conducted a study on the "Prevalence of Musculoskeletal Disorders among Taxi Drivers in Yaoundé, Cameroon." This analytical cross-sectional study aimed to determine the prevalence of musculoskeletal disorders (Musculoskeletal disorders) among 151 adult male taxi drivers and identify associated factors for effective prevention strategies. Using non-probabilistic consecutive sampling, sociodemographic, anthropometric, and occupational data were collected. Musculoskeletal disorders over the past 12 months were assessed using the Nordic Questionnaire, while physical activity levels were measured with the WHO Global Physical Activity Questionnaire (GPAQ). Univariate and multivariate

logistic regression models were employed to determine factors associated with Musculoskeletal disorders. The results showed an overall MSD prevalence of 86.8 per cent, with the lower back (72.8 per cent), neck (42.4 per cent), and knees (29.1 per cent) being the most affected areas. Job dissatisfaction was significantly associated with Musculoskeletal disorders (OR = 2.1, 95 per cent CI = 1.1–3.9). Despite 62.9 per cent of drivers having a low physical activity level, no association was found between physical activity and Musculoskeletal disorders.

Rabal-Pelay et al. (2021) conducted a significant study on “Assessment of Spinal Range of Motion and Musculoskeletal Discomfort in Forklift Drivers. A Cross-Sectional Study” conducted in Jungheinrich, Hamburg, Germany. Forklifts are commonly used in industrial supply chains to transport heavy loads, and forklift drivers are at risk of developing Musculoskeletal Discomfort due to the movement patterns required at work. This research aimed to investigate the spinal range of motion (ROM) and Musculoskeletal Discomfort of forklift drivers and compare it with a control group. Forklift drivers (39 males) and office workers (31 males) were recruited to assess cervical, thoracic, and lumbar ROM with an electronic double inclinometer. Additionally, Musculoskeletal Discomfort was recorded using the Cornell Discomfort Musculoskeletal Questionnaire. The results revealed that forklift drivers exhibited higher cervical discomfort and greater ROM in lateral lumbar bending compared to office workers. Both groups reported lower ROM in cervical and lumbar lateral bending on the right side versus the left side. No differences in asymmetry were reported for any variable between groups.

Aliabadi et al. (2021) conducted a study titled “An investigation of Musculoskeletal Discomforts among mining truck drivers with respect to human vibration and awkward body posture using random forest algorithm” in Hamadan, Iran. The study investigated Musculoskeletal Discomforts among mining truck drivers, focusing on human vibration and awkward body posture using random forest algorithms. The study included 65 professional male mining truck drivers. Musculoskeletal Discomfort was assessed using the Cornell questionnaire, vibrations were measured with the Svanteck 106A

vibration meter, and body posture was analyzed using the Quick Exposure Check (QEC). The main mechanical and individual risk factors were used as predictor variables for the Musculoskeletal Discomfort model. The equivalent acceleration of whole-body vibration (WBV) exceeded the exposure limit, while hand-transmitted vibration (HTV) remained below the limit. Drivers' body postures ranged from moderate to high risk, indicating an urgent need for investigation and changes. The predictive error of the Random Forest model for Musculoskeletal Discomfort scores was acceptable, with a root mean square error (RMSE) of 5.29, compared to the regression model's RMSE of 15.92. The Random Forest model identified awkward body posture, vibration, and age as the most significant factors for Musculoskeletal Discomfort. These findings highlighted that the relative importance of risk factors, showing that awkward body posture has a greater effect than whole-body vibration.

Yirdaw and Adane (2022) conducted a cross-sectional community-based study on "Self-Reported Work-Related Musculoskeletal Problems among Three-Wheel Car Drivers in Debre Markos town, East Gojjam zone, Northwest Ethiopia." The study aimed to assess the prevalence of musculoskeletal disorders (MSDs) and identify associated risk factors among this group. Using structured questionnaires adapted from the Nordic Musculoskeletal Questionnaire, the study surveyed 422 drivers selected through stratified and random sampling methods. The results indicated a high 12-month prevalence of Musculoskeletal disorders (62.45% per cent), primarily manifested as back pain. The risk factors included lack of physical exercise, longer work experience, service site conditions, inadequate rest breaks, and uncomfortable sitting postures.

Oluseun et al. (2022) conducted a study on "Assessment of Musculoskeletal Discomfort among Mini-Bus Drivers in Osun State, Nigeria". There have been many reports on the physical factors that contributed to the development of work-related musculoskeletal disorders (WMSDs), which negatively affect the health of employees across various occupations, including bus drivers. This study focused on assessing musculoskeletal disorders among mini-bus drivers, popularly called "Korope," in Osun State, Nigeria. The

research was based on questionnaires extracted from the standard Nordic questionnaire for the assessment of musculoskeletal disorders (MSDs). The results obtained from the questionnaire showed that the lower back, knee, and ankle/foot were the most common areas of discomfort among the population. The elbow showed the least area of Musculoskeletal Discomfort, while the shoulder, upper back, neck, thigh/hips, and wrist/hands showed moderate discomfort. Some subjects experienced at least two of these discomforts.

Rasheed et al. (2023) conducted a descriptive study titled "Assessment of Musculoskeletal Disorders and Contributing Factors in Professional Drivers in Lahore, Punjab, Pakistan." This study aimed to assess the demographic, general, lifestyle, and wellness profiles of professional drivers in Lahore, focusing on musculoskeletal disorders (MSDs) and associated factors. The data were collected from 67 professional drivers at major bus stands in Lahore using a structured questionnaire. The study found that drivers were predominantly middle-aged (average age 39.72 years) and married (95.52 per cent), with limited formal education. The lifestyle assessments revealed high rates of smoking (61.19 per cent) and frequent consumption of soft drinks (88.06 per cent). In their work environment, a significant proportion of drivers worked daytime shifts (68.66 per cent) and reported exposure to whole-body vibrations (56.72 per cent). Musculoskeletal symptoms, particularly in the lower back (reported by 58.21 per cent in the past 12 months and 43.28 per cent in the past 7 days) and hips/thighs (61.19 per cent in the past 12 months), were prevalent and affected their ability to work effectively. The study concluded by emphasizing the critical need for targeted ergonomic interventions and lifestyle modifications to enhance the occupational health and safety of professional drivers in Lahore.

Chen et al. (2023) conducted a study on "Self-Reported Musculoskeletal Disorder Symptoms among Bus Drivers in the Taipei Metropolitan Area" in Taiwan, Indonesia. Bus driving was considered a highly stressful and unhealthy occupation, even among sedentary jobs, due to its particular task characteristics. This study used the Nordic Musculoskeletal Questionnaire (NMQ) to interview bus drivers and determine the risk factors for

Musculoskeletal Discomfort. The NMQ was distributed to 152 bus drivers in the Taipei metropolitan area (Taiwan), and valid data from 145 respondents were analysed. The survey revealed that the overall prevalence of musculoskeletal disorder symptoms in any body part during the preceding year was 78.3 per cent. The body parts with the highest prevalence of discomfort were the neck (46.9 per cent), right shoulder (40.0 per cent), lower back (37.2 per cent), and left shoulder (33.8 per cent). Stress and an uncomfortable seat were identified as contributors to neck, shoulder, and lower back discomfort. Stretching between trips might help reduce neck and shoulder discomfort. When comparing these results with similar studies, it was discovered that the prevalence of symptoms and detailed risk factors vary by country and region.

Khan et al. (2023) conducted a cross-sectional study titled "Frequency of Musculoskeletal Pain among Rickshaw Drivers of Rawalpindi, Pakistan." The study aimed to investigate the prevalence of musculoskeletal pain among rickshaw drivers, considering the significant postural stress associated with their occupation. The data were collected from 284 rickshaw drivers recruited from various stands and surrounding areas in Rawalpindi. The participants were aged 18 to 65 years, were surveyed using a self-structured questionnaire to assess the frequency of musculoskeletal pain. The key characteristics such as age, work experience, and weekly driving hours were recorded. Results indicated that 162 drivers (57 per cent) reported musculoskeletal pain, with the back being the most commonly affected area (64.81 per cent). Other reported pain sites included the knees (32.71 per cent), shoulders (30.68 per cent), ankles (18.51 per cent), neck (14.19 per cent), and elbows (3.70 per cent). Drivers with over ten years of experience and those driving more than 8 hours daily reported higher frequencies of musculoskeletal pain. The study concluded that musculoskeletal pain is prevalent among rickshaw drivers in Rawalpindi, with work experience and long driving hours being associated factors.

Liawdy et al. (2024) conducted a study on an "Analysis of Ergonomic Factor Measurement for Transjakarta Bus Drivers" in Jakarta, Indonesia. The

frequency of Transjakarta transportation accidents has been rising annually. These accidents can cause discomfort and decreased concentration for the drivers. To address this issue, a study was conducted to investigate the ergonomic factors affecting Transjakarta bus drivers. The study utilized the Rapid Upper Limb Assessment (RULA) method, analyzing data from 30 drivers, and the Nordic Body Map (NBM) method, which involved a questionnaire completed by 30 drivers. The RULA results indicated that the activity of reaching the steering wheel scored between 3 and 4, suggesting the need for further investigation and potential ergonomic improvements. The average time to reach the buttons was between 5 and 6, indicating an urgent need for examination and modifications. The NBM results revealed that many drivers experienced waist pain, highlighting the necessity of improving waist support and positioning. A correlation test was performed using Minitab software to analyze the relationship between reaching the steering wheel and reaching the buttons. The correlation coefficient was -0.209 with a P-value of 0.268, indicating a very weak inverse relationship. The study revealed that as the activity of reaching the steering wheel increases, the activity of reaching the buttons decreases slightly.

2.2.2. Researches conducted inside India

Agarwal et al. (2017) conducted a significant study on the "Prevalence and Risk Factors of Low Back Pain among the Auto Rickshaw Drivers in Urban Kolkata, India." The study aimed to determine the prevalence and risk factors of low back pain (LBP) among 500 randomly surveyed the Auto Rickshaw Drivers in Kolkata. For collecting the data, the Nordic Pain Questionnaire, 101 Numerical Pain Rating Scale, and Oswestry Disability Index were used. The study assessed low back pain (LBP) prevalence, pain intensity, and disability. The findings revealed that 12-month LBP prevalence of 79.8 per cent and a 7-day point prevalence of 36 per cent. The significant risk factors for LBP were age, BMI, driving posture, and vehicle vibration. Forward bent and twisted sitting postures (OWAS action level 2) were notably associated with LBP. The study concluded that the Auto Rickshaw Drivers were at high risk for LBP.

Mahadik et al. (2017) studied the "Health Status of the Auto Rickshaw Drivers in Vashi, Navi Mumbai, India." The cross-sectional study assessed the health, disease profile, and substance abuse among 159 the Auto Rickshaw Drivers. The data were collected through a detailed questionnaire and medical tests, the study found that 88.1 per cent of drivers reported health complaints, with Musculoskeletal pain (59.9 per cent), fatigue, acidity, and headaches being common. Additionally, 61.1 per cent had osteopenia, associated with age and years in the profession, and 59.7 per cent reported substance abuse. The study highlighted the high susceptibility of the Auto Rickshaw Drivers to various health issues, underscoring the need for regular monitoring and preventive measures.

Mohokar et al. (2018) conducted a significant study on the "Prevalence and Risk Factors of Musculoskeletal Impairments among the Auto Rickshaw Drivers" in a semi-urban area of central India. The study focused on the high risk of Musculoskeletal Disorders (MSDs) faced by the Auto Rickshaw Drivers due to poor road conditions, long working hours in bad postures, traffic congestion, and inadequate vehicle ergonomics. The data were collected using a cross-sectional design from 231 drivers who were registered with a local union, utilizing the Standardized Nordic Questionnaire and clinical examinations. The analysis with Chi-square tests revealed that shoulder (50.6 per cent), neck (42 per cent), and lower back (40.7 per cent) disorders were most common. The study revealed that significant associations were found between Musculoskeletal disorders and factors such as age, years of driving, vehicle age ($p < 0.001$), and BMI ($p < 0.01$), with longer driving years increasing MSD risk.

Aslam et al. (2019) conducted a significant study on the "Ergonomic Analysis of Driver Posture of an E - Rickshaw" in Faridabad, Haryana, India. The aim of paper was to identify the ergonomic risks associated with Indian e-rickshaws and implement necessary changes and improvements to develop a new design that is ergonomically beneficial for drivers. The ergonomic risk was calculated by analyzing the various postures assumed by the drivers using the Rapid Upper Limb Assessment (RULA) tool. A RULA score of 6

or higher indicated an immediate need for changes. To minimize ergonomic risk, modifications were suggested for the design of e-rickshaws. The RULA scores computed after making the suggested modifications to the model, generated using SolidWorks and inserting mannequins with H-CAD, showed a significant reduction in ergonomic risk. Although e-rickshaws are environment friendly, they pose safety hazards to human life and property due to their dimensional drawbacks. This analysis provided information on the various posture's drivers assume in e-rickshaws, which will be useful for manufacturers in their research and development efforts.

Singh et al. (2019) conducted a study on the “Musculoskeletal Disorders and Whole-Body Vibration Exposure among Auto-Rickshaw (Three Wheelers) Drivers: A Case Study in Northern India”. The three-wheelers (autorickshaws) are predominantly being used as a means of transportation goods in industries and local transportation in cities and suburban areas of northern India. The study aims to assess the whole-body vibration exposure and prevalence of musculoskeletal disorders among autorickshaw drivers. The study included four models of autorickshaws for the assessment of whole-body vibration. Exposure to different road conditions, the number of passengers boarded, and its association with musculoskeletal complaints. Whole-body vibration exposure was measured using the SVAN 106 tri-axial accelerometer and the SVANPC+. software. A comprehensive questionnaire was devised and used for the subjective assessment of Musculoskeletal complaints. The data were analysed using the analysis of variance and the Chi-Square test to check the variability and association. of whole-body vibration exposure and musculoskeletal disorders for all the models of autorickshaws. There is a significant dependency of the magnitude of whole-body vibration exposure on the road conditions and a number of passengers. Also, there was a significant influence (p value < 0.05) of whole-body vibration exposure due to driving experience and age of autorickshaw drivers on Musculoskeletal complaints, low back pain is found to be more prominent factor.

Suryavanshi et al. (2020) conducted a study titled "Ergonomic Risk Analysis of the Auto Rickshaw Drivers Using RULA and REBA" to assess the ergonomic risks and Musculoskeletal Disorders (MSD) associated with Indian the Auto Rickshaw Drivers. The study aimed to identify ergonomic risks during driving and propose modifications for designing an ergonomically improved auto-rickshaw. The research employed Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) to analyze driver's postures. The data were collected through interviews with 20 the Auto Rickshaw Drivers, focusing on their demographics, work history, and Musculoskeletal pain history. The results indicated a REBA score of 6-7, suggesting a medium risk of Musculoskeletal disorders, warranting further investigation and prompt ergonomic changes. The RULA assessment yielded scores of 5-6, indicating the need for immediate ergonomic interventions.

Patel and Kulkarni (2023) conducted a significant study on the "Work-Related Musculoskeletal Disorders in Occupational Taxi Drivers" in Mahabaleshwar. The study aimed to examine the prevalence of work-related musculoskeletal disorders (WRMDs) among taxi drivers, who are susceptible to these disorders due to prolonged posture, mechanical pressures, and long working hours. Previous research has linked poor posture, heavy workloads, and whole-body vibration to increased low back issues. This survey-based study included 100 taxi drivers, utilizing the Nordic Musculoskeletal Questionnaire (NMQ) to assess WRMDs. The results indicated that 87 per cent of the drivers experienced WRMDs, with 49 per cent reporting low back pain. Sustained postures over extended periods were found to frequently affect the low back, neck, knees, and wrist/hands, suggesting that these postures are significant risk factors for WRMDs in taxi drivers. The study concluded that occupational taxi drivers are at a higher risk of developing WRMDs, emphasizing the need for interventions to address these risk factors.

Kumar et al. (2023) conducted a study titled "Ergonomic Analysis of Factors Causing Musculoskeletal Disorders (MSD) in Heavy Vehicle Drivers" in Trivandrum, Thiruvananthapuram, Kerala, India. The study

focused on Musculoskeletal Disorders (MSDs) among bus drivers employed by a public transportation corporation in Kerala. A sample of 110 drivers was selected using purposive sampling, targeting those with extensive driving experience to ensure relevant data regarding occupational health risks. The data were collected through interview and the use of the Nordic Musculoskeletal Questionnaire (NMQ), which covered demographic information (age, weight, height, BMI), years of experience, working hours, and history of MSDs. The analysis revealed a high prevalence of MSDs, particularly in the neck, shoulders, upper back, and lower back, with age and years of experience being significant contributing factors. The study concluded that proper ergonomic interventions, including better seating design and adequate rest, could reduce the occurrence of MSDs in heavy vehicle drivers.

Chougule et al. (2024) conducted a study to assess the “Knowledge regarding musculoskeletal problems among auto drivers in selected areas of Pune city”. Auto drivers commonly experience musculoskeletal issues due to prolonged sitting, repetitive motions, and poor posture while driving, impacting their daily lives and livelihoods significantly. The research employed a non-experimental quantitative approach, targeting 200 auto drivers aged 18 to 70 years through non-probability sampling. The data were collected using a self-structured questionnaire. The questionnaire included demographic information and focused on assessing knowledge about musculoskeletal problems. The results indicated that 49 per cent of participants had poor knowledge, 39.5 per cent had average knowledge, and 11.5 per cent had good knowledge regarding musculoskeletal problems. The study concluded that the majority of auto drivers surveyed lacked adequate knowledge about these issues. This study underscores the importance of improving awareness and implementing interventions to enhance the health and well-being of auto drivers, potentially informing policies aimed at preventing or reducing musculoskeletal problems in this occupational group.

2.3 Conclusion

The studies reviewed reveal a significant prevalence of Musculoskeletal Discomfort among professional drivers, both in India and globally. These discomforts primarily affect the lower back, neck, and shoulders and are significantly influenced by various ergonomic and occupational factors.

Studies conducted outside India on the research topic primarily focused on the prevalence and causes of Musculoskeletal Discomfort among drivers. In Bangladesh and Pakistan, research indicated that low back pain was common among auto-rickshaw and car drivers, attributed to long working hours, poor posture, and vehicle vibration. In Cameroon, taxi drivers reported high rates of Musculoskeletal Discomfort, with job dissatisfaction identified as a significant contributing factor. Similarly, studies in Iran and Ethiopia highlighted the effects of awkward postures and inadequate ergonomic adjustments on musculoskeletal health. Research from Taiwan and Nigeria also confirmed elevated levels of discomfort among bus and mini-bus drivers, respectively, underscoring the necessity for ergonomic improvements and targeted interventions.

Studies conducted in India on the prevalence of Musculoskeletal Discomforts among the Auto Rickshaw Drivers indicate that the rates are notably high, with significant discomfort reported in the lower back, neck, and shoulders. Contributing factors include poor road conditions, long working hours, and inadequate vehicle ergonomics. The studies emphasize the necessity for ergonomic design improvements and health interventions to mitigate the risks associated with driving. Furthermore, the findings suggest that factors such as body posture, vehicle vibration, and the work environment play critical roles in influencing the prevalence of Musculoskeletal Discomforts.

Overall, evidence from both international and Indian studies highlights the urgent need for ergonomic interventions and preventive measures to address the high prevalence of Musculoskeletal Discomforts among professional drivers. Enhancing vehicle design, optimizing driving postures, and implementing regular health check-ups and awareness programs are essential steps to improve driver's health and reduce occupational risks.

Despite extensive research on Musculoskeletal Discomfort among professional drivers both in India and internationally, there is a notable dearth of studies specifically examining the extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers in Vadodara City. While existing studies have highlighted the prevalence of Musculoskeletal Discomfort among the Auto Rickshaw Drivers in other regions of India, particularly in metropolitan areas, the unique occupational challenges faced by drivers in Vadodara remain underexplored.

Consequently, the researcher aims to conduct a comprehensive investigation of the selected topic.

METHODOLOGY



CHAPTER III

METHODOLOGY

According to Kothari and Garg (2019), Research Methodology is a way to systematically solve the research problem, or it may be understood as a science of studying how research is done scientifically. This chapter outlines the research design, variables under study, sample size and sampling procedure, data collection tools, and operational definitions of key terms used in the study.

The present study aims to assess the Extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers and to provide solutions for the problems faced by the respondents. To achieve these objectives, a detailed plan and sequential procedure were followed, which are presented in this chapter under the following sub-headings:

3.1 Research Design

3.2 Variables and Conceptual framework under study

3.3 Operational Definitions

3.4 Locale of the Study

3.5 Unit of Inquiry

3.6 Sampling Size and Sampling Procedure

3.7 Selection, Development and Description of the tools

3.8 Data Collection

3.9 Data Analysis

3.10 Development and Design of an Ergonomic Solution for Auto Rickshaw Drivers

3.1. Research Design

A research design is an arrangement of condition for collection and analysis of the data in manner that aims to combine relevance to the research purpose with scientific procedures. Research design is the specification of method and procedure used for acquiring the information needed for the study (Kothari, 2012). According to Kothari and Garg, (2019), "Descriptive research studies are concerned with describing the characteristics of a particular individual, or of a Group". A descriptive approach was considered as a most suitable method to assess the extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city.

3.2. Variables

According to Kothari and Garg (2019), a concept which can take on different quantitative values is called a variable. For the present study, there were two sets of variables viz. Independent and Dependent variables.

3.2.1. Independent Variables

The variable that is antecedent to the dependent variable is termed as an independent variable (Kothari and Garg, 2019).

For the present study the independent variables were categorized under two subheads:

i. Personal Variables of the respondents:

Personal Variables of the respondents included Age (in years), and Body Mass Index (BMI).

ii. Situational Variables of the respondents:

Situational Variables of the respondents included Duration of Driving per day and Driving Experience (in years).

3.2.2. Dependent Variables

A variable that depends upon or is a consequence of the other variable is termed as dependent variable (Kothari and Garg, 2019). For the present study, dependent variables were:

- i. Extent of Musculoskeletal Discomfort experienced by the respondents.
- ii. Extent of Postural Discomfort experienced by the respondents.

3.2.3. Hypothetical Relationship between Variable:

A schematic diagram showing hypothetical relationship between selected variables with its explanation is presented below:

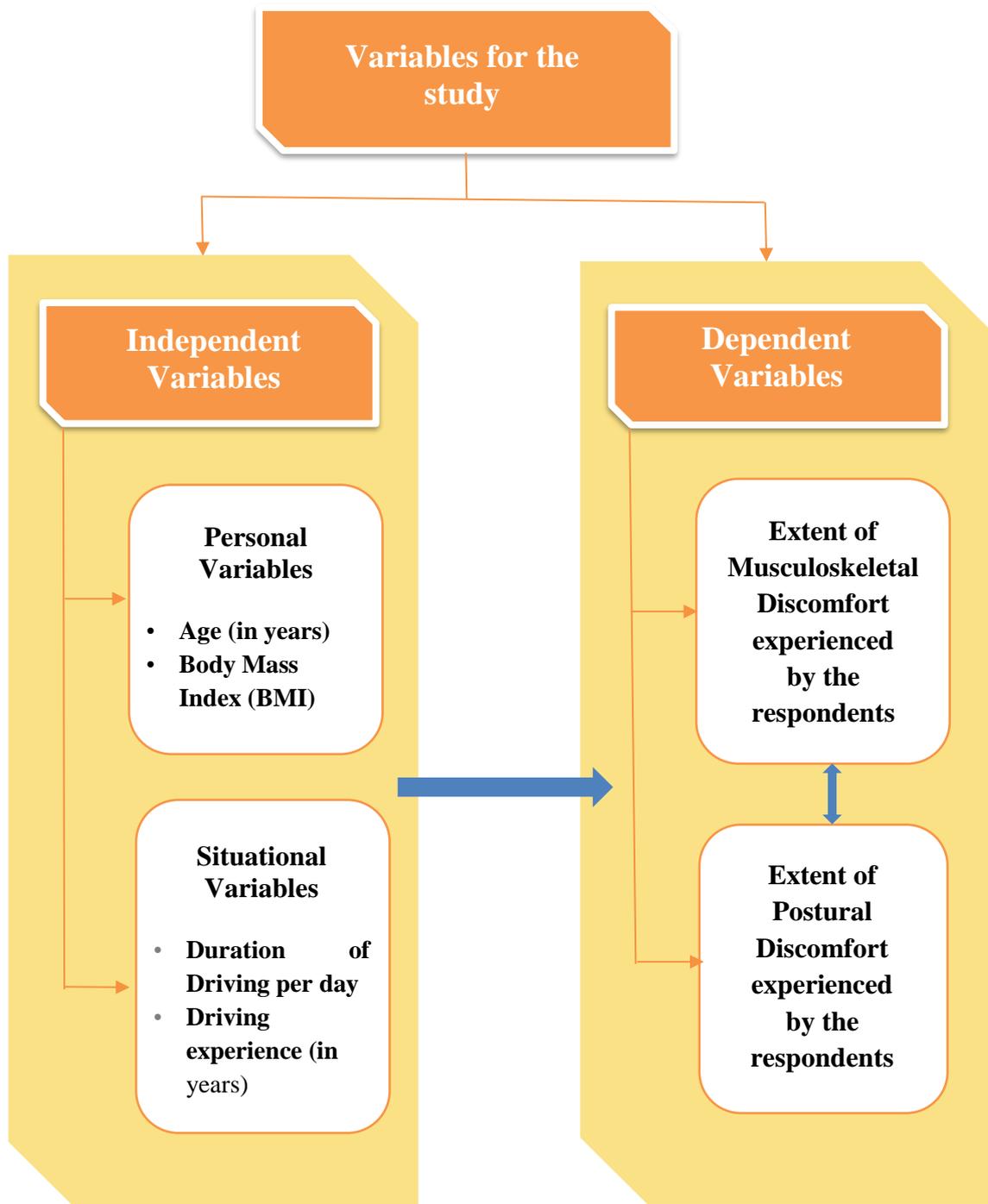


Figure 1: Schematic Framework showing the Hypothetical Relationship between the variables under the study

Explanation of Conceptual Framework

It was conceptualized that the Dependent variables viz. Extent of Musculoskeletal Discomfort experienced by the respondents varies with their Independent variables sub categorized as Personal Variables such as Age (in years) and Body Mass Index (BMI) and Situational variables such as Duration of Driving per day and Driving Experience (in years).

It was also theorized that the Extent of Musculoskeletal Discomfort experienced by the Auto Rickshaw Drivers directly influences the Extent of Postural Discomfort experienced by the respondents.

It was conceptualized that the Dependent variables viz. Extent of Postural Discomfort experienced by the respondents varies with their Independent variables sub categorized as Personal Variables such as Age (in years) and Body Mass Index (BMI) and Situational variables such as Duration of Driving per day and Driving Experience (in years).

3.3. Operational Definitions

The operational definitions thus formulated for the present research study are given below:

3.3.1. Auto Rickshaw Drivers: For the present study, Auto Rickshaw Drivers were operationally defined as individuals who operate CNG Auto Rickshaws.

3.3.2. Extent of Musculoskeletal Discomfort experienced by the Auto Rickshaw Drivers: For the present study, the extent of musculoskeletal discomfort experienced by Auto Rickshaw Drivers was operationally defined as the degree of physical discomfort or pain reported in specific body regions, including the neck, shoulders, upper back, upper arms, lower back, forearms, wrists, thighs, knees, and lower legs. This discomfort arises due to prolonged sitting, repetitive motions, and awkward postures while driving. The assessment was conducted using the pre-validated Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), evaluating the frequency, severity, and interference of discomfort in daily activities over a specified period.

a. Radial Region: For this present study, the radial region was

operationally defined as the lateral (thumb-side) aspect of the hand and forearm, including the radius bone, the base of the thumb, and the associated muscles, tendons, and nerves.

b. Ulnar Region: For this present study, the ulnar region was operationally defined as the medial (pinky-side) aspect of the hand and forearm, involving the ulna bone, the little finger, and the associated muscles, tendons, and nerves.

c. Entire Thumb: For this present study, the entire thumb was operationally defined as the thumb from the base to the tip, including the metacarpal, proximal phalanx, distal phalanx, and associated tendons.

d. Metacarpophalangeal Region: For this present study, the metacarpophalangeal region was operationally defined as the joint area where the metacarpal bones of the hand meet the proximal phalanges of the fingers.

e. Thenar Eminence: For this present study, the thenar eminence was operationally defined as the muscular area at the base of the thumb, encompassing the muscles responsible for thumb opposition, flexion, and abduction.

f. Pisiform Area: For this present study, the pisiform area was operationally defined as the small, pea-shaped bone located at the base of the wrist on the ulnar side, forming part of the carpal region.

3.3.3. Extent of Postural Discomfort experienced by the Auto Rickshaw

Drivers: For the present study, the extent of Postural Discomfort experienced by Auto Rickshaw Drivers was operationally defined as the physical discomfort or strain reported in various body regions due to sustained or awkward postures adopted while driving. Factors contributing to Postural Discomfort include prolonged sitting, inadequate seat ergonomics, constrained body movements, and repetitive motions. The assessment was conducted using the Postural Discomfort Survey Tool (PDST), which was specifically developed by the researcher for this study. The PDST comprises four key sections: individual factors, psychosocial factors, physical factors, and postures adopted by the drivers, providing a

comprehensive evaluation of the discomfort associated with their occupational posture.

3.4. Locale of the Study

The locale of the study was Vadodara, Gujarat, India. Vadodara, also known as Baroda, is a prominent city located in the western Indian state of Gujarat. It is situated on the banks of the Vishwamitri River, it is the third-largest city in Gujarat. Vadodara is strategically located with excellent rail and road connectivity to both Mumbai and Delhi, making it a pivotal junction for transportation and commerce in western India.

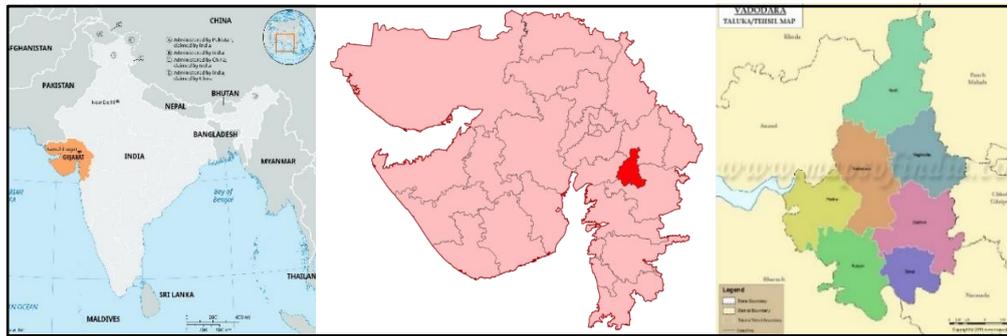


Plate 15: Map of Vadodara, Gujarat, India [25,26,27]

3.5. Unit of Inquiry

The unit of inquiry for the present study were the CNG operated Auto Rickshaw Drivers of the Vadodara city.

3.6. Sampling Size and Sampling Procedure

3.6.1. Sample Size

For the present study, the total sample size consisted of 120 CNG operated Auto Rickshaw Drivers of the Vadodara city.

3.6.2. Sampling Technique

Given below sampling technique was used to select sample for the present study:

Purposive Sampling Technique:

According to Kothari and Garg (2019), Purposive sampling technique is a method of collecting samples involves selection of particular units of the universe for constituting a sample which represents the whole universe. The sample for the present study comprised of 120 Auto Rickshaw Drivers of

Vadodara city. By dividing the city into four directional segments: North, South, East, and West. From each zone, 30 samples were taken, resulting in a total of 120 samples. Purposive sampling was utilized to focus on specific attributes within the population that directly addresses the research questions, ensuring targeted data collection to achieve the study's objectives effectively (Figure 2)

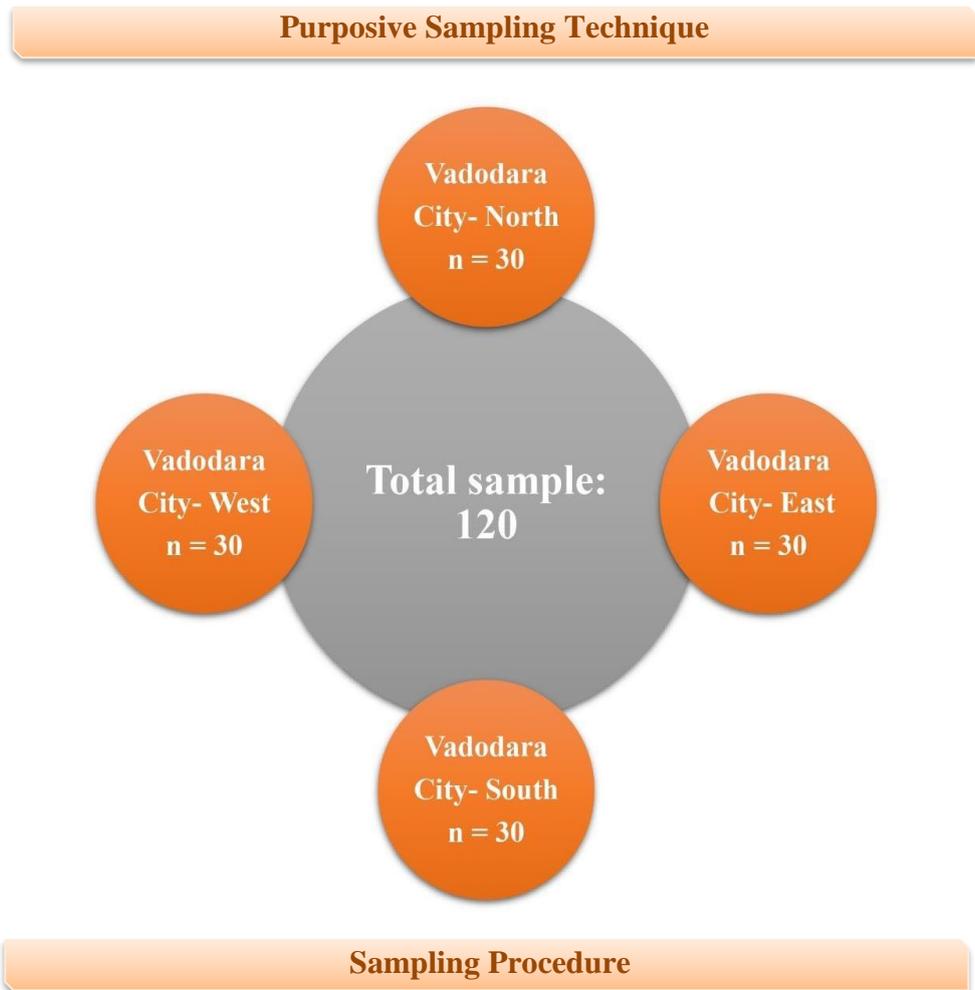


Figure 2: Sampling and Sampling Procedure

3.6.3. Sample Selection

Inclusion Criteria of the study

- Auto Rickshaw Drivers aged between 18 and 60 years old.
- Auto Rickshaw Drivers with a minimum of two years of experience in driving.
- Auto Rickshaw Drivers who were men.
- Auto Rickshaw Drivers willing to participate in the study voluntarily.
- Participants without any pre-existing medical conditions affecting musculoskeletal health, such as arthritis or severe back injuries.
- Auto Rickshaw Drivers operating only CNG Auto Rickshaws.

Exclusion Criteria of the study

- Auto Rickshaw Drivers with severe cardiovascular or respiratory conditions.
- Participants unable to communicate effectively in the language of the study.
- Participants do not reside within the city of Vadodara.
- Auto Rickshaw Drivers operating fuel-powered or electric-operated auto rickshaws

3.7. Selection, Development and Description of the tool

For the present study, Questionnaire and Observation Sheet were used for collecting the data.

3.7.1. Selection of the tool

In light of the objectives framed for the present study, a Questionnaire and an Observation Sheet were developed. The questionnaire was designed to

assess the Extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers. The observation sheet was used to record the Anthropometric Measurements of the respondents.

A. Questionnaire

According to Cohen (2013), the Questionnaire is the instrument for collecting the primary data. The questionnaire had been thought to be the best suited tool for collection of data due to the following reasons:

- a. Ensures consistent data collection across all respondents, allowing for reliable comparisons and analysis.
- b. Provides a cost-effective and efficient means of reaching a large number of respondents.
- c. Allows respondents sufficient time to formulate well-considered answers.
- d. Simplifies administration and completion, ensuring accessibility for respondents with diverse schedules and locations.
- e. Aligns effectively with the time and resources typically available for research studies.

B. Observation Sheet

The observation sheet served as a recording tool for capturing the anthropometric measurements of the respondents, particularly their sitting postures. The observation sheet was considered the most suitable tool for data collection for the following reasons:

- a. Eliminating bias and ensuring the collection of accurate data.
- b. Facilitating prompt data collection, especially as many respondents were not educated.
- c. Allowing for a focus on the specific elements that are critical to the analysis.

3.7.2. Development of the tool

Based on the information collected through review of related literature by

the researcher, guidance of the experts and personal observation, Questionnaire and Observation Sheet were developed to collect the data. Special care was taken to ensure that all questions designed for this study were comprehensive and aimed at gathering the necessary information to achieve research objectives. To help respondents understand better, the tool was professionally translated into Gujarati. This ensured that language differences did not affect the accuracy of the data collected.

3.7.3. Description of the tool

The various sections of the tool (Figure. 3) developed for the study is described in detail as follow:

3.7.3.1. Questionnaire

The questionnaire comprised of three sections which are described as below:

Section I: Background information:

This section was designed to collect comprehensive background information of the respondents, focusing on three main areas: Demographic Details, Work-Related Factors, and Health and well-being of the respondents. Demographic Details includes questions on the respondent's Name, Age (in years), and Educational Level. The Work-Related section captures Driving Experience (in years), Ownership Status, Daily Working Hours, Usual Work Schedule, and Frequency of Breaks during working hours. The Health and Well-Being section explores the respondent's experience with Consultation with Healthcare Professionals, and the use of Exercises to alleviate discomfort.

Section II: Extent of Musculoskeletal Discomfort experienced by the respondents

In this section, the Cornell Musculoskeletal Discomfort Questionnaire (Sedentary Worker, Male Version) was utilized to assess the extent of Musculoskeletal Discomfort experienced by the respondents. This standardized questionnaire, first published in 1999 by Dr. Alan Hedge and his team at Cornell University, was developed to evaluate the prevalence and severity of Musculoskeletal Discomfort in individuals engaged in sedentary

work. The questionnaire covers various body regions, including the neck, shoulder, back, arm, forearm, wrist, thigh, knee, and lower leg, and assesses the frequency, intensity, and duration of discomfort experienced in these areas. It was published to provide a reliable tool for researchers and practitioners to identify ergonomic risks associated with sedentary work environments and to develop interventions aimed at reducing Musculoskeletal Discomfort and improving overall occupational health.

Additionally, the Cornell Hand Discomfort Questionnaire was utilized for Right and Left hands to evaluate discomfort levels experienced by the respondents. The questionnaire measures several aspects, such as frequency, intensity, and the impact on daily driving activities.

Section III: Extent of Postural Discomfort experienced by the respondents

This section evaluates Postural Discomfort experienced by the Auto Rickshaw Drivers using the Postural Discomfort Survey Tool for Three-Wheeler Drivers (PDST), which was developed by the researcher. The PDST was divided into four sections: Individual Factors, Psychosocial Factors, Physical Factors, and Postures Adopted by the Drivers. The Individual Factors section comprised of driver's exercise habits, smoking, tobacco consumption, and drinking status, examining their impact on Postural Discomfort. The Psychosocial Factors section covered work-related stressors, such as hazardous conditions, traffic congestion, fatigue, and job dissatisfaction. The Physical Factors section evaluated ergonomic aspects, including arm and wrist position, sitting posture, and vibration exposure. Lastly, the section on Postures Adopted by the Drivers section focused on the alignment of the neck, back, trunk, and limbs, as well as seat comfort. Hand-drawn images were included in the questionnaire to enhance the respondent's understanding. The PDST uses a 3-point Likert scale (Always, Sometimes, Never) to measure discomfort frequency, providing insights into how various factors affect the driver's postural comfort.

3.7.3.2. Observation Sheet

Section IV: Anthropometric Measurements of the respondents

An Observation Sheet was used to record detailed Anthropometric data (in cm) were taken with the help of a non-elastic measuring tape and a weighing scale. The respondents were asked to sit in their usual driving position on their vehicle's seat. The measurements were then recorded in centimeter simultaneously by the researcher in the observation sheet.

The anthropometric measurement was collected by the researchers using anthropometric kit. By using anthropometric kit, the Height, Weight (in kg), Sitting Height, Sitting Eye Height, Shoulder Breadth, Elbow Rest Height, Thigh Clearance, Buttock-Popliteal Length, Knee Height, Popliteal Height, Forearm-Hand Length, Hip Breadth, Sitting Shoulder Height, Backrest Contact Point and Foot Length of the Auto Rickshaw Drivers were measured. These measurements were collected with precision to ensure accuracy for the study.



Plate 16: Recording anthropometric measurements with the measure tape

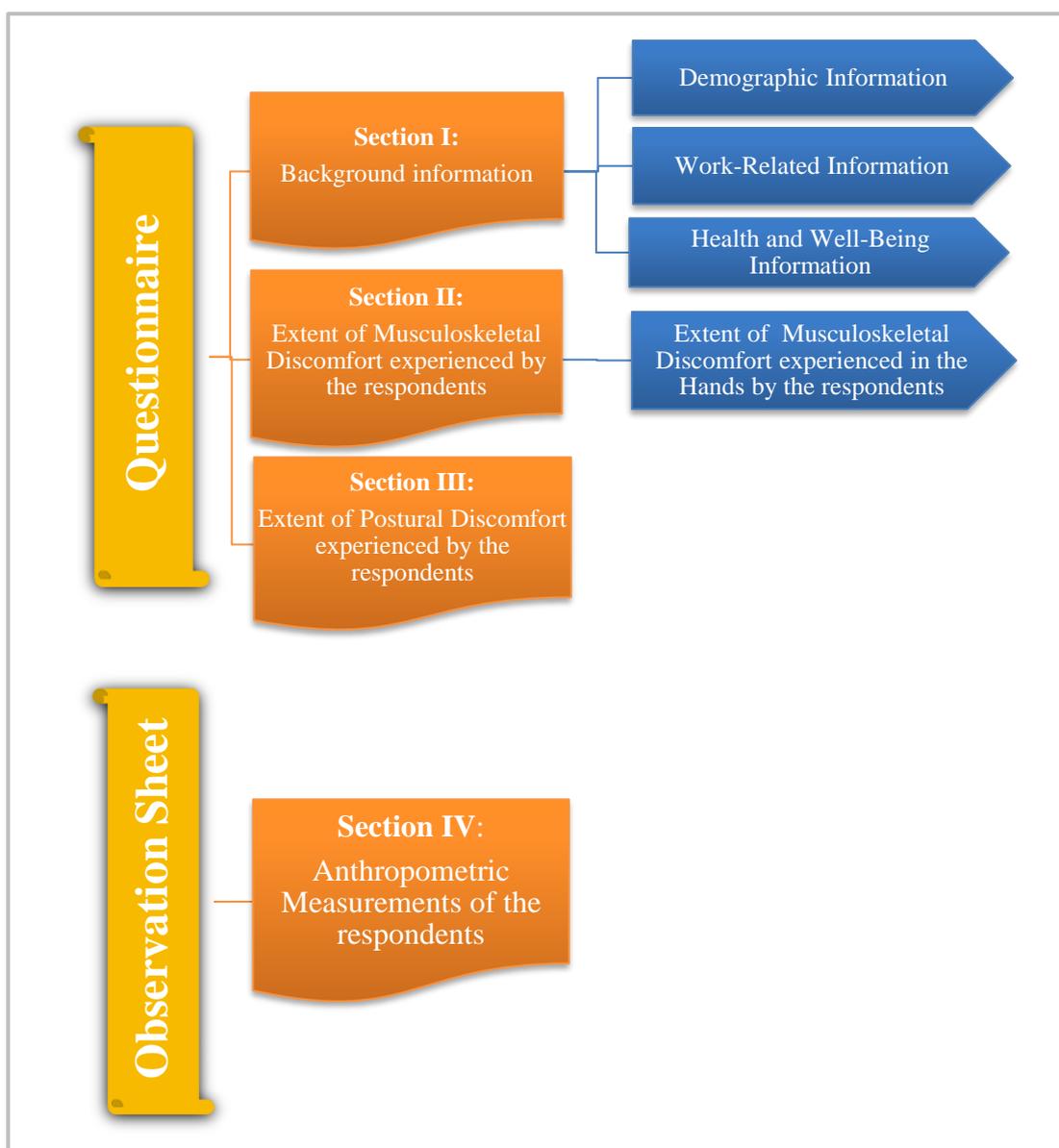


Figure 3: Description of tool

3.7.4. Establishment of Content Validity of Scales

The scale Extent of Postural Discomfort experienced by the respondents developed by the researcher for the study, was given to the panel of eleven experts from the Department of Family and Community Resource Management, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda, Vadodara. The experts reviewed the scales for clarity, relevance, and appropriateness of each statement within its respective category. A consensus threshold of 80% agreement among the

judges was set as the criterion for finalizing the tool. Based on their suggestions, necessary modifications were made to refine the scales.

Establishment of Reliability

The reliability was established for the scale Extent of Postural Discomfort experienced by the Auto Rickshaw Drivers through pretesting.

Pretesting:

A pilot study was conducted to find out the feasibility and clarity of the scale developed. Therefore, the developed scale was pretested on 35 respondents who had similar characteristics as of those of final respondents of the study.

Reliability of the scale:

The reliability of the scale was established through internal consistency, based on the average inter-item correlation to establishing reliability. The Cronbach's alpha test has been applied on 35 samples. The formula of Cronbach's alpha is as below:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N - 1) \cdot \bar{c}}$$

Where, N is the number of items, \bar{c} = average covariance between item-pairs, \bar{v} = average variance. In order to get overview of each of the scale used in present study, the reliability coefficient was as given below (Table 1). The reliability values were found to be high for all the scales as reported below.

Table 3: Overview of the scales with reliability values

Sr. No.	Scales	Values
1.	Extent of Postural Discomfort experienced by the Auto Rickshaw Drivers	0.905
Overall score		0.905

3.8. Data Collection

The data were collected between October 2024 and December 2024 using a questionnaire and observation sheet. The questionnaire assessed the background

information and extent of Musculoskeletal and Postural Discomfort experienced by the respondents. The observation sheet was utilized to record anthropometric measurements, primarily related to the sitting posture. To ensure better understanding, the tool was professionally translated into Gujarati. Informed consent was obtained from each respondent before administering the questionnaire and conducting observations.

3.9. Data Analysis

The procedure used to analyze the data were categorization, coding, tabulation and statistical analysis.

3.9.1. Categorization

The following categories were made to enable researcher to analyze the data for further statistical application.

A. Age of the respondents (in years):

It referred to the age of the respondents at the time of the data collection.

The obtained range of the age of the respondents based on equal intervals are as follows:

1. 26 – 40 years
2. 41 – 55 years
3. 56 – 70 years

B. Educational level of the respondents:

It referred to the educational level of the respondents at the time of data collection and was categorized as follows:

1. Illiterate
2. Primary
3. Secondary
4. Higher Secondary
5. Graduation

C. Body Mass Index (BMI) of the respondents:

It referred to the body mass index (BMI) of the respondents at the time of data collection and was categorized as follows:

1. Underweight (Below 18.5)
2. Normal weight (18.5 - 24.9)
3. Overweight (25 - 29.9)
4. Obese (30 and above)

D. Driving experience of the respondents (in years):

The obtained range of the driving experience of the respondents based on equal intervals are as follows:

1. 3 – 16 years
2. 17 – 30 years
3. 31 – 45 years

E. Ownership Status of the Auto Rickshaw by the respondents:

It referred to the Ownership Status of the Auto Rickshaw by the respondents at the time of data collection and was categorized as follows:

1. Owned
2. Hired

F. Average Daily Working Hours (per day):

The obtained range of the driving experience of the respondents based on equal intervals are as follows:

1. 6 – 8 hours
2. 9 – 10 hours
3. 11 – 12 hours

G. Extent of Postural Discomfort experienced due to Physical Factors of the respondents:

It referred to the Extent of Postural Discomfort experienced due to Physical Factors of the respondents (Table 4).

Table 4: Extent of Postural Discomfort experienced due to Physical Factors of the respondents

S r. No.	Extent of Postural Discomfort experienced due to Physical Factors of the respondents	Ranges of Score
1.	High Extent	82 – 105
2.	Moderate Extent	59 - 81
3.	Low Extent	35 - 58

The scale consisted of 35 statements developed to assess the extent of Postural Discomfort experienced by respondents due to various physical factors. These factors included arm position, wrist position, sitting posture,

trunk posture, neck posture, vibration exposure, foot posture, leg posture, hip posture, and the seat design and comfort of the workstation.

Respondents rated their discomfort on a 3-point scale consisting of "High Extent," "Moderate Extent," and "Low Extent", assigned scores of 3, 2, and 1, respectively. The total possible scores ranged from a minimum of 35 to a maximum of 105. This range was divided into three equal intervals, corresponding to high, moderate, and low extent of discomfort. A higher score indicated a greater extent of Postural Discomfort experienced due to physical factors of the respondents (Table 4).

H. Extent of Postural Discomfort experienced due to Postures adopted by the respondents:

It referred to the Extent of Postural Discomfort experienced due to Postures adopted by the respondents (Table5).

Table 5: Extent of Postural Discomfort experienced due to Postures adopted by the respondents

Sr. No.	Extent of Postural Discomfort experienced due to Postures adopted by the respondents	Ranges of Score
1.	High Extent	59 - 75
2.	Moderate Extent	42 - 58
3.	Low Extent	25 - 41

The scale consisted of 25 statements developed to assess the extent of Postural Discomfort experienced due to the postures adopted by the respondents while driving. These postures included arm position, wrist position, sitting posture, trunk posture, neck posture, foot posture, and leg posture.

The respondents rated their discomfort on a 3-point scale consisting of "High Extent," "Moderate Extent," and "Low Extent, assigned scores of 3, 2, and 1, respectively. The total possible scores ranged from a minimum of 25 to a maximum of 75. This range was divided into three equal intervals, corresponding to high, moderate, and low extent of discomfort. A higher score indicated a greater extent of Postural Discomfort experienced due to

physical factors (Table 5).

3.9.2. Weighted mean score

The weighted mean is a type of mean that is calculated by multiplying the score (or probability) associated with a particular statement.

$$W = \frac{\sum_{i=1}^n w_i X_i}{\sum_{i=1}^n w_i}$$

Where, W is weighted average, n= number of terms to be averaged, wi = weights applied to x values and Xi = data values to be averaged.

3.9.3. Coding

Coding plan was developed by the researcher assigning appropriate code numbers to every possible response. Then the information from each scale of the questionnaire were transferred on excel sheet.

3.9.4. Tabulation

The data was tabulated from the coding sheet to a tabular form for arriving at the frequencies and percentages.

3.9.5. Statistical Analysis

The data were analyzed employing descriptive as well as relational statistics.

Descriptive statistics: The data were presented in frequencies, percentage, mean and standard deviation.

Relational statistics: Analysis of Variance (ANOVA), and Co-efficient of Correlation was applied to test the hypotheses postulated for the study (Table 6).

Table 6: Relational statistics applied to test the hypotheses

Test	Independent and Dependent Variables
<p>(ANOVA) F-test</p>	<p>Independent Variables: Age (in years), Body Mass Index (BMI), Duration of Driving (per day) and Driving Experience (in years)</p> <p>with</p> <p>Dependent Variable: Extent of Musculoskeletal Discomfort experienced by the respondents.</p>
<p>(ANOVA) F-test</p>	<p>Independent Variables: Age (in years), Body Mass Index (BMI), Duration of Driving (per day) and Driving Experience (in years)</p> <p>with</p> <p>Dependent Variable: Extent of Postural Discomfort experienced by the respondents.</p>
<p>Co-relation of coefficient -test</p>	<p>Dependent Variable: Extent of Musculoskeletal Discomfort experienced by the respondents.</p> <p>with</p> <p>Dependent Variable: Extent of Postural Discomfort experienced by the respondents.</p>

3.10. Development and Design of an Ergonomic Solution for the Auto Rickshaw Drivers:

Based on the observations and data collected during the study, the researcher identified that the most affected areas included the lower back, upper back, neck, shoulders, and wrists, leading to chronic pain and reduced productivity. Due to the impact of these issues, there was a critical need for ergonomic seating solutions to enhance driver's comfort, reduce discomfort, and promote better occupational health.

The development of the ergonomic seat began with anthropometric data collection, where measurements of 120 Auto Rickshaw Drivers were taken. The seat dimensions were designed using the 5th and 95th percentile measurements to accommodate a diverse range of users. Additionally, the design was guided by principles of applied anthropometry, workspace design, and seating, as outlined in *Human Factors in Engineering and Design* (7th ed.) by Sanders and McCormick (1993, p. 415). After finalizing the dimensions, material selection was carried out. High-density foam was chosen for structural strength, soft-density foam for cushioning and comfort, and EVA foam for vibration dampening to reduce road impact. PU leather was selected as a cost-effective and durable top covering, ensuring longevity and ease of maintenance.

With the materials finalized, the ergonomic features were integrated into the seat design. Lumbar support was incorporated to maintain spinal alignment and reduce lower back strain, while contoured cushioning was designed to distribute weight evenly and enhance comfort. Additionally, the seat also included a belt to enable the respondents in adjusting back rest placement as per their comfort.

A 3D model of the ergonomic seat was developed using SketchUp before fabrication. This allowed for detailed visualization, modifications, and expert reviews to ensure that the seat met ergonomic standards and driver needs. Once the design was finalized, product fabrication commenced. The ergonomic seat was manufactured using the selected materials, incorporating all ergonomic features to optimize support and comfort. Adjustments were made based on expert recommendations to enhance usability and effectiveness.

The ergonomic seat was showcased to selected Auto Rickshaw Drivers to assess the ergonomic seat design to obtain their feedback. The majority of drivers reported that the material was more durable and significantly more comfortable than their existing seats. They found the seat's cushioning and support to be highly effective in reducing back and shoulder discomfort. Additionally, the overall cost was feasible for them, and they expressed a strong willingness to purchase the ergonomic seat for long-term use.

FINDINGS AND DISCUSSION



CHAPTER IV

FINDINGS AND DISCUSSION

The aim of the present study was to find out the Extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city. This chapter deals with presenting, interpreting and discussing the findings obtained through analysis of the data collected through Questionnaire and Observation sheet. The results are presented in the following sub sections:

Section I 4.1 Background Information of the respondents

4.1.1 Demographic Information of the respondents

4.1.2 Work Related Information of the respondents

4.1.3 Health and Well-being of the respondents

Section II 4.2 Extent of Musculoskeletal Discomfort experienced by the respondents

4.2.1 Extent of Musculoskeletal Discomfort experienced in the Hands by the respondents

Section III 4.3 Extent of Postural Discomfort experienced by the respondents

4.3.1 Psychosocial Factors

4.3.2 Extent of Postural Discomfort experienced due to Physical Factors of the respondents

4.3.3 Extent of Postural Discomfort experienced due to Postures adopted by the respondents

Section IV 4.4 Anthropometric Measurements of the respondents

Section V 4.5 Testing of Hypotheses

Section VI 4.6 Development of the Ergonomic Seat Design for the Auto Rickshaw Drivers

SECTION I

4.1 Background Information of the respondents

This section dealt with information regarding selected Auto Rickshaw Drivers of Vadodara City. The results regarding data on personal and situational variables of the respondents are presented here.

4.1.1 Demographic Information of the respondents

This section contained information regarding Age (in years), Educational Level and Body Mass Index (BMI) of the respondents.

Table 7: Frequency and percentage distribution of the respondents according to their Demographic Information

Sr. No.	Demographic Information of the respondents	Respondents (n=120)	
		f	%
1.	Age in years		
	26 – 40 years	76	63.33
	41 – 55 years	31	25.84
	56 – 70 years	13	10.83
	Mean	41.21	
	Standard Deviation	11.89	
2.	Educational Level		
	Illiterate	16	13.33
	Primary	28	23.33
	Secondary	52	43.33
	Higher Secondary	15	12.51
	Graduate	09	07.50
3.	Body Mass Index (BMI)		
	Underweight (Below 18.5)	14	11.67
	Normal weight (18.5 - 24.9)	41	34.16
	Overweight (25 - 29.9)	32	26.67
	Obese (30 and above)	33	27.50

Age

The age of the respondents ranged between 26 to 70 years at the time of data collection. The mean age of the respondents was 41.21 years, with a standard deviation of 11.89. The data revealed that 63.33 per cent of the respondents belonged to the age group of 26 to 40 years, followed by 25.84 per cent of the respondents were in the age group of 41 to 55 years. A smaller proportion 10.83 per cent of the respondents belonged to the age group of 56 to 70 years (Table 7 and Figure 4).

Educational Level

The findings revealed that 13.33 per cent of the respondents were illiterate. A total of 23.33 per cent of the respondents had completed primary education, while 43.33 per cent of the respondents had attained secondary education. About 12.51 per cent of the respondents had studied up to the higher secondary level, whereas 7.50 per cent of the respondents had completed graduation (Table 7 and Figure 4).

Body Mass Index (BMI)

The data in Table 7 and Figure 4 revealed that 34.16 per cent of the respondents had a normal weight (18.5 - 24.9), followed by 27.50 per cent of the respondents belonged to the obese category (30 and above) and 26.67 per cent of the respondents were overweight (25 - 29.9). Meanwhile, 11.67 per cent of the respondents were underweight (below 18.5).

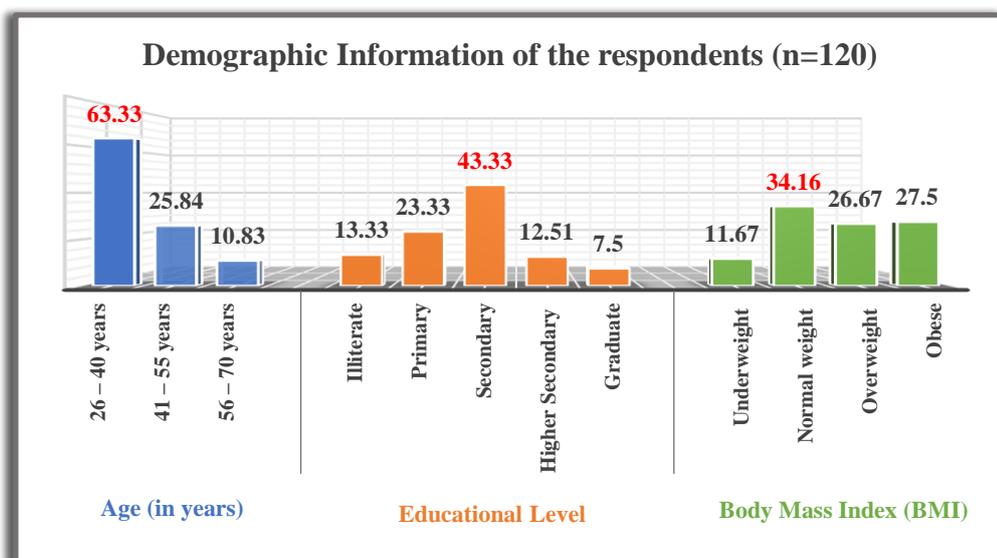


Figure 4: Percentage distribution of the respondents according to their Demographic Information

4.1.2 Work Related Information of the respondents

This section dealt with information related to Driving Experience (in years), Ownership Status of the Auto Rickshaw, Daily Working Hours, Work Shift, and Frequency of Breaks during working hours of the respondents.

Table 8: Frequency and percentage distribution of the respondents according to their Work-Related Information

Sr. No.	Work-Related Information of the respondents	Respondents (n=120)	
		f	%
1.	Driving Experience (in years)		
	3 – 16 years	73	60.84
	17 – 30 years	35	29.16
	31 – 45 years	12	10.00
	Mean	17.90	
2.	Ownership Status of the Auto Rickshaw		
	Owned	83	69.16
	Hired	37	30.84
3.	Daily Working Hours per day		
	6 – 8 hours	43	35.84
	9 – 10 hours	35	29.16
	11 – 12 hours	42	35.00
	Mean	09.70	
4.	Work Shift		
	Morning Shift (6:00 am – 2:00 pm)	110	91.67
	Evening Shift (2:00 pm – 10:00 pm)	10	08.33
5.	Frequency of Breaks		
	Once	81	67.51
	Twice	29	24.16
	Thrice	10	08.33

Driving Experience

The data in Table 8 and Figure 5 reported that 60.84 per cent of the respondents had 3-16 years of experience of driving the Auto Rickshaw, followed by 29.16 per

cent of the respondents had an experience of driving the Auto Rickshaw since 17-30 years.

Ownership Status

The data in Table 8 and Figure 5 revealed that 69.16 per cent of the respondents owned the Auto Rickshaw, while 30.84 per cent of the respondents had hired Auto Rickshaw from vehicle owners.

Daily Working Hours

The daily working hours of the respondents were 9.70 hours. The data revealed that 35.84 per cent of the respondents worked for 6 to 8 hours per day, while 29.16 per cent of the respondents worked for 9 to 10 hours per day, followed by 35.00 per cent of the respondents reported working for 11 to 12 hours daily (Table 8 and Figure 5).

Work Shift

The data in Table 8 and Figure 5 revealed that 91.67 per cent of the respondents worked in the morning shift (6:00 am – 2:00 pm), whereas 8.33 per cent of the respondents were engaged in the evening shift (2:00 pm – 10:00 pm).

Frequency of Breaks

The data revealed that 67.51 per cent of the respondents took break once during their work hours. Additionally, 24.16 per cent of the respondents took breaks twice a day, while 8.33 per cent of the respondents took breaks three times a day (Table 8 and Figure 5).

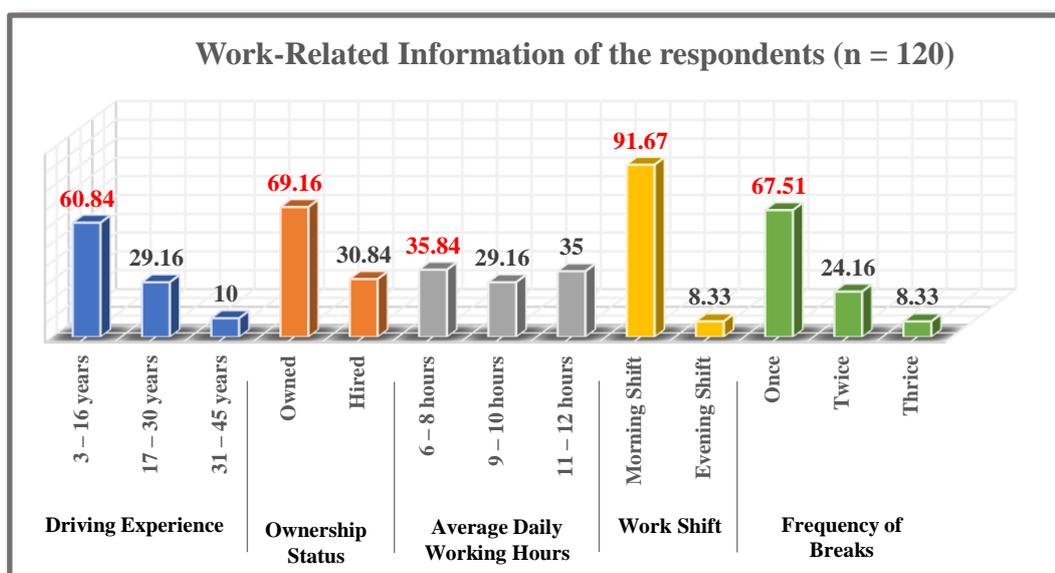


Figure 5: Percentage distribution of the respondents according to their Work-Related Information

4.1.3 Health and Wellbeing of the respondents

4.1.3.1 Health Status

This section dealt with information related to the respondent's health status, including consultations with Healthcare Professionals, and the use of exercises to alleviate discomfort.

Table 9: Frequency and percentage distribution of the respondents according to their Health Status

Sr. No.	Statements regarding Health Status	Respondents (n=120)			
		Yes		No	
		f	%	f	%
1.	Consulted Healthcare Professional for Discomfort	45	37.50	75	62.50
2.	Practice Exercises to alleviate Discomfort	50	41.67	70	58.33

Health Status

The data in Table 9 and Figure 6 revealed that 37.50 per cent of the respondents sought healthcare advice for their discomfort, while 62.50 per cent of the respondents did not consult any healthcare professional regarding their discomfort. Additionally, 41.67 per cent of the respondents engaged in exercises to alleviate their discomfort, whereas 58.33 per cent of the respondents did not engaged in such practices.

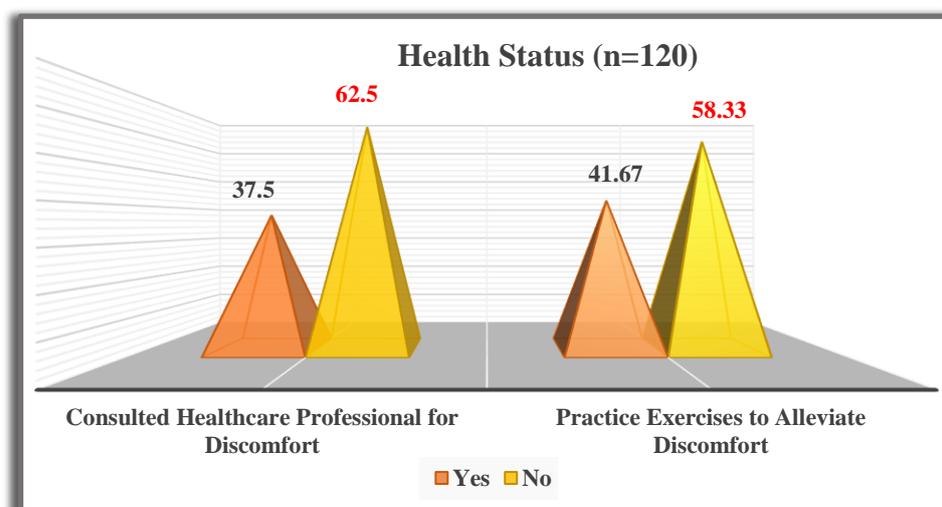


Figure 6: Percentage distribution of the respondents according to their Health Status

4.1.3.2 Life Style of the respondents

This section presented information related to lifestyle habits of the Auto Rickshaw Drivers, including their engagement in physical exercise, smoking habits, alcohol and tobacco consumption.

Table 10: Frequency and percentage distribution of the respondents according to their Life Style

Sr. No.	Statements regarding Lifestyle of the respondents	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
1.	Frequency of Exercise	16	13.33	34	28.33	70	58.34
2.	Frequency of Smoking	60	50.00	43	35.70	17	14.30
3.	Frequency of consuming Alcohol	48	40.00	54	45.00	18	15.00
4.	Frequency of consuming Tobacco	84	70.00	27	22.50	09	07.50

Lifestyle of the respondents

The data in Table 10 and Figure 7 revealed that 70.00 per cent of the respondents always consumed tobacco, followed by 58.34 per cent of the respondents never did exercise, while 50.00 per cent of the respondents always smoked. The data also revealed that 45.00 per cent of the respondents sometimes consumed alcohol whereas, 40.00 per cent of the respondents always consumed alcohol.

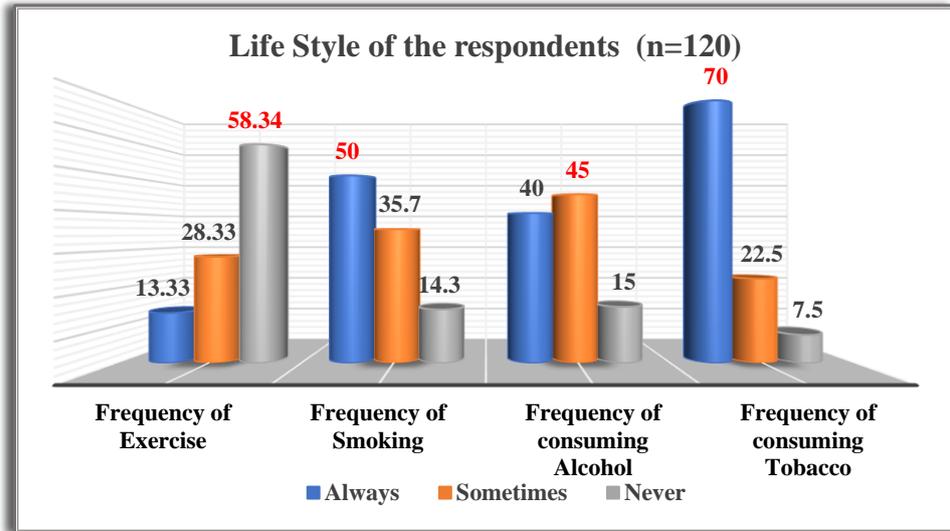


Figure 7: Percentage distribution of the respondents according to their Lifestyle

SECTION II

4.2 Extent of Musculoskeletal Discomfort experienced by the respondents

This section examined the extent of Musculoskeletal Discomfort among Auto Rickshaw Drivers, focusing on three key aspects: Musculoskeletal Discomfort, the level of discomfort experienced, and its interference with work ability during the last work week.

Table 11: Frequency and Percentage distribution of the respondents according to the Musculoskeletal Discomfort experienced during the last work week

Musculoskeletal Discomfort experienced by the respondents during the Last Work Week											
Sr. No.	Body parts	Respondents (n=120)									
		Several times a day		Once every day		3-4 times last week		1-2 times last week		Never	
		f	%	f	%	f	%	f	%	f	%
1.	Neck	04	03.33	22	18.33	30	25.00	36	30.00	28	23.34
2.	Right Shoulder	10	08.33	32	26.67	24	20.00	32	26.67	22	18.33
3.	Left Shoulder	12	10.00	33	27.50	24	20.00	26	21.67	25	20.83
4.	Upper Back	30	25.00	24	20.00	30	25.00	24	20.00	12	10.00
5.	Right Upper Arm	26	21.67	17	14.16	28	23.34	25	20.83	24	20.00
6.	Left Upper Arm	30	25.00	14	11.66	22	18.33	28	23.34	26	21.67
7.	Lower Back	43	35.83	26	21.67	20	16.67	20	16.67	11	09.16
8.	Right Forearm	18	15.00	24	20.00	24	20.00	20	16.67	34	28.33
9.	Left Forearm	16	13.33	30	25.00	18	15.00	20	16.67	36	30.00
10.	Right Wrist	29	24.16	26	21.67	22	18.33	19	15.84	24	20.00
11.	Left Wrist	18	15.00	18	15.00	30	25.00	20	16.67	34	28.33
12.	Right Thigh	16	13.33	38	31.67	12	10.00	20	16.67	34	28.33
13.	Left Thigh	25	20.83	18	15.00	31	25.85	17	14.16	29	24.16
14.	Right Knee	20	16.67	40	33.33	10	08.33	22	18.33	28	23.34
15.	Left Knee	24	20.00	28	23.34	22	18.33	22	18.33	24	20.00
16.	Right Lower Leg	16	13.33	22	18.33	20	16.67	30	25.00	32	26.67
17.	Left Lower Leg	16	13.33	26	21.67	16	13.33	24	20.00	38	31.67

Musculoskeletal Discomfort experienced by the respondents during the Last Work Week

The data in Table 11 and Figure 8 reported that 35.83 per cent of the respondents experienced musculoskeletal discomfort in lower back several times a day, followed by

33.33 per cent of the respondents experienced discomfort once a day in right knee. A similar percentage (30.00 per cent) of the respondents experienced discomfort in neck 1-2 times last week and never in left forearm. The data revealed that 27.50 per cent of the respondents experienced discomfort once a day in left shoulder, followed by a similar percentage (26.67 per cent) of the respondents experienced discomfort once a day and 1-2 times a day in right shoulder. Additionally, 25.00 per cent of the respondents experienced discomfort several times a day in upper back and left upper arm whereas, same per cent of the respondents experienced discomfort 3-4 times last week in neck, upper back and left wrist and 1-2 times last week in right lower leg. A similar percentage (24.16 per cent) of the respondents experienced discomfort several time a day in right wrist and never in left thigh, while 23.34 per cent of the respondents experienced discomfort once a day in left knee and 3-4 times last week in right upper arm, 1-2 times last week in left upper arm and never in right knee, followed by 21.67 per cent of the respondents experienced discomfort several times a day and once a day in right upper arm and lower back respectively. The data also revealed that 20.83 per cent of the respondents experienced discomfort several times a day in left thigh and 11-2 times last week in right upper arm, followed by a similar percentage (20.00 per cent) of the respondents experienced discomfort several times a day in left knee, once a day in upper back and right forearm, 3-4 times last week right and left shoulder and right forearm, 1-2 times last week in upper back and left lower leg.

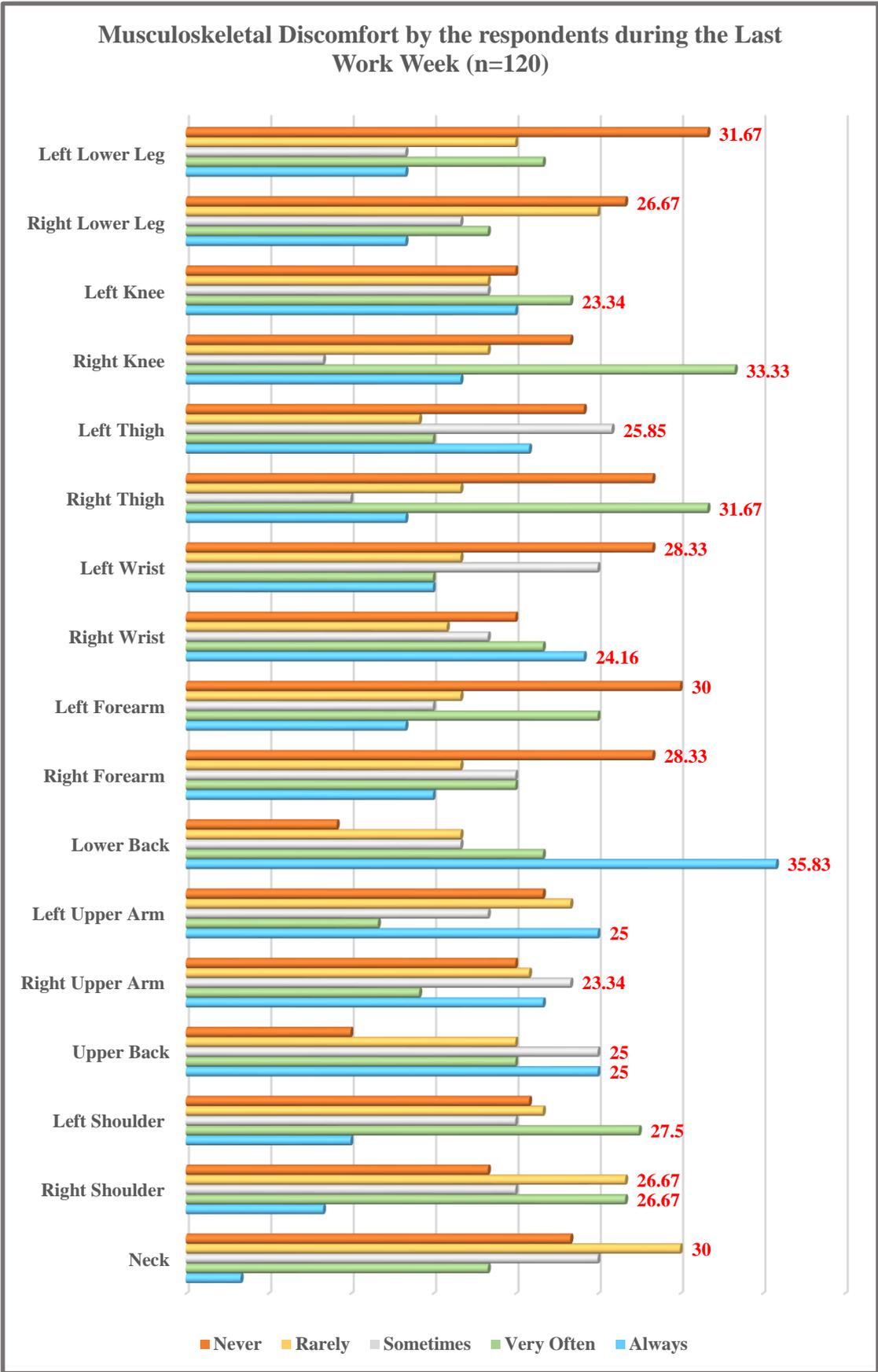


Figure 8: Percentage distribution of the respondents due to the Musculoskeletal Discomfort experienced by the respondents during the last work week

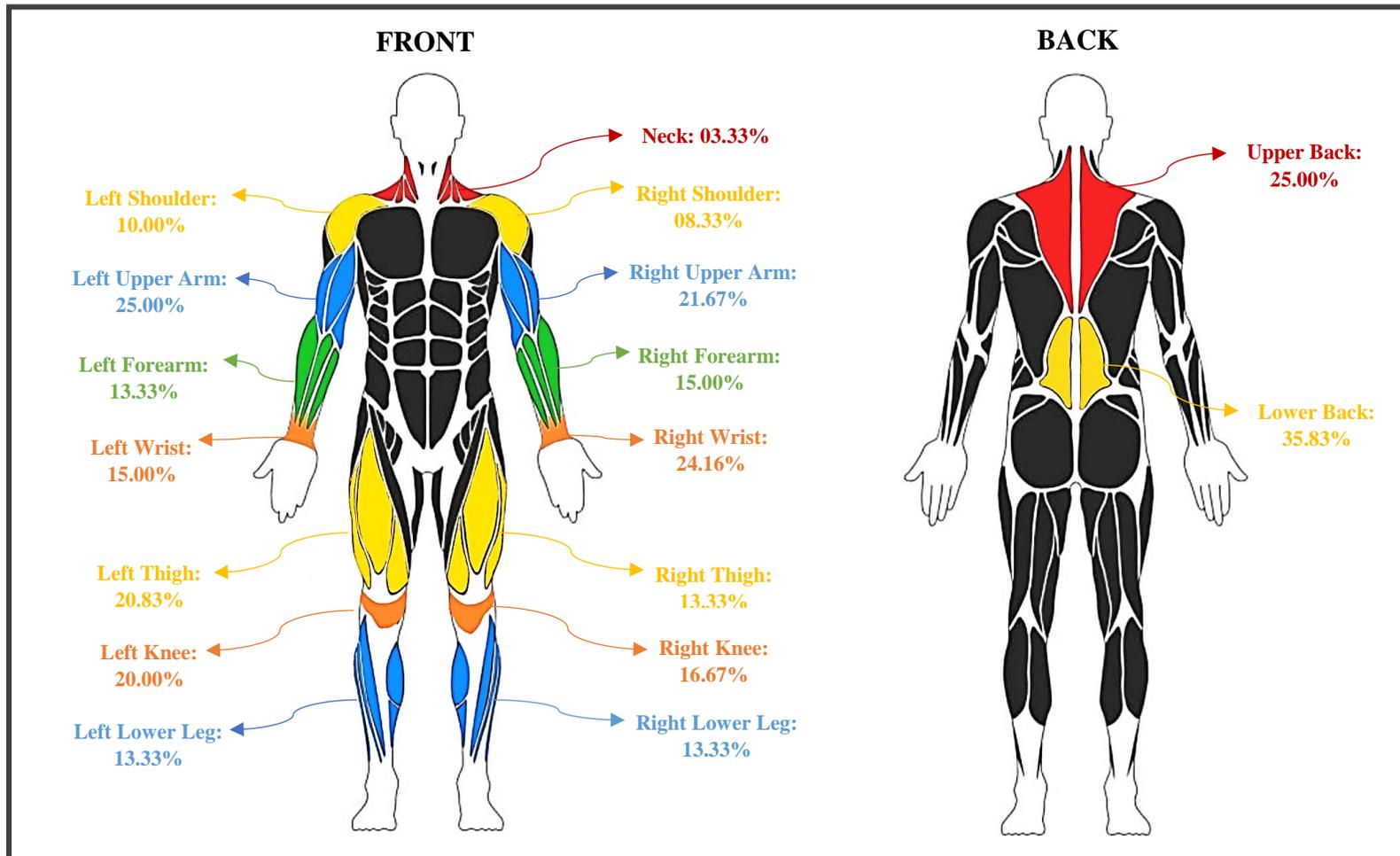


Figure 9: Musculoskeletal Discomfort experienced by the respondents in various body parts during the last work week

Table 12: Frequency and Percentage distribution of the respondents according to Level of Discomfort experienced due to Musculoskeletal Discomfort during the last work week

Level of Discomfort experienced by the respondents due to Musculoskeletal Discomfort during the last work week							
Sr. No.	Body parts	Respondents (n=120)					
		High Discomfort		Moderate Discomfort		Low Discomfort	
		f	%	f	%	f	%
1.	Neck	6	05.00	48	40.00	66	55.00
2.	Right Shoulder	24	20.00	48	40.00	48	40.00
3.	Left Shoulder	28	23.33	36	30.00	56	46.67
4.	Upper Back	38	31.67	46	38.33	36	30.00
5.	Right Upper Arm	26	21.67	42	35.00	52	43.33
6.	Left Upper Arm	20	16.67	34	28.33	66	55.00
7.	Lower Back	58	48.33	38	31.67	24	20.00
8.	Right Forearm	10	08.33	52	43.34	58	48.33
9.	Left Forearm	14	11.66	34	28.33	72	60.01
10.	Right Wrist	26	21.67	38	31.67	56	46.66
11.	Left Wrist	30	25.00	32	26.67	58	48.33
12.	Right Thigh	24	20.00	41	34.16	55	45.84
13.	Left Thigh	24	20.00	42	35.00	54	45.00
14.	Right Knee	30	25.00	44	36.34	46	38.33
15.	Left Knee	34	28.33	39	32.51	47	39.16
16.	Right Lower Leg	24	20.00	28	23.33	68	56.67
17.	Left Lower Leg	22	18.33	31	25.83	67	55.84

Level of Discomfort experienced by the respondents due to Musculoskeletal Discomfort during the last work week

The data in Table 12 and Figure 10 revealed that 48.33 per cent of the respondents experienced high level of discomfort in the lower back due to Musculoskeletal Discomfort during the last work week, followed by 31.67 per cent of the respondents experienced high discomfort in the upper back. The data also revealed that 25.00 per cent of the respondents experienced high level of discomfort in the left wrist, and 28.33

per cent of the respondents experienced high discomfort in the left knee due to Musculoskeletal Discomfort during the last work week. The data reported that 40.00 per cent of the respondents experienced moderate level of discomfort in the neck, followed by 30.00 per cent of the respondents experienced moderate level of discomfort in the left shoulder, and 36.34 per cent of the respondents experienced moderate level of discomfort in the right knee, followed by 32.51 per cent of the respondents experienced moderate level discomfort in the left knee due to Musculoskeletal Discomfort during the last work week. The data revealed that 60.01 per cent of the respondents experienced low level of discomfort in their left forearm, followed by 56.67 per cent of the respondents experienced low discomfort in the right lower leg and 55.84 per cent of the respondents experienced low discomfort in the left lower leg. The findings also revealed that 55.00 per cent of the respondents experienced low level of discomfort in their neck due to Musculoskeletal Discomfort during the last work week.

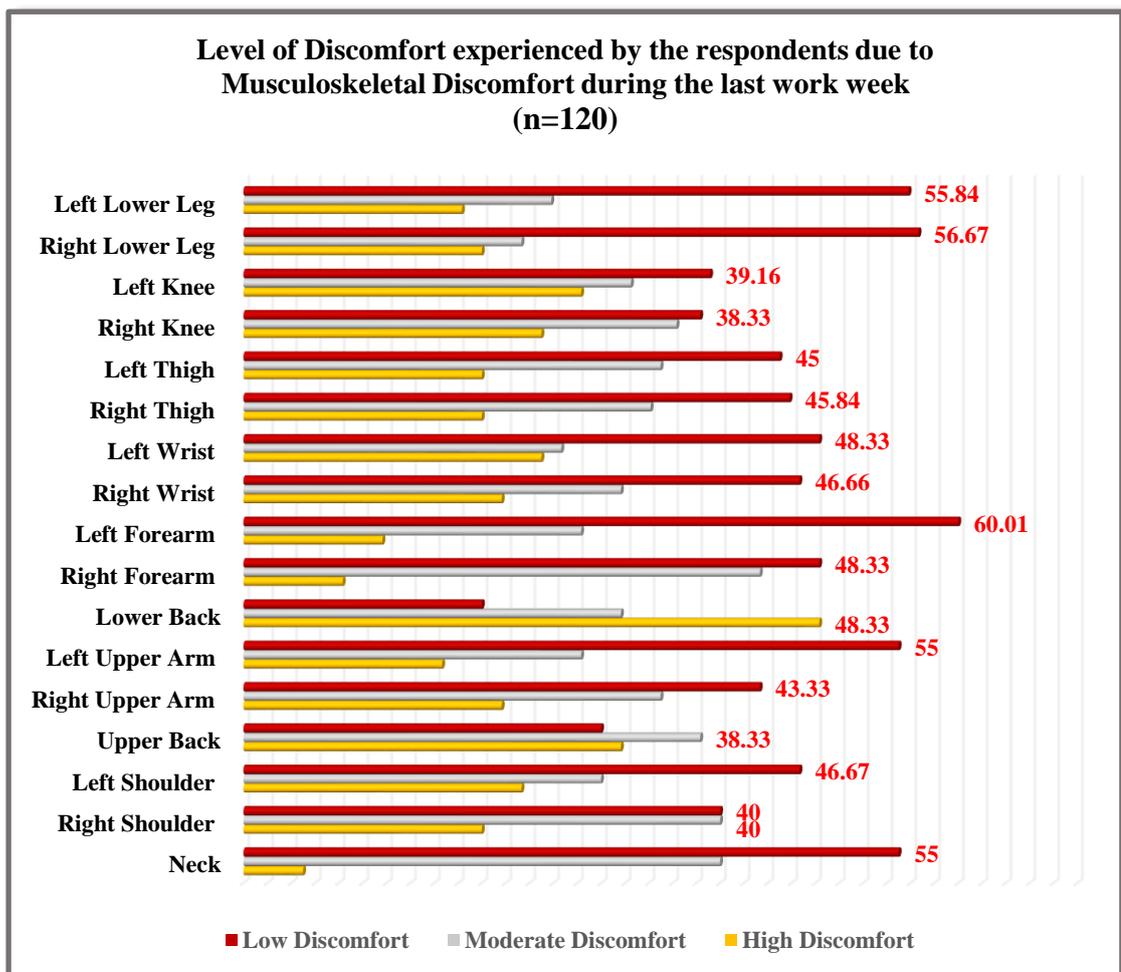


Figure 10: Percentage distribution of the respondents according to Level of Discomfort experienced due to Musculoskeletal Discomfort during the last work week

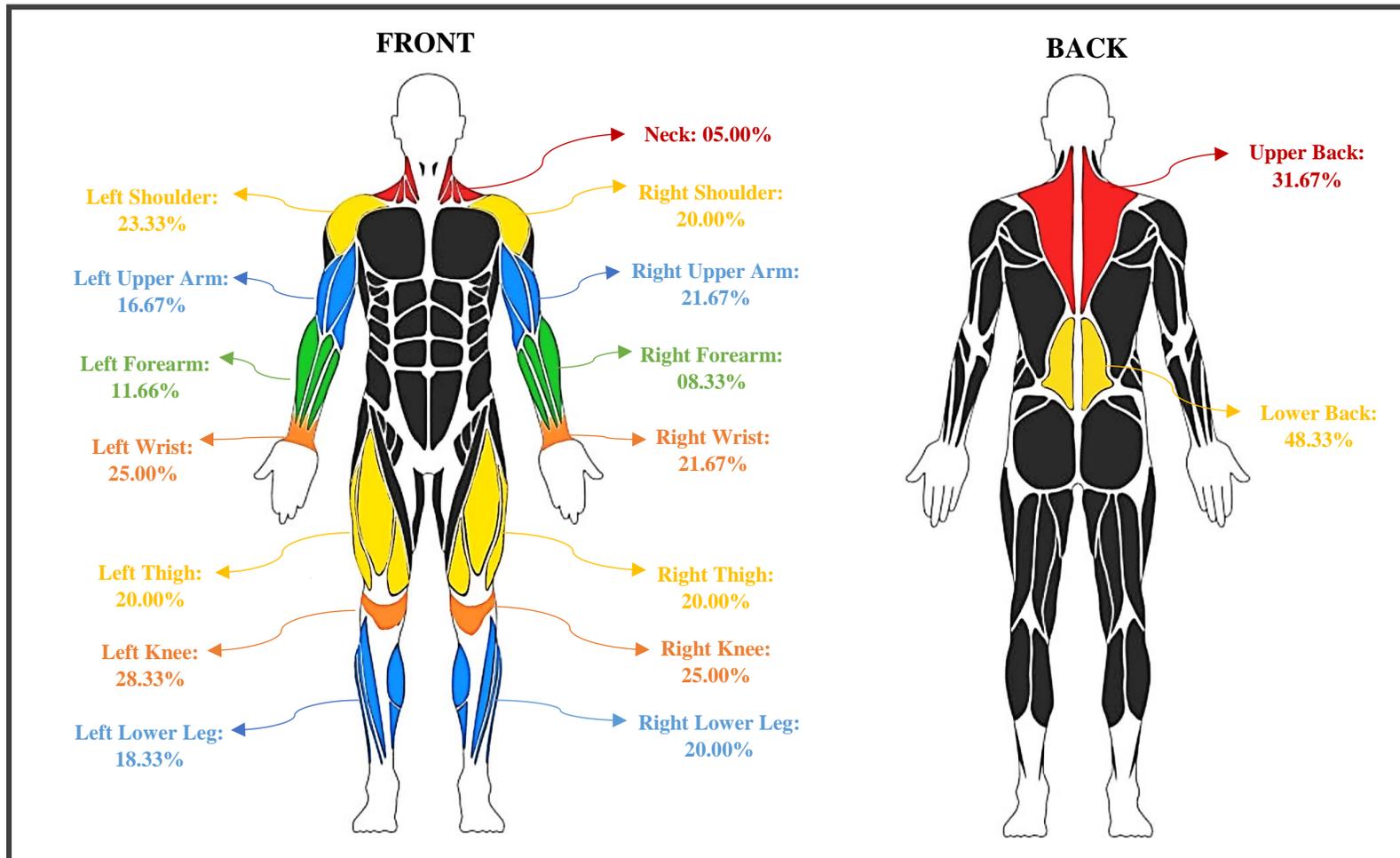


Figure 11: Level of Discomfort experienced by the respondents due to Musculoskeletal Discomfort in various body parts during the last work

Table 13: Frequency and Percentage distribution of the respondents according to Interference with Work Ability due to Musculoskeletal Discomfort experienced during the last work week

Interference with Work Ability due to Musculoskeletal Discomfort experienced by the respondents during the last work week							
Sr. No.	Body parts	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
1.	Neck	8	06.67	58	48.33	54	45.00
2.	Right Shoulder	26	21.67	54	45.00	40	33.33
3.	Left Shoulder	34	28.33	48	40.00	38	31.67
4.	Upper Back	28	23.33	54	45.00	38	31.67
5.	Right Upper Arm	20	16.67	54	45.00	46	38.33
6.	Left Upper Arm	16	13.33	54	45.00	50	41.67
7.	Lower Back	54	45.00	40	33.33	26	21.67
8.	Right Forearm	12	10.00	68	56.67	40	33.33
9.	Left Forearm	10	08.33	54	45.00	56	46.67
10.	Right Wrist	26	21.67	42	35.00	52	43.33
11.	Left Wrist	22	18.33	43	35.84	55	45.83
12.	Right Thigh	22	18.33	48	40.00	50	41.67
13.	Left Thigh	18	15.00	46	38.33	56	46.67
14.	Right Knee	32	26.66	50	41.66	38	31.66
15.	Left Knee	26	21.67	46	38.33	48	40.00
16.	Right Lower Leg	18	15.00	42	35.00	60	50.00
17.	Left Lower Leg	16	13.33	54	45.00	50	41.67

Interference with Work Ability due to Musculoskeletal Discomfort experienced during the last work week by the respondents

The data in Table 13 and Figure 12 revealed that 45.00 per cent of respondents always experienced interference with their work ability due to musculoskeletal discomfort in the lower back during the last work week, followed by 28.33 per cent of the respondents always experienced interference with their work ability due to discomfort in the left shoulder and 26.66 per cent of the respondents always experienced interference with

their work ability due to discomfort in the right knee during the last work week. Additionally, 23.33 per cent of the respondents always experienced interference with their work ability due to musculoskeletal discomfort in the upper back, followed by 21.67 per cent of the respondents reported the same for the right shoulder and left knee during the last work week. Furthermore, the findings revealed that 56.67 per cent of the respondents sometimes experienced interference with their work ability due to musculoskeletal discomfort in the right forearm, followed by 48.33 per cent of the respondents sometimes experienced interference with their work ability due to musculoskeletal discomfort in the neck and 45.00 per cent of the respondents sometimes experienced interference with their work ability due to discomfort in the right shoulder, upper back, right upper arm, left upper arm, left forearm, and left lower leg during the last work week. Additionally, 41.66 per cent of the respondents experienced interference with their work ability due to discomfort in the right knee during the last work week. The findings also revealed that 50.00 per cent of the respondents never experienced interference with their work ability due to musculoskeletal discomfort in the right lower leg, followed by 46.67 per cent of the respondents never experienced interference with their work ability due to musculoskeletal discomfort in the left forearm and left thigh during the last work week.

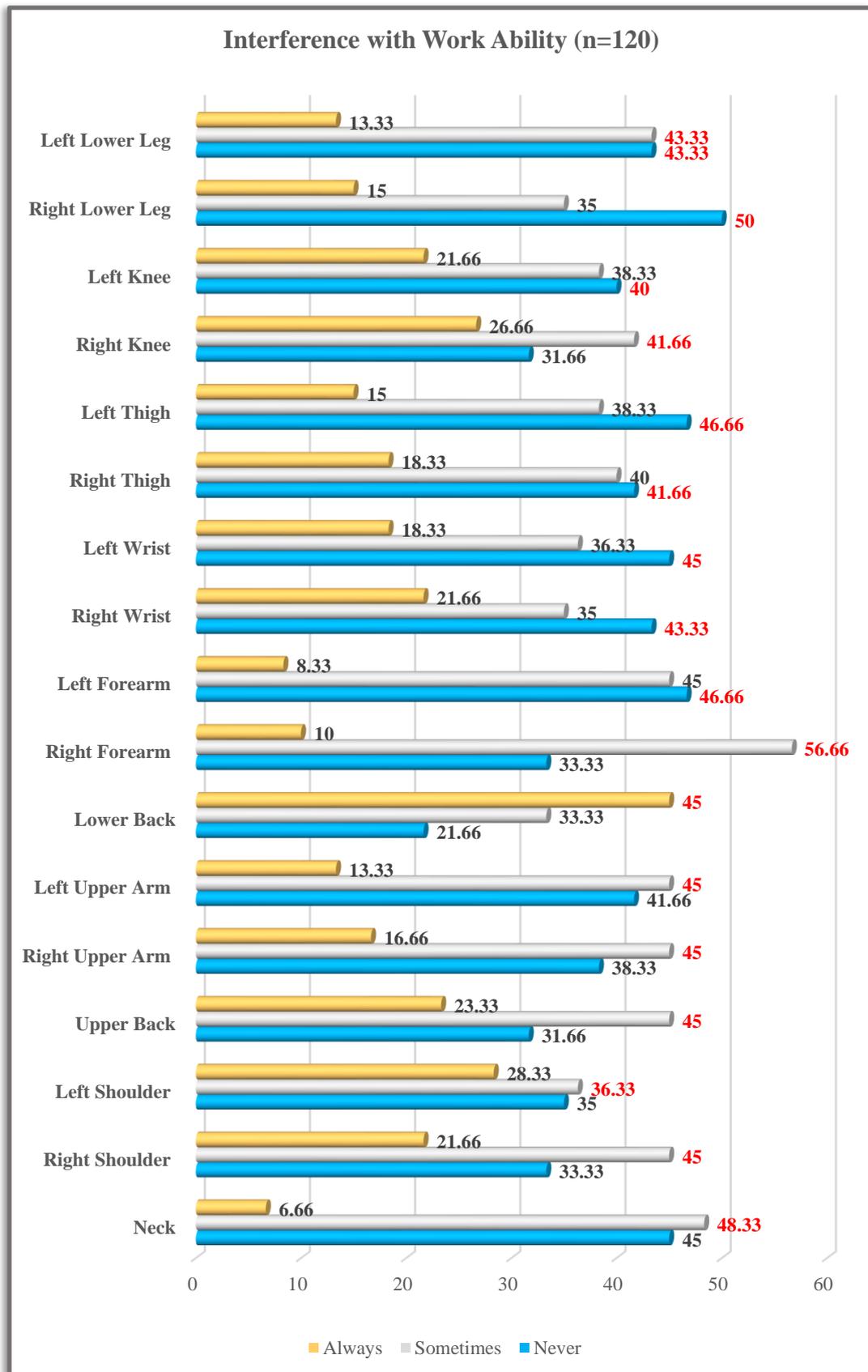


Figure 12: Percentage distribution of respondents according to Interference with Work Ability due to Musculoskeletal Discomfort experienced by the respondents during the last work week

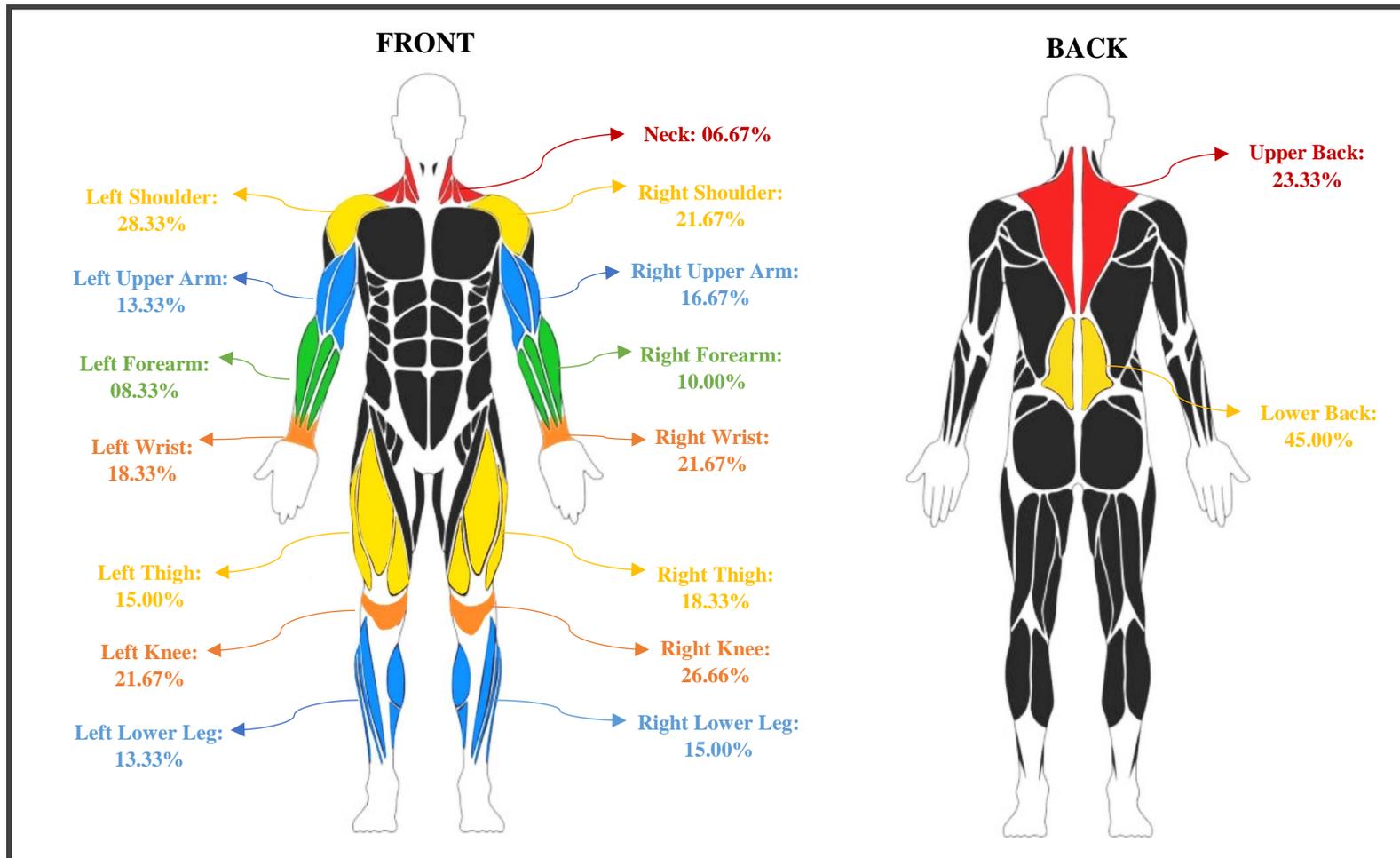
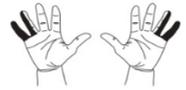


Figure 13: Interference with Work Ability due to Musculoskeletal Discomfort experienced by the respondents in various body parts during the last work week

4.2.1 Extent of Musculoskeletal Discomfort experienced in the Hands by the Auto Rickshaw Drivers

This section explored the Musculoskeletal Discomfort experienced by the Auto Rickshaw Drivers in their hands, focusing on three key aspects: Musculoskeletal Discomfort, level of discomfort experienced, and its interference with work ability during the last work week. The anatomical regions affected included the radial region, ulnar region, entire thumb, metacarpophalangeal region, thenar region, and pisiform area.

Table 14: Frequency and Percentage distribution of the respondents according to the Musculoskeletal Discomfort experienced in the Hands during the last work week

Musculoskeletal Discomfort experienced by the respondents in the Hands during Last Work Week (n=120)																					
Anatomical Regions of the Hands		Right Hand										Left Hand									
		Several times a day		Once every day		3-4 times last week		1-2 times last week		Never		Several times a every day		Once every day		3-4 times last week		1-2 times last week		Never	
		f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
Radial Region		02	01.67	04	03.33	04	03.33	26	21.67	84	70.00	06	05.00	24	01.67	16	13.33	22	18.33	74	61.67
Ulnar Region		02	01.67	03	02.50	11	09.16	26	21.67	78	65.00	10	08.33	08	06.66	07	05.84	15	12.50	80	66.67
Entire Thumb		04	03.33	02	01.67	12	10.00	22	18.33	80	66.67	07	05.84	09	07.49	13	10.84	11	09.16	80	66.67
Metacarpophalangeal Region		08	06.66	02	01.67	18	15.00	26	21.67	66	55.00	14	11.67	10	08.33	06	05.00	26	21.67	64	53.33
Thenar Eminence		10	08.33	02	01.67	16	13.33	28	23.33	64	53.34	16	13.33	06	05.00	14	11.67	20	16.67	64	53.33
Pisiform Area		08	06.66	06	05.00	10	08.33	22	18.33	74	61.67	12	10.00	08	06.66	14	11.67	20	16.67	66	55.00

Musculoskeletal Discomfort experienced by the respondents in the Hands during Last Work Week

The findings in Table 14 and Figure 14 and 15 revealed that 23.33 per cent of the respondents experienced Musculoskeletal Discomfort since 1-2 times per week in the thenar eminence of the right hand, followed by 21.67 per cent of the respondents experienced Musculoskeletal Discomfort since 1-2 times per week in the radial, ulnar and metacarpophalangeal regions of the right hand. A similar percentage (18.33 per cent) of the respondents also experienced Musculoskeletal Discomfort in their Entire Thumb and Pisiform Area of the right hand and radial region of the left hand since 1-2 times per week.

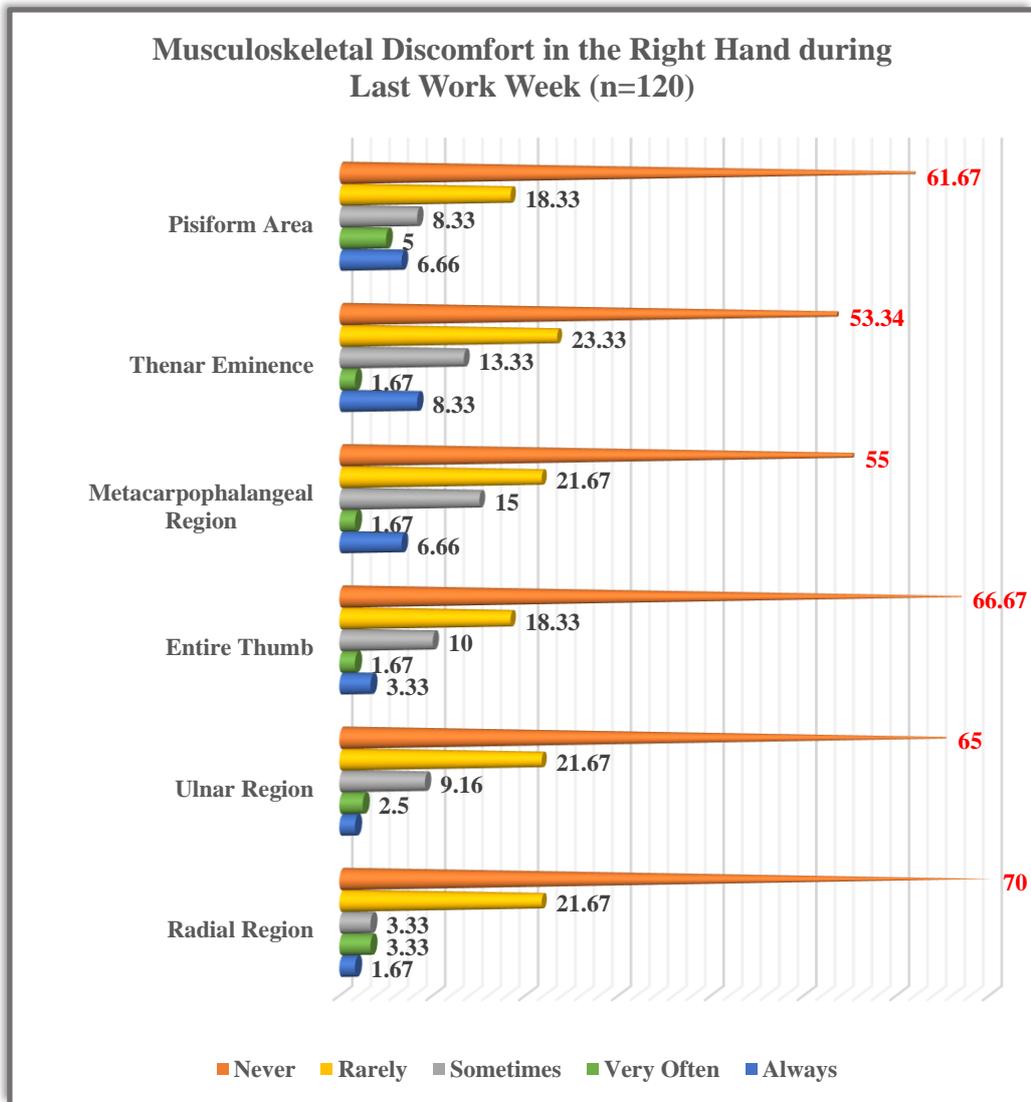


Figure 14: Percentage distribution of respondents according to the Musculoskeletal Discomfort experienced by the respondents in the Right Hand during the last work week

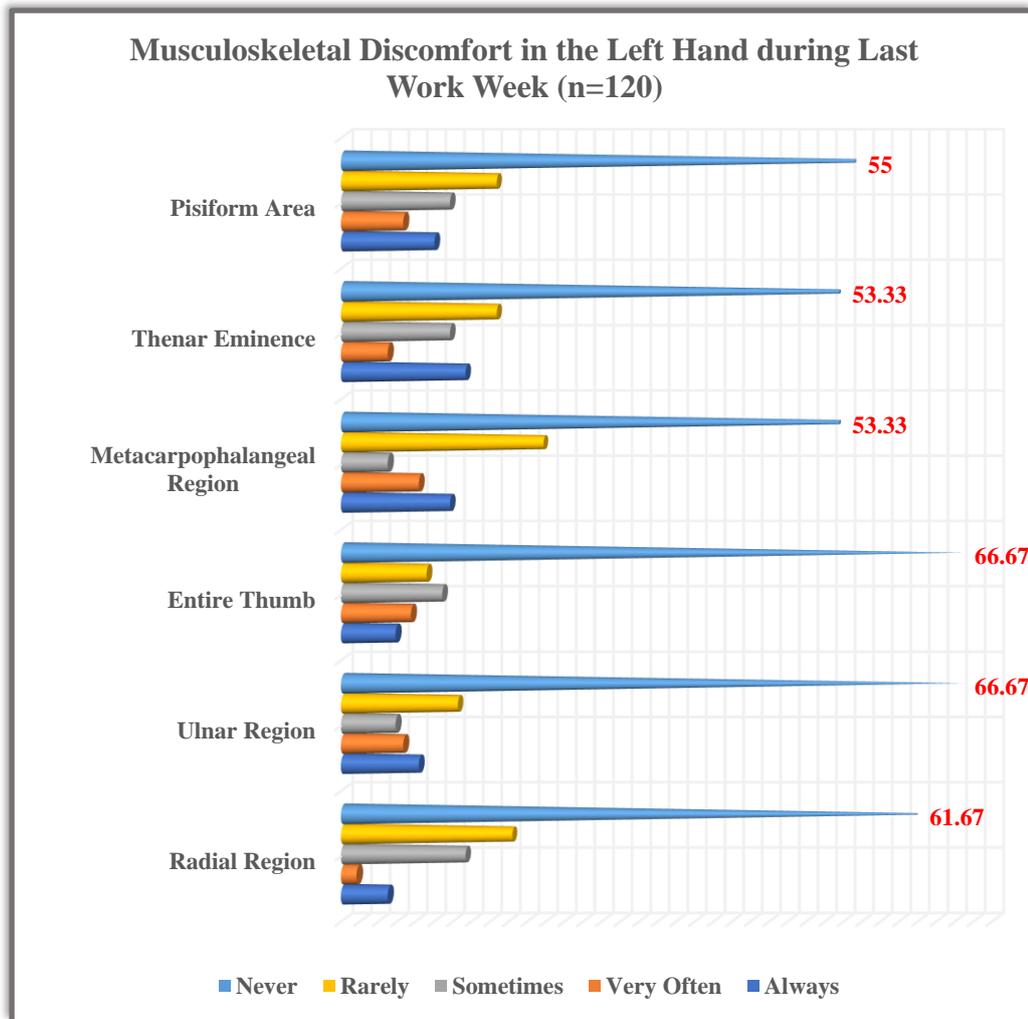


Figure 15: Percentage distribution of respondents according to the Musculoskeletal Discomfort experienced by the respondents in the Left Hand during the last work week

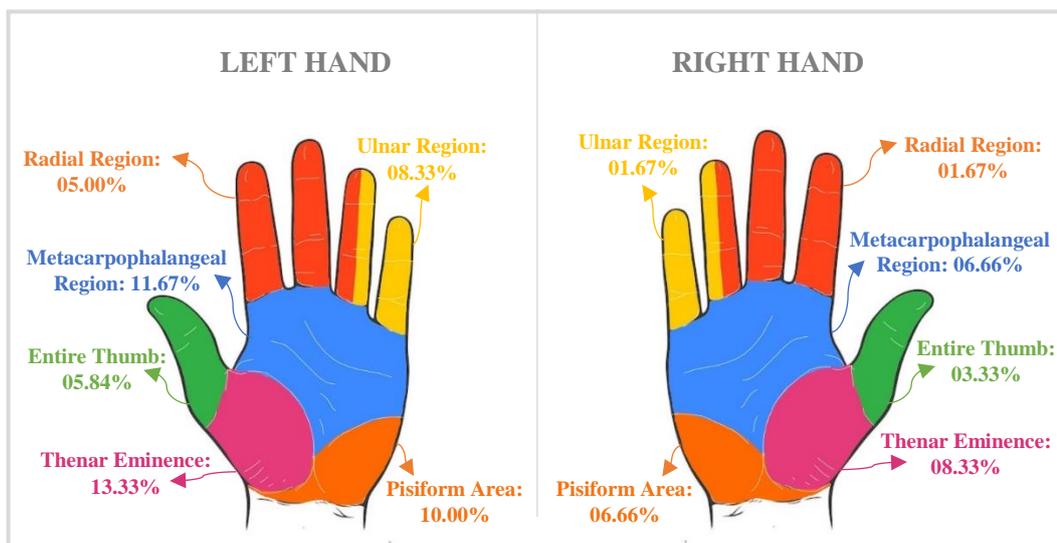
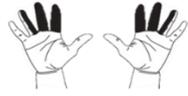
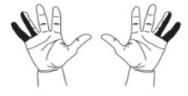
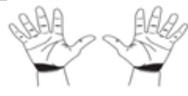


Figure 16: Musculoskeletal Discomfort experienced by the respondents in the Anatomical Regions of the Hands during the last work week

Table 15: Frequency and Percentage distribution of the respondents according to the Level of Discomfort experienced due to Musculoskeletal Discomfort in the Hands during the last work week

Level of Discomfort experienced by the respondents in the Hands during the last work week (n=120)													
Anatomical Regions of the Hands		Right Hand						Left Hand					
		High Discomfort		Moderate Discomfort		Low Discomfort		High Discomfort		Moderate Discomfort		Low Discomfort	
		f	%	f	%	f	%	f	%	f	%	f	%
Radial Region		14	11.67	102	85.00	04	03.33	26	21.67	80	66.66	14	11.67
Ulnar Region		22	18.33	92	76.67	06	05.00	16	13.33	84	70.00	20	16.67
Entire Thumb		21	17.50	90	75.00	09	07.50	14	11.66	82	68.33	24	20.00
Metacarpophalangeal Region		32	26.67	78	65.00	10	08.33	28	23.33	72	60.00	20	16.67
Thenar Eminence		42	35.00	74	61.67	04	03.33	24	20.00	76	63.33	20	16.67
Pisiform Area		16	13.33	90	75.00	14	11.67	34	28.33	72	60.00	14	11.67

Level of Discomfort experienced by the respondents in the Hands during the last work week

The data in the Table 15 and figure 17 and 18 revealed that 85.00 per cent of the respondents experienced moderate level of discomfort in their radial region of right hand, followed by 76.66 per cent of the respondents experienced moderate level of discomfort in ulnar region in their right hand. A similar percentage (75.00 per cent) of the respondents experienced moderate level of discomfort in entire thumb and pisiform area of their right hand. The findings also revealed that 68.33 per cent of the respondents experienced moderate level of discomfort in their entire thumb of left hand. Followed by 66.66 per cent of the respondents experienced moderate level of discomfort in radial region in their left hand. A similar percentage (60.00 per cent) of the respondents experienced moderate level of discomfort in their Metacarpophalangeal Region and Pisiform Area of left hand.

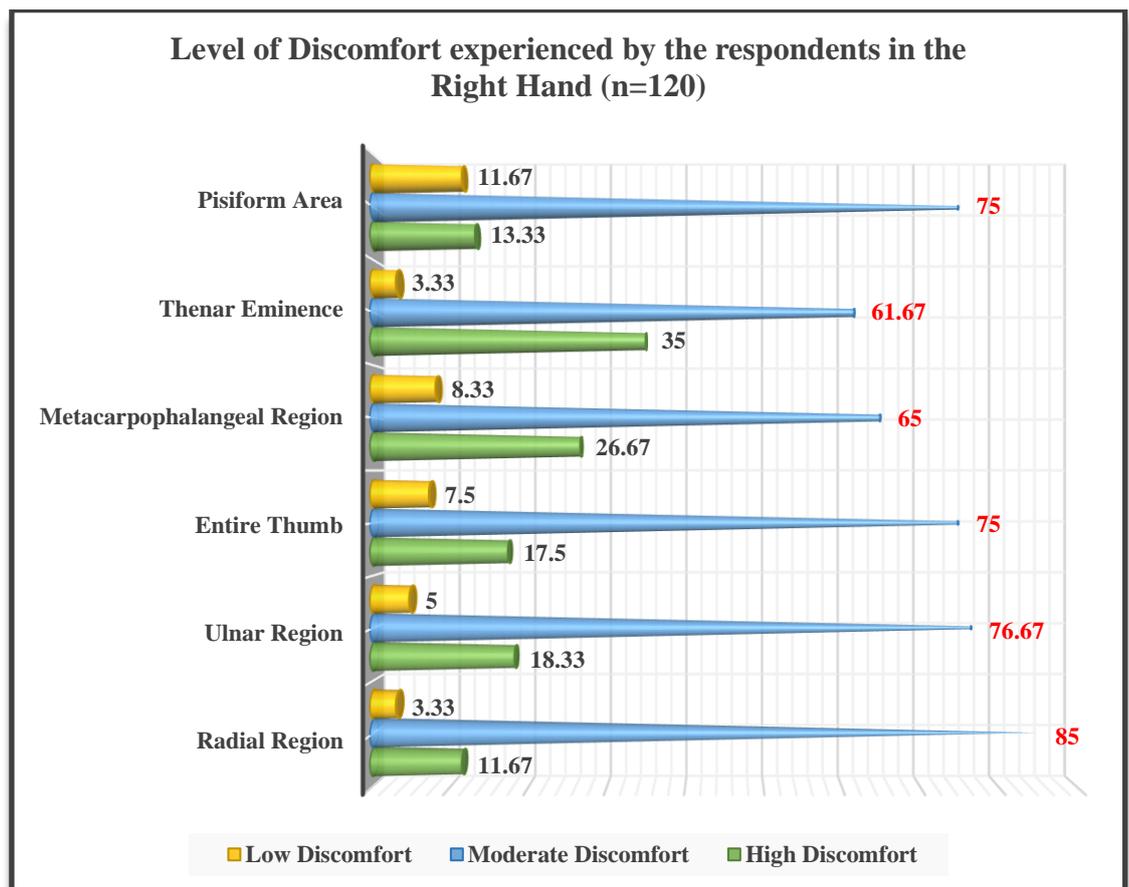


Figure 17: Percentage distribution of the respondents according to the Level of Discomfort experienced due to Musculoskeletal Discomfort experienced by the respondents in the Right Hand during the last work week

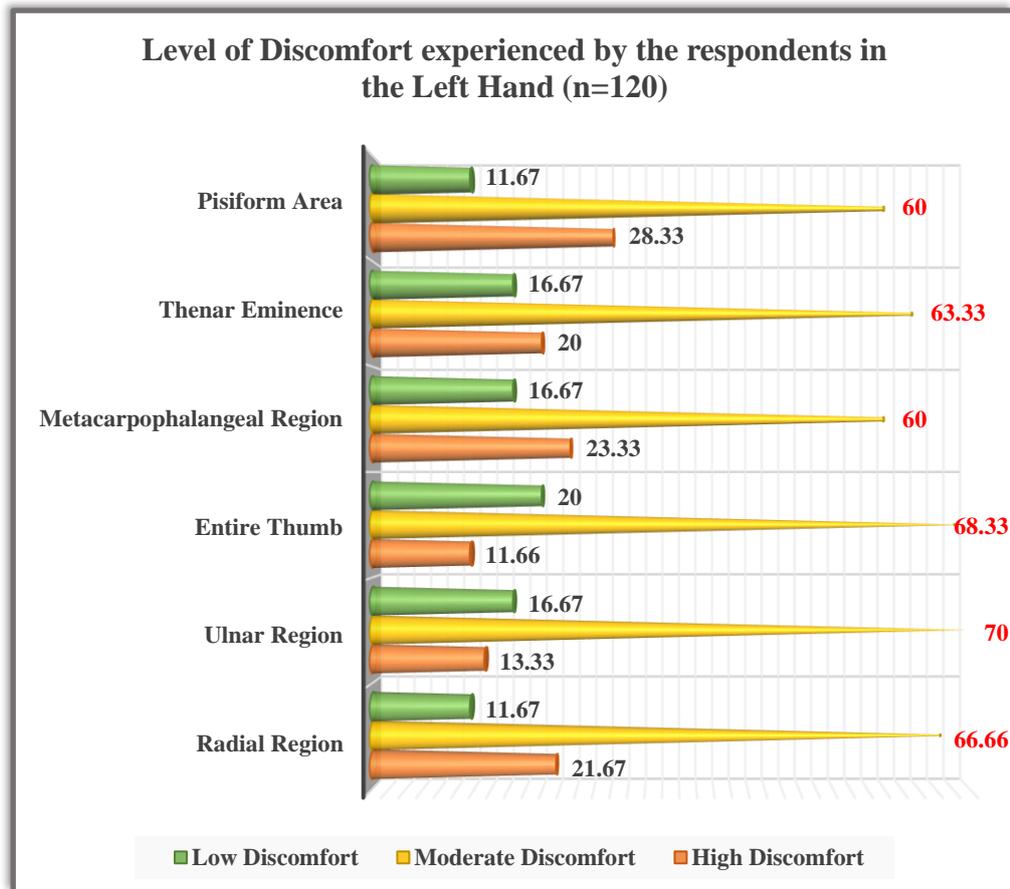


Figure 18: Percentage distribution of respondents according to the Level of Discomfort experienced due to Musculoskeletal Discomfort experienced by the respondents in the Left Hand during the last work week

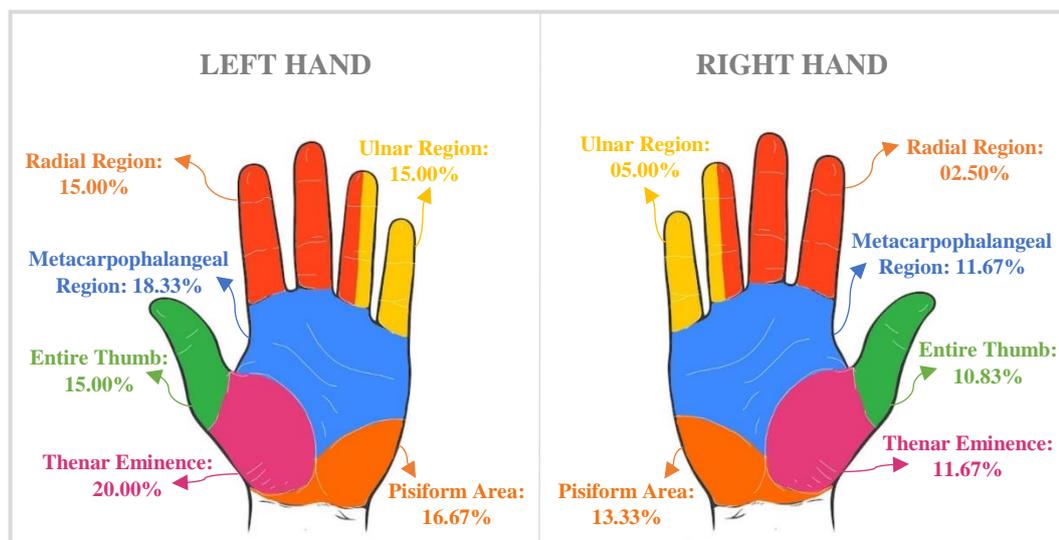
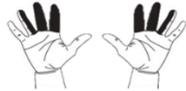
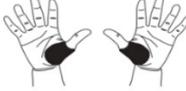
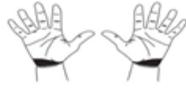


Figure 19: Level of Discomfort experienced due to Musculoskeletal Discomfort experienced in the Anatomical Regions of the Hands by the respondents during the last work week

Table 16: Frequency and Percentage distribution of respondents according to the Interference with Work Ability due to Musculoskeletal Discomfort experienced in the Hands during the last work week

Interference with Work Ability due to Musculoskeletal Discomfort experienced by the respondents in the Hands (n=120)													
Anatomical Regions of the Hands		Right Hand						Left Hand					
		Always		Sometimes		Never		Always		Sometimes		Never	
		f	%	f	%	f	%	f	%	f	%	f	%
Radial Region		03	02.50	92	76.66	25	20.84	18	15.00	82	68.33	20	16.67
Ulnar Region		06	05.00	90	75.00	24	20.00	18	15.00	80	66.67	22	18.33
Entire Thumb		13	10.83	86	71.67	21	17.50	18	15.00	86	71.67	16	13.33
Metacarpophalangeal Region		14	11.67	70	58.33	36	30.00	22	18.33	68	56.67	30	25.00
Thenar Eminence		14	11.67	72	60.00	34	28.33	24	20.00	64	53.33	32	26.67
Pisiform Area		16	13.33	86	71.67	18	15.00	20	16.67	72	60.00	28	23.33

Interference with Work Ability due to Musculoskeletal Discomfort experienced by the respondents in the Hands during the last work week

The data in the Table 16 and Figure 20 and 21 revealed that 76.66 per cent of the respondents sometimes experienced interference in work due to musculoskeletal discomfort in radial region of their right hand, followed by 75.00 per cent of the respondents sometimes experienced interference in work due to musculoskeletal discomfort in ulnar region of right hand. A similar percentage (71.67 per cent) of the respondents sometimes experienced interference in work due to musculoskeletal discomfort in entire thumb of both right and left hand and pisiform area of right hand. The data also reported that 68.33 per cent of the respondents sometimes experienced interference with work ability due to musculoskeletal discomfort in radial region of left hand. The data of the left hand also revealed that 66.67 per cent of the respondents sometimes experienced interference in work ability due to musculoskeletal discomfort in ulnar region.

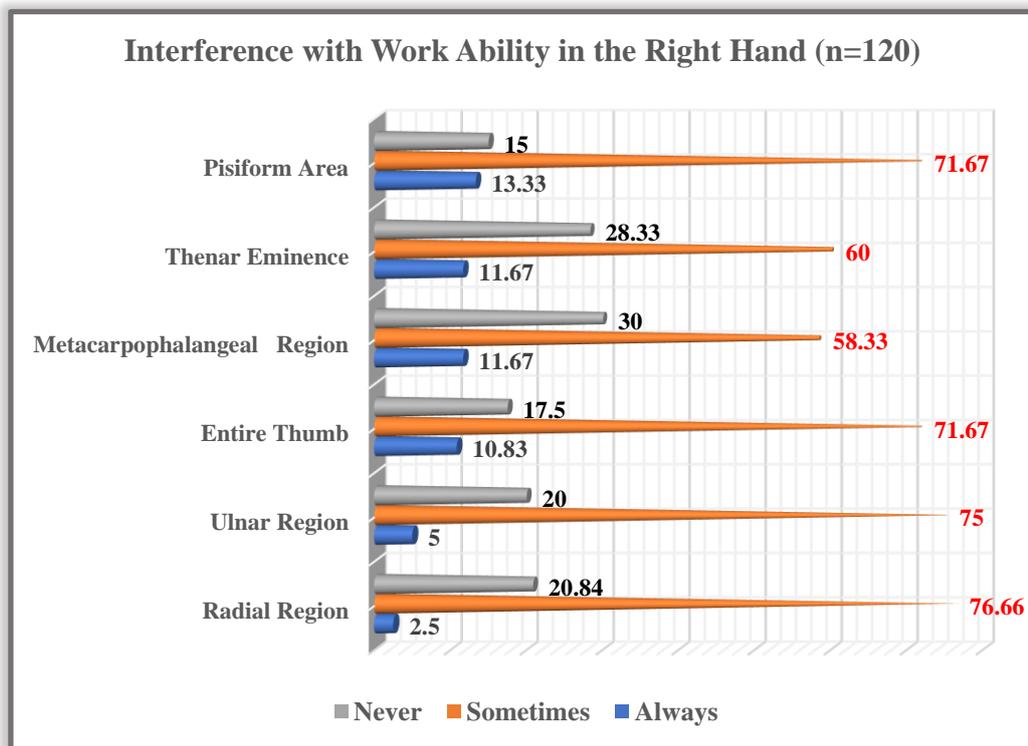


Figure 20: Percentage distribution of respondents according to the Interference with Work Ability due to Musculoskeletal Discomfort experienced by the respondents in the Right Hand during the last work week

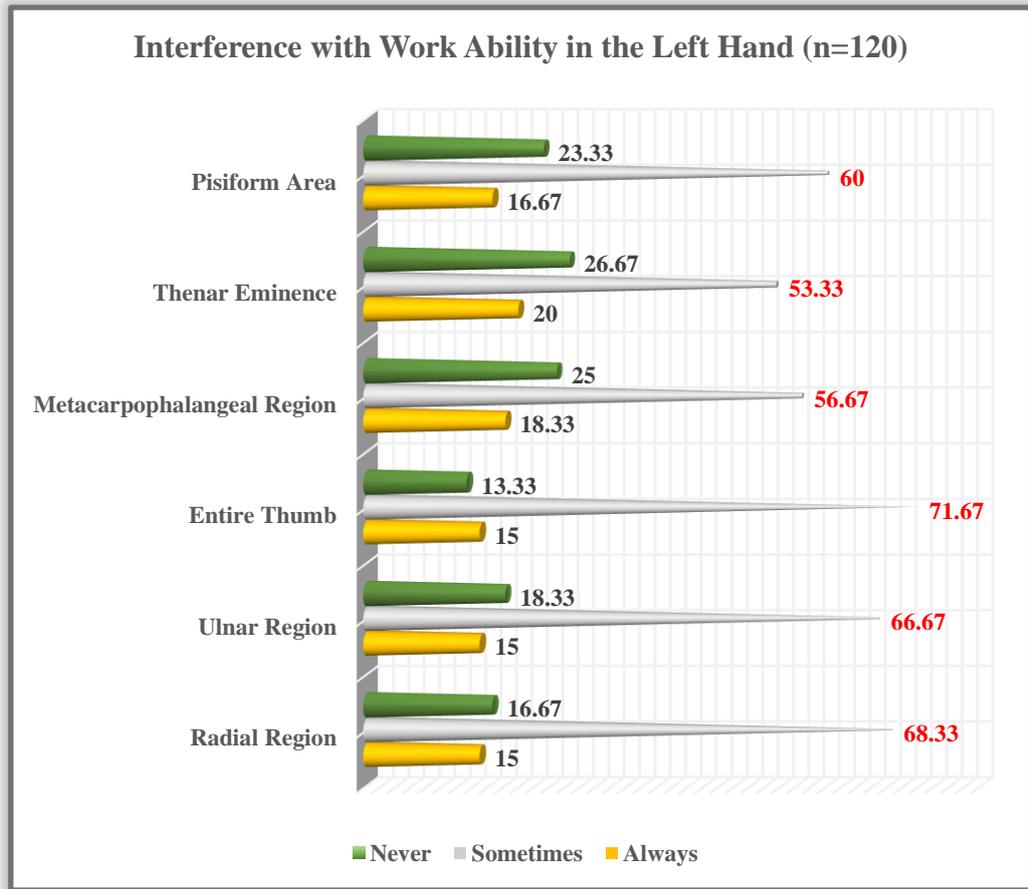


Figure 21: Percentage distribution of respondents according to the Interference with Work Ability due to Musculoskeletal Discomfort experienced by the respondents in the Left Hand during the last work week

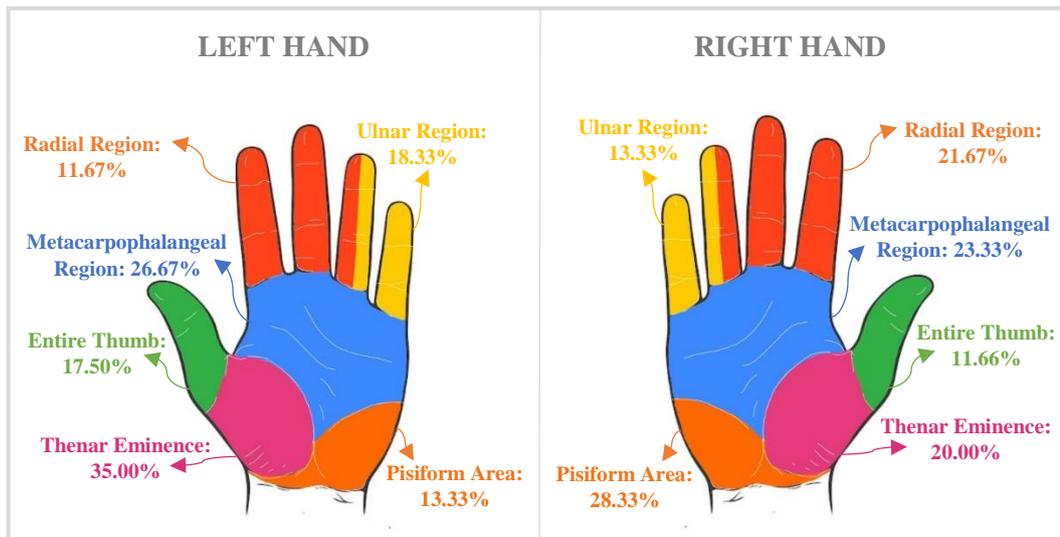


Figure 22: Interference with Work Ability due to Musculoskeletal Discomfort experienced by the respondents in the Anatomical Regions of the Hands during the last work week

SECTION III

4.3 Extent of Postural Discomfort experienced by the respondents

This section dealt with the psychosocial factors, discomfort caused by physical factors, and the adopted driving postures while driving contributing to postural discomfort among the Auto Rickshaw Drivers.

4.3.1 Psychosocial Factors

This section dealt with the psychosocial factors contributing to stress among Auto Rickshaw Drivers. It highlights various sources of stress, including financial uncertainty, long working hours, traffic congestion, passenger behavior, physical discomfort, safety concerns, and work-life balance challenges. Additionally, it addressed how interactions with authorities, unpredictable income, and health-related worries impact their overall well-being.

Table 17: Frequency and Percentage distribution of the respondents according to their Psychosocial Factors

Sr. No.	Statements regarding Psychosocial Factors	Respondents (n=120)										Weighted Mean 5-1
		Very High		High		Moderate		Low		Very Low		
		f	%	f	%	f	%	f	%	f	%	
1.	Stress is experienced due to uncertainty in daily income.	12	10.00	20	16.67	24	20.00	22	18.33	42	35.00	2.48
2.	Long driving hours contribute to significant stress.	14	11.67	24	20.00	24	20.00	36	30.00	22	18.33	2.76
3.	Heavy traffic and congestion increase stress levels while driving.	18	15.00	24	20.00	30	25.00	28	23.33	20	16.67	2.93
4.	Passenger behavior, especially when rude or difficult, causes stress.	13	10.83	38	31.67	22	18.33	40	33.33	7	05.84	2.98
5.	Physical discomfort experienced while driving adds to stress.	35	29.17	17	14.17	22	18.33	34	28.33	12	10.00	3.23
6.	Safety concerns, such as the risk of accidents or crime, cause stress.	18	15.00	24	20.00	20	16.67	40	33.33	18	15.00	2.86
7.	Competition with other Auto Rickshaw Drivers for passengers increases stress.	24	20.00	12	10.00	26	21.67	32	26.66	26	21.67	2.8
8.	Earning enough money to cover daily expenses is a source of stress.	28	23.33	21	17.50	26	21.67	26	21.67	19	15.83	3.08
9.	The costs of maintaining and repairing the auto rickshaw contribute to stress.	20	16.67	22	18.33	24	20.00	28	23.33	26	21.67	2.85
10.	Driving in extreme weather conditions e.g., heat, rain elevates stress levels.	15	12.50	14	11.67	37	30.83	24	20.00	30	25.00	2.7
11.	Lack of sufficient rest or breaks during the workday leads to stress.	18	15.00	30	25.00	20	16.67	28	23.33	24	20.00	2.91
12.	Balancing work with family responsibilities contributes to stress.	18	15.00	24	20.00	26	21.67	30	25.00	22	18.33	2.88
13.	Interactions with traffic police or other authorities add to stress levels.	22	18.33	30	25.00	18	15.00	24	20.00	26	21.67	2.98
14.	Unpredictability in the number of passengers or trips per day causes stress.	20	16.67	28	23.33	28	23.33	18	15.00	26	21.66	2.98
15.	Worry about the potential impact of illness or injury on the ability to work contributes to stress.	36	30.00	16	13.33	16	13.33	32	26.67	20	16.67	3.13

Psychosocial Factors

The data in the Table 17 and Figure 23 revealed that 31.67 per cent of the respondents experienced high psychosocial stress due to Passenger behavior, especially when rude or difficult, followed by 25.00 per cent of the respondents experienced high psychosocial stress due to Lack of sufficient rest or breaks during the workday leads to stress and Interactions with traffic police or other authorities. The data also reported that very high stress was experienced among 30 per cent of the respondents due to worry about the potential impact of illness or injury on the ability to work contributes to stress. The data also revealed that 29.17 per cent of the respondents experienced very high psychosocial stress due to Physical discomfort experienced while driving. A similar percentage (23.33 per cent) of the respondents experienced very high stress due to Earning money which covered only daily expenses and high stress was experienced due to unpredictability in the number of passengers or trips per day respectively. Very high stress among 20 per cent of the respondents was reported due to Competition with other Auto Rickshaw Drivers for passengers, followed by 20 per cent of the respondents experienced high psychosocial stress due to long driving hours, heavy traffic and congestion while driving, safety concerns, such as the risk of accidents or crime and balancing work with family responsibilities.

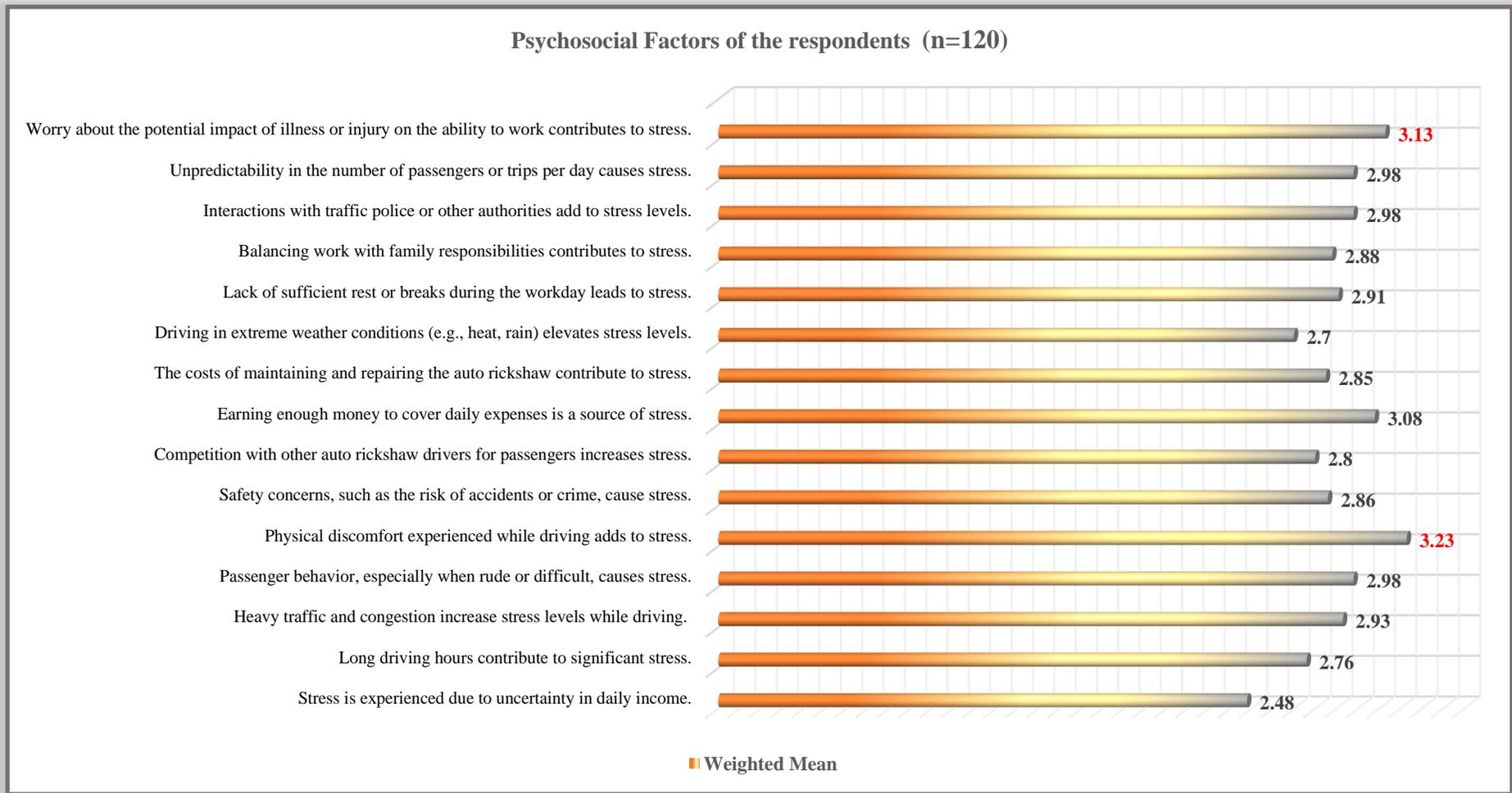


Figure 23: Weighted mean scores for Psychosocial Factors of the respondents

4.3.2 Extent of Postural Discomfort experienced due to Physical Factors of the respondents

This section examined the physical discomfort experienced by the Auto Rickshaw Drivers due to their driving posture. It evaluated various body postures such as arm, wrist, trunk, neck, feet, leg, hip and sitting posture, seat design and vibration exposure.

Table 18: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Arm and Wrist while driving

Sr. No.	Statements regarding Arm and Wrist	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
A	Arm						
1.	Frequent adjustments of the seat while driving.	14	11.67	10	08.33	96	80.00
2.	Frequent adjustments of the steering while driving.	90	75.00	18	15.00	12	10.00
3.	Presence of an armrest or a place to rest the arm while driving.	10	08.33	26	21.67	84	70.00
B	Wrist						
1.	Steering wheel grip is comfortable.	38	31.67	42	35.00	40	33.33
2.	High force is applied to the steering wheel while driving.	32	26.67	64	53.33	24	20.00
3.	Discomfort is experienced in hands due to steering the auto rickshaw.	44	36.67	42	35.00	34	28.33

Physical factor related to Arm

The data in table 18 and figure 24 revealed that 75.00 per cent of the respondents always experienced postural discomfort due to Frequent adjustments of the

steering while driving. The data also revealed that 70.00 per cent of the respondents never experienced postural discomfort due to presence of an armrest or a place to rest the arm while driving.

Physical factor related to Wrist

The data in Table 18 and Figure 19 revealed that 36.67 per cent of the respondents always experienced postural discomfort due to steering the Auto Rickshaw, followed by 31.67 per cent of the respondents always experienced postural discomfort due to steering wheel grip.

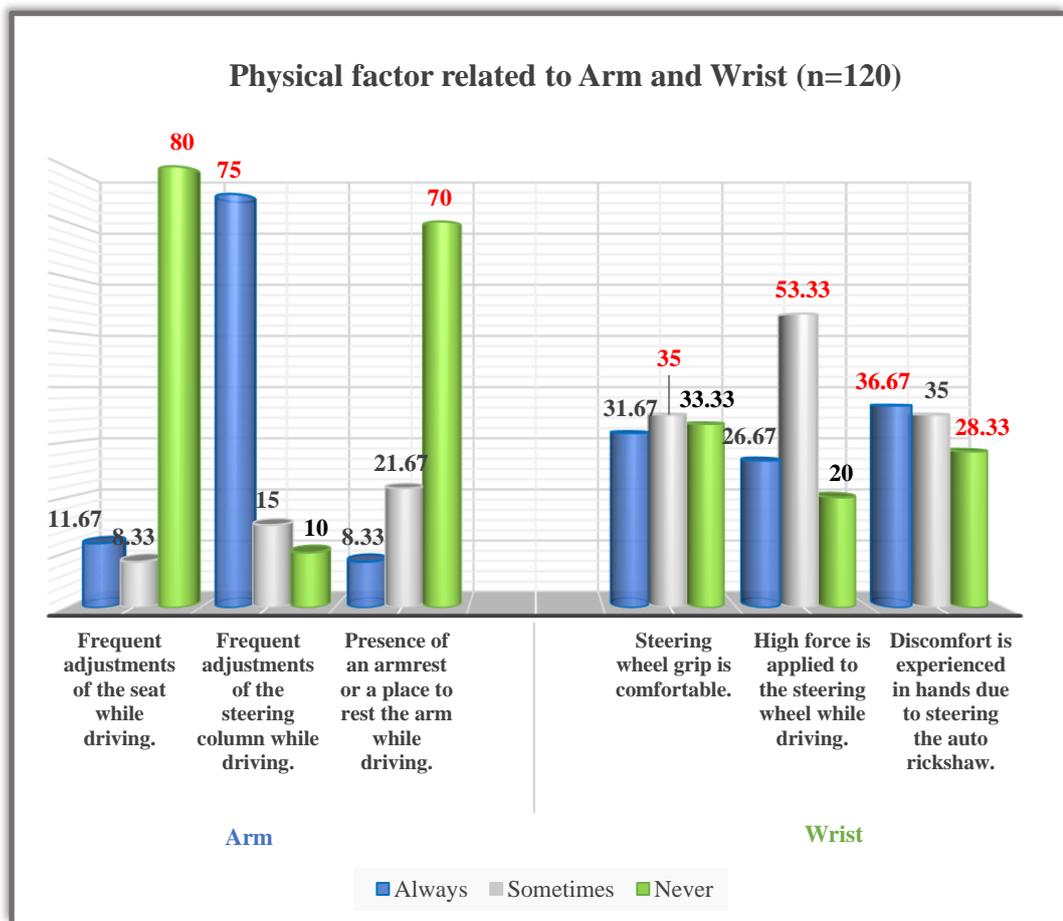


Figure 24: Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Arm and Wrist while driving

Table 19: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Trunk and Neck while driving

Sr. No.	Statements regarding Trunk and Neck	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
C	Trunk						
1.	Trunk is tilted while driving.	32	26.67	68	56.66	20	16.67
2.	Trunk bends to the side while driving.	20	16.67	82	68.33	18	15.00
D	Neck						
1.	Neck is tilted while driving.	54	45.00	48	40.00	18	15.00
2.	Neck bends to the side while driving.	52	43.33	50	41.67	18	15.00

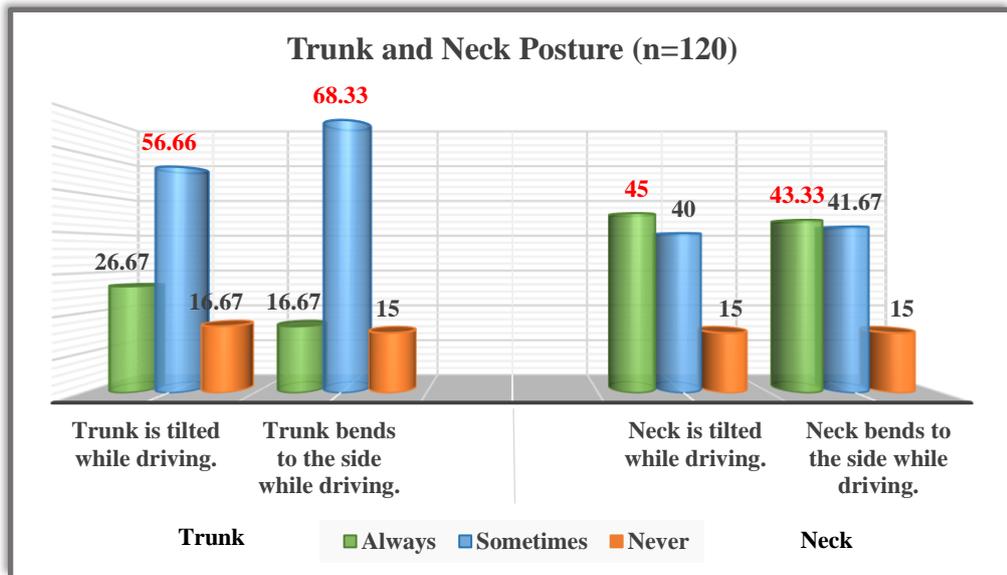


Figure 25: Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Trunk and Neck while driving

Physical Factors related to Trunk

The data in Table 19 and Figure 25 revealed that 68.33 per cent of the respondents sometimes had Postural Discomfort due to bending their trunk to the side while driving, followed by 56.66 per cent of the respondents sometimes experienced Postural Discomfort due to tilting their trunk while driving, whereas, 16.67 per cent of the respondents never tilted their trunk while driving.

Physical Factors related to Neck

The data in Table 19 and Figure 25 revealed that 45.00 per cent of the respondents always and 40.00 per cent of the respondents sometimes experienced Postural Discomfort due to tilting their neck while driving, followed by 43.33 per cent of the respondents always and 41.67 per cent of the respondents sometimes experienced Postural Discomfort due to bending neck to the side.

Table 20: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Feet and Leg Posture while driving

Sr. No.	Statement regarding Feet and Leg	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
E	Feet						
1.	Lack of feet support in the vehicle.	48	40.00	40	33.33	32	26.67
2.	Pain is experienced in the feet while driving.	58	48.34	40	33.33	22	18.33
3.	Discomfort is experienced in the ankles while driving.	60	50.00	42	35.00	18	15.00
F	Leg						
1.	Discomfort is experienced in the legs while driving.	62	51.67	30	25.00	28	23.33
2.	Fatigue in the legs after driving for an extended period.	54	45.00	42	35.00	24	20.00
3.	Feeling numbness in the legs while driving.	46	38.33	42	35.00	32	26.67

Physical Factors related to Feet

The data in Table 20 and Figure 26 revealed that 50.00 per cent of the respondents always experienced postural discomfort in the ankles while driving, followed by 48.34 per cent of the respondents always experienced postural discomfort due to pain in feet while driving. A similar percentage (33.33 per cent) of the respondents

sometimes experienced postural discomfort due to lack of feet support in the vehicle and pain in the feet while driving.

Physical Factors related to Leg

The data in Table 20 and Figure 26 revealed that 51.67 per cent of the respondents always experienced discomfort in the legs while driving, followed by 45.00 per cent of the respondents always experienced postural discomfort due to fatigue in the legs after driving for an extended period. A similar percentage (35.00 percent) of the respondents sometimes experienced postural discomfort due to fatigue in the legs after driving for an extended period and numbness in the legs while driving.

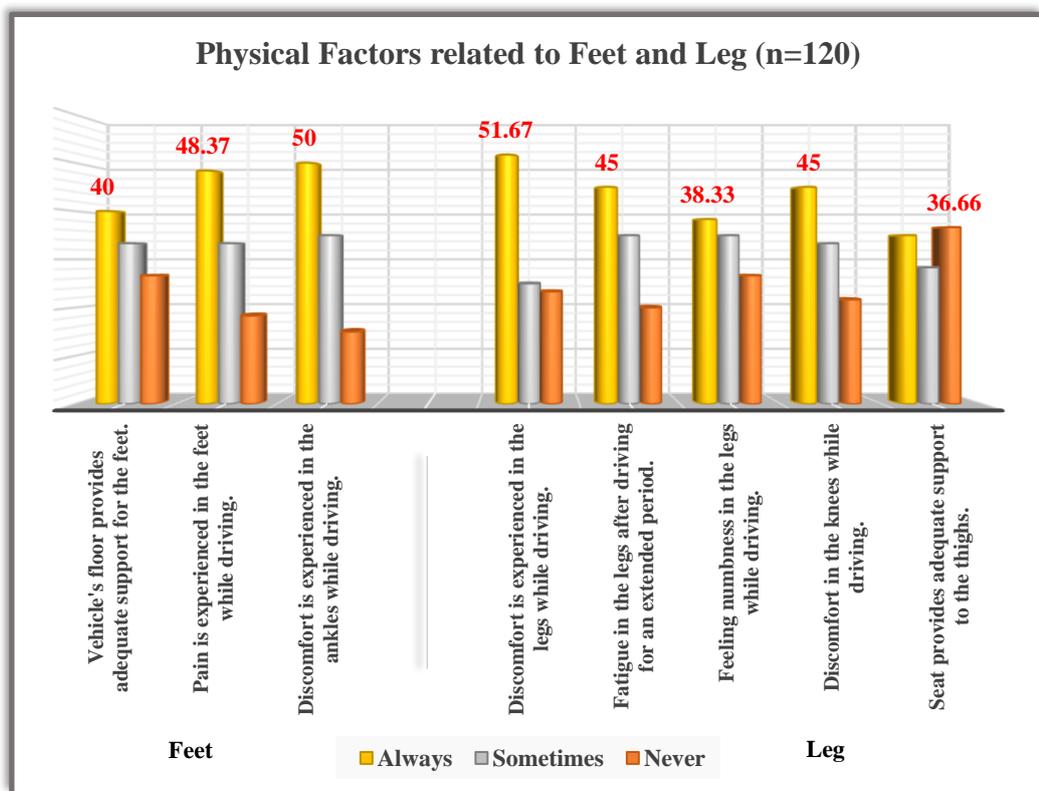


Figure 26: Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Feet and Leg while driving

Table 21: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Hip and Vibration Exposure while driving

Sr. No.	Statements regarding Hip and Vibration Exposure	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
G	Hip						
1.	Frequent alignments of the hips are made.	48	40.00	48	40.00	24	20.00
2.	Frequent adjustments of the hip position are made while driving.	54	45.00	56	46.67	10	08.33
3.	Discomfort is experienced in the hips while driving.	62	51.67	38	31.66	20	16.67
H	Vibration Exposure						
1.	Feeling severe vibrations while driving.	56	46.67	46	38.33	18	15.00
2.	Vibrations while driving affect specific parts of the body.	60	50.00	44	36.67	16	13.33

Physical Factors related to Hip Posture

The data in the Table 21 and Figure 27 revealed that 51.67 per cent of the respondents always experienced postural discomfort in the hips while driving, followed by 46.67 per cent of the respondents sometimes experienced discomfort in the hips while driving and 45.00 per cent of the respondents always experienced postural discomfort due to frequent adjustments of the hip position while driving. A similar percentage (40.00 per cent) of the respondents experienced postural discomfort due to frequent alignment of hips while driving always and sometimes respectively.

Physical Factors related to Vibration Exposure

The data in the Table 21 and Figure 27 revealed that 50.00 per cent of the respondents always experienced postural discomfort due to vibrations affected

specific parts of the body while driving, followed by 46.67 per cent of the respondents always experienced postural discomfort due to severe vibrations felt while driving and 36.67 of the respondents sometimes experienced postural discomfort due to Vibrations while driving affect specific parts of the body.

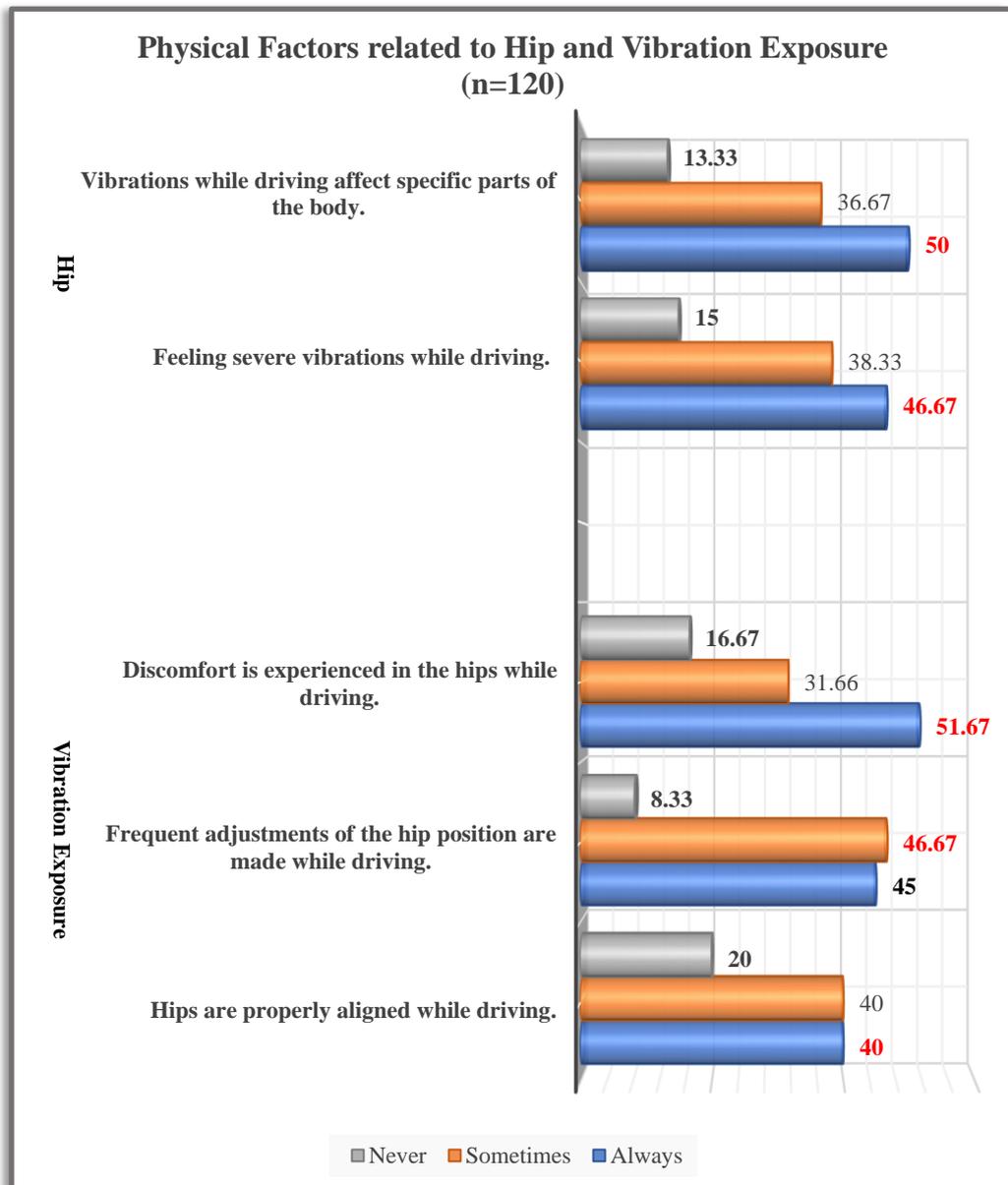


Figure 27: Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Hip and Vibration Exposure while driving

Table 22: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Seat Design and Comfort Factors of the Work Station

Sr. No.	Statements regarding Seat Design and Comfort Factors of the Work Station	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
1.	Seat in the auto rickshaw is comfortable.	44	36.67	39	32.50	37	30.83
2.	Seat requires modifications.	44	36.67	44	36.67	32	26.66
3.	Seat provides adequate support for the back and thighs.	40	33.33	24	20.00	56	46.67
4.	Seat effectively reduces the impact of vibrations while driving.	34	28.33	26	21.67	60	50.00
5.	Seat can be easily adjusted to achieve a comfortable driving position.	24	20.00	22	18.33	74	61.67
7.	Seat is durable in terms of wear and tear.	39	32.50	37	30.83	44	36.67
8.	Seat design affects driving posture.	64	53.33	18	15.00	38	31.67
9.	Additional supports e.g., cushions, lumbar support are used to improve sitting posture.	46	38.33	42	35.00	32	26.67

Physical factors related to Seat Design and Comfort Factors of the Work Station

The data in Table 22 and Figure 28 revealed that 61.67 per cent of the respondents never adjusted their seat to achieve a comfortable driving position, followed by 53.33 per cent of the respondents always experienced postural discomfort due to seat design while driving. The data also revealed that 50.00 per cent of the respondents never experienced reduction of impact of vibrations while driving,

followed by 46.67 per cent of the respondents never experienced adequate support for the back and thighs.

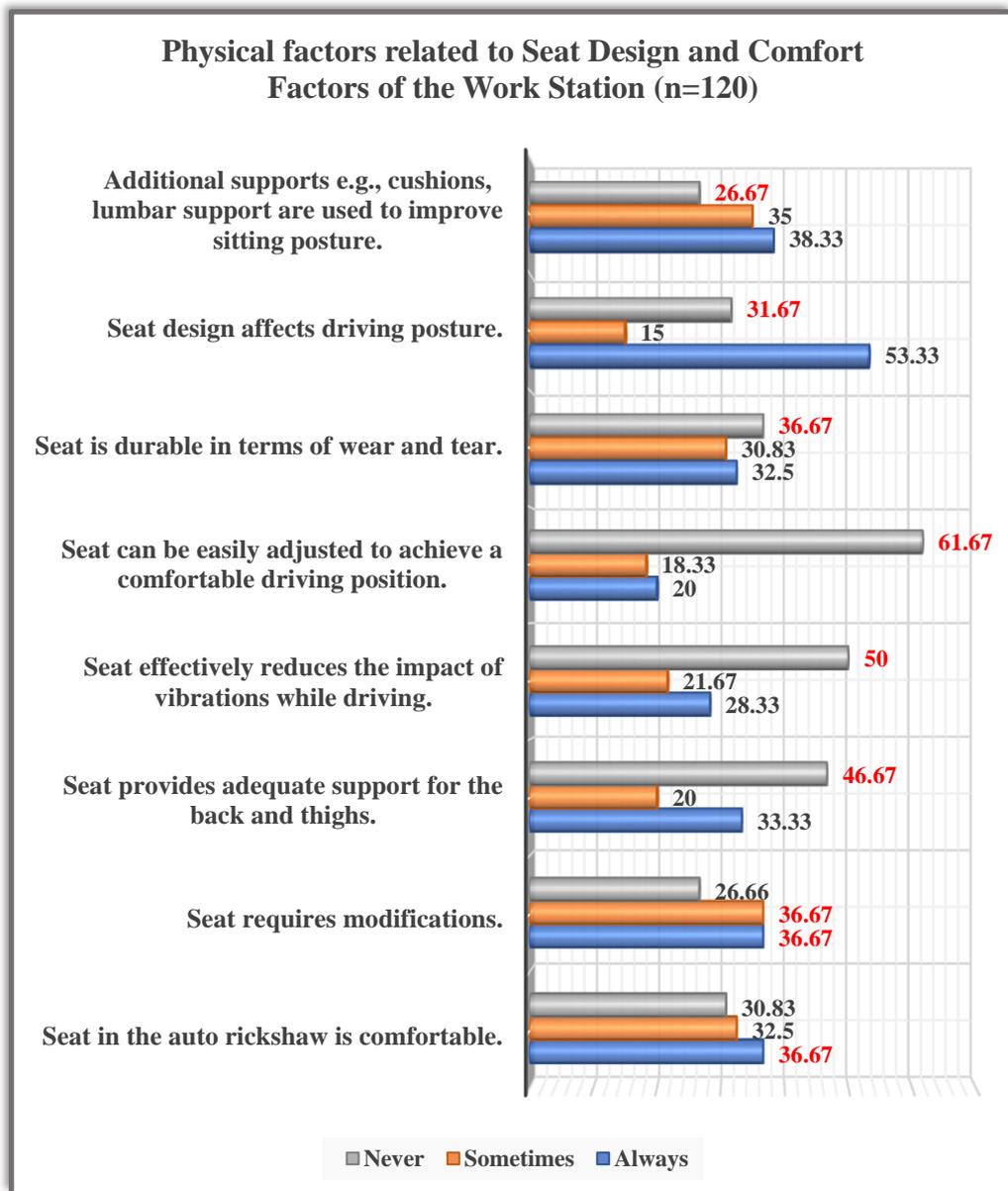


Figure 28: Percentage distribution of the respondents according to their Postural Discomfort experienced due to Physical factors related to Seat Design and Comfort Factors of the Work Station

4.3.3 Extent of Postural Discomfort experienced due to Postures adopted while driving by the respondents

This section analysed the postural discomfort experienced by the Auto Rickshaw Drivers due to their adopted driving postures. It focuses on various body postures such as Arm, Wrist, Trunk, Neck, Feet, Leg and Sitting.

Table 23: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to adopted Arm and Wrist Postures while driving

Sr. No.	Postures adopted while Driving	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
A. Arm Posture							
1.	 Bent at elbows at 90°	40	33.33	36	30.00	44	36.67
2.	 Bent at elbows at 120°	56	46.67	48	40.00	16	13.33
3.	 Arm Extended forward	56	46.67	40	33.33	24	20.00
B. Wrist Posture							
1.	 Slightly bent upwards	30	25.00	80	66.67	10	08.33
2.	 Neutral (Straight)	78	65.00	38	31.67	4	03.33
3.	 Slightly bent downwards	30	25.00	50	41.67	40	33.33

Arm Posture

The data in Table 23 and Figure 29 revealed that 46.67 per cent of the respondents always adopted arms posture wherein, the elbows were bent at elbows at 120° and the arms were always extended forward while driving respectively, followed by 40.00 per cent of the respondents sometimes adopted arms posture wherein, elbows bent at 120° while driving. A similar percentage (33.33 per cent) of the respondents always adopted arms posture wherein, the arms were bent at elbows at 90° and the arms were sometimes extended forward while driving.

Wrist Posture

The data in Table 23 and Figure 29 revealed that 66.67 per cent of the respondents sometimes adopted posture wherein, the wrist was slightly bent upwards while driving, followed by 65.00 per cent of the respondents always adopted posture wherein, the wrist was neutral (straight) while driving. The data also revealed that 41.67 per cent of the respondents sometimes adopted wrist posture wherein, the wrist was slightly bent downwards while driving.

Table 24: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to adopted Sitting Postures while driving

Sr. No.	Postures adopted while Driving	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
C.	Sitting Posture						
1.	 Upright with support	52	43.33	17	14.17	51	42.50
2.	 Slightly slouched	52	43.33	36	30.00	32	26.67
3.	 Leaning forward	36	30.00	14	11.67	70	58.33
4.	 Leaning backward	18	15.00	56	46.67	46	38.33

Sitting Posture

The data in Table 24 and Figure 29 revealed that 46.67 per cent of the respondents sometimes adopted leaning backward sitting posture while driving. A similar percentage (43.33 per cent) of the respondents always adopted upright and slightly slouched sitting posture while driving. The data also revealed that 30.00 per cent of the respondents always adopted leaning forward sitting posture whereas, same percentage of the respondents sometimes adopted slightly slouched sitting posture while driving.

Table 25: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to adopted Trunk and Neck Posture while driving

Sr. No.	Postures adopted while Driving	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
D.	Trunk Posture						
1.	 Straight and aligned with the seat	48	40.00	62	51.67	10	08.33
2.	 Leaning to one side	18	15.00	90	75.00	12	10
E.	Neck Posture						
1.	 Neutral and aligned	74	61.67	24	20.00	22	18.33
2.	 Slightly forward	20	16.67	58	48.33	42	35.00
3.	 Slightly backward	24	20.00	30	25.00	66	55.00
4.	 Bent to one side	16	13.33	86	71.67	18	15.00

Trunk Posture

The data in Table 25 and Figure 29 revealed that 75.00 per cent of the respondents sometimes adopted posture wherein, the trunk was leaning to one side while driving, followed by 40.00 per cent of the respondents always adopted posture wherein, the trunk was straight and aligned with the seat while driving.

Neck Posture

The data in Table 25 and Figure 29 revealed that 71.67 per cent of the respondents sometimes adopted posture wherein, the neck was bent to one side while driving, followed by 61.67 per cent of the respondents always adopted posture wherein, the neck was neutral and aligned with the seat while driving. The data also revealed that 48.33 per cent of the respondents sometimes adopted posture wherein, the neck was slightly forward while driving.

Table 26: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to adopted Feet Posture while driving

Sr. No.	Postures adopted while Driving	Respondents (n=120)					
		Always		Sometimes		Never	
		f	%	f	%	f	%
F.	Feet Posture						
1.	 Flat on the floor	38	31.67	34	28.33	48	40.00
2.	 Resting on the pedal	66	55.00	48	40.00	6	05.00
3.	 Hovering above the pedal	60	50.00	60	50.00	0	00.00
4.	 Slightly pointed upwards	52	43.33	54	45.00	14	11.67
5.	 Slightly pointed downwards	24	20.00	31	25.84	65	54.16
6.	 Alternating between positions	64	53.33	50	41.67	6	05.00

Feet Posture

The data in Table 26 and Figure 29 revealed that 55.00 per cent of the respondents always adopted posture wherein, the feet rested on the pedal while driving, followed by 53.33 per cent of the respondents always adopted posture wherein, the feet alternated between positions, while a similar percentage (50.00 per cent) of the respondents always and sometimes adopted posture wherein, the feet hovered above the pedal while driving. The data also revealed that 45.00 per cent of the respondents sometimes adopted posture wherein, the feet posture slightly pointed upwards while driving.

Table 27: Frequency and Percentage distribution of the respondents according to their Postural Discomfort experienced due to adopted Leg Posture while driving

Sr. No.	Postures adopted while Driving	Respondents (n=120)					
		Always		Always		Always	
		f	%	f	%	f	%
F.	Leg Posture						
1.	 Straight with knees slightly bent	26	21.67	54	45.00	40	33.33
2.	 Knees bent at 90°	52	43.33	54	45.00	14	11.67
3.	 Legs spread apart	58	48.33	26	21.67	36	30.00

Leg Posture

The data in Table 27 and Figure 29 revealed that 48.33 per cent of the respondents always adopted posture wherein, the legs were spread apart while driving, followed by a similar percentage (45.00 per cent) of the respondents sometimes adopted posture wherein, the legs were straight with knees slightly bent and knees bent at 90° while driving respectively.



Figure 29: Percentage distribution of the respondents according to their adopted Postural Discomfort experienced due to adopted postures

SECTION IV

4.4 Anthropometric Measurements of the respondents

This section analyzed the seated anthropometric measurements of the Auto Rickshaw Drivers to evaluate their ergonomic fit, comfort, and posture while driving. The mean, standard deviation, 95th, and 5th percentile values were computed for key parameters such as height, weight, sitting height, shoulder breadth, and limb lengths, which influence seat design, visibility, and ease of movement. Additionally, knee height, popliteal height, and thigh clearance were assessed to determine legroom and pedal reach, while backrest contact and hip breadth were examined to evaluate spinal support. The anthropometric measurements followed guidelines from Human Factors in Engineering and Design (7th ed.) by Sanders and McCormick (1993, p. 415).

Anthropometric Measurements of the respondents

The present study recorded the mean anthropometric measurements of the Auto Rickshaw Drivers, considering key dimensions related to their seated posture. The mean height of the respondents was 168.69 cm, while their mean weight was 70.57 kg. Sitting height, sitting eye height, and sitting shoulder height were logged as 89.40 cm, 81.35 cm, and 74.20 cm, respectively. Measurements such as shoulder breadth 38.79 cm, elbow rest height 21.42 cm, and thigh clearance 10.71 cm were analyzed to assess upper body posture and arm positioning during driving.

Lower body dimensions, including buttock-popliteal length 57.35 cm, knee height 48.07 cm, and popliteal height 40.86 cm, were measured to evaluate legroom and seating ergonomics. Additionally, hip breadth 33.73 cm, foot length 25.30 cm, and backrest contact point 60.79 cm were recorded to determine seat fit and lumbar support.

To accommodate variations among drivers, measurements were analyzed using the 5th, and 95th percentiles. According to Chauhan 2015, designing for a broad population requires considering the range between the 5th and 95th percentile, ensuring inclusivity and reducing discomfort. The standard deviations (SD) calculated in the study highlighted variations in anthropometric characteristics, essential for ergonomic interventions.

Table 28: Frequency and Percentage distribution of the respondents according to their Anthropometric Measurements

Sr. No.	Anthropometric Measurements (in cm)	Mean	SD	95th Percentile	5th Percentile
1.	Height	168.69	09.03	185	152
2.	Weight	70.57	13.53	97.05	50
3.	Sitting Height from seat to top of head	89.40	04.78	98.05	80.56
4.	Sitting Eye Height from seat to eyes	81.35	04.35	89.22	73.30
5.	Shoulder Breadth distance between the two outermost points of the shoulders	38.79	02.07	42.55	34.96
6.	Elbow Rest Height from seat to the bottom of the elbow	21.42	01.14	23.49	19.30
7.	Thigh Clearance from seat to the top of the thigh	10.71	00.57	11.74	09.65
8.	Buttock-Popliteal Length horizontal distance from the back of the buttocks to the back of the knee	57.35	03.07	62.90	51.68
9.	Knee Height from the floor to the top of the knee when sitting	48.07	02.57	52.72	43.32
10.	Popliteal Height from the floor to the underside of the thigh just behind the knee	40.86	02.18	44.81	36.82
11.	Forearm-Hand Length from the elbow to the tip of the middle finger	43.85	02.34	48.1	39.52
12.	Hip Breadth distance across the widest part of the hips when sitting	33.73	01.80	37.00	30.40
13.	Sitting Shoulder Height from seat to the top of the shoulder	74.20	03.97	81.38	66.86
14.	Backrest Contact Point distance from the seat to the point where the back contacts the backrest	60.79	03.25	66.67	54.78
15.	Foot Length from the heel to the tip of the longest toe	25.30	01.35	27.75	22.80

**The unit of measurements was centimeter*

SECTION V

4.5 Testing of Hypotheses

Several hypotheses were formulated to find out the relationship between selected variables of the present study. In the present investigation, as per the nature of variables Analysis of the Variance ANOVA and Coefficient of Correlation were computed. For the purpose of statistical analysis, the hypotheses were formulated in null form. The results are presented in this section:

H₀₁: There exists no variation in the extent of Musculoskeletal Discomfort experienced by the respondents with their Personal Variables (Age in years and Body Mass Index) and Situational Variables (Duration of Driving per day and Driving experience in years)

Analysis of Variance ANOVA was computed to test the variation of the extent of Musculoskeletal Discomfort experienced by the respondents with their Age (in years), Body Mass Index, Duration of Driving (per day) and Driving experience (in years).

Table 29: Analysis of variance showing variation in the extent of Musculoskeletal Discomfort experienced by the respondents with their Age (in years) and Body Mass Index, Duration of Driving (per day) and Driving experience (in years).

Sr. No.	Selected Variable	Source of variable	Sum of Squares	Mean Squares	df	F-Value	Level of Significance
1.	Age (in years)	Between groups	1000.597	500.298	2	3.084	0.05
		Within groups	158245.336	1536.362	118		
2.	Body Mass Index	Between groups	3282.112	1094.037	3	2.680	N.S*
		Within groups	188823.6	1573.53	117		
3.	Duration of Driving (per day)	Between groups	5033.308	2516.654	2	3.071	N.S*
		Within groups	176215.7	1468.464	118		

4.	Driving experience (in years)	Between groups	2060.437	1030.218	2	3.071	N.S*
		Within groups	179188.6	1493.238	118		

Note: df = Degree of Freedom N.S = Not Significant

The statistical findings of the study Table 26 highlighted that, the computation of F-value showed significant variation ($\alpha=0.05$) in the extent of Musculoskeletal Discomfort experienced by the respondents with their Age (in years). The F-value was not found significant for Body Mass Index, Duration of Driving (per day) and Driving experience (in years). Thus, the null hypothesis was partially accepted. Hence, it was inferred that extent of Musculoskeletal Discomfort experienced by the respondents varied with their Age (in years).

Table 30: Scheffe's test showing the mean significant in the extent of Musculoskeletal Discomfort experienced by the respondents with their Personal Variables (Age in years)

Sr. No.	Selected Variable	Mean	df	Level of significance
Age (in years)				
1.	26 – 40 years	102.937	118	0.05
2.	41 – 55 years	111.031		
3.	56 – 70 years	106.538		
Significantly differed pairs: 2) 41 – 55 years and 3) 56 – 70 years				

The statistical analysis in Scheffe's test on various categories of age of the respondents stated that respondents between age group of 41 to 55 years significantly differed in the Musculoskeletal Discomfort experienced by the respondents with age group of 56 to 70 years. Hence, it can be conjectured that the extent of Musculoskeletal Discomfort experienced by the respondents with their Age (in years) was more among respondents who were above 41 to 55 years of age (Table 24).

H₀₂: There exists no variation in the extent of Postural Discomfort experienced by the respondents with their Personal Variables Age (in years), Body Mass Index and Situational Variables Duration of Driving (per day) and Driving experience (in years).

Analysis of Variance ANOVA was computed to test the variation of the extent of Postural Discomfort experienced by the respondents with their Age (in years), Body Mass Index, Duration of Driving (per day) and Driving experience (in years).

Table 31: Analysis of variance showing variation in the extent of Postural Discomfort experienced by the respondents with their Personal Variables Age (in years) and Body Mass Index and Situational Variables Duration of Driving (per day) and Driving experience (in years).

Sr. No.	Selected Variables	df	Sum of Squares	Mean Squares	F-Value	Level of Significance
1.	Age (in years)	2	1592.98	796.490	3.084	0.05
	Between groups	118	58493.08	487.442		
	Within groups					
2.	Body Mass Index	3	15178.09	5059.365	2.680	N.S*
	Between groups	118	58522.45	487.687		
	Within groups					
3.	Duration of Driving (per day)	2	5033.308	2516.654	3.084	0.05
	Between groups	118	176215.7	1468.464		
	Within groups					
4.	Driving experience (in years)	2	2060.437	1030.218	3.071	N.S*
	Between groups	118	179188.6	1493.238		
	Within groups					

Note: df = Degree of Freedom N.S = Not Significant

The statistical findings of the study Table 27 highlighted that, the computation of F-value showed significant variation ($\alpha=0.05$) in the extent of Postural Discomfort experienced by the respondents with their Age (in years) and Duration of Driving (per day). The F-value was not found significant for Body Mass Index and Driving

experience (in years). Thus, the null hypothesis was partially accepted. Hence, it was inferred that extent of Postural Discomfort experienced by the respondents varied with their Age (in years) and Duration of Driving (per day).

Table 32: Scheffe's test showing the mean significant in the extent of Postural Discomfort experienced by the respondents with their Personal Variables (Age in years)

Sr. No.	Selected Variable	Mean	df	Level of significance
Age (in years)				
4.	26 – 40 years	102.937	118	0.05
5.	41 – 55 years	111.031		
6.	56 – 70 years	106.538		
Significantly differed pairs: 2) 41 – 55 years and 3) 56 – 70 years				

The statistical analysis in Scheffe's test on various categories of age of the respondents stated that respondents between age group of 41 to 55 years significantly differed in the Postural Discomfort experienced by the respondents with age group of 56 to 70 years. Hence, it can be conjectured that the extent of Postural Discomfort experienced by the respondents with their Age (in years) was more among respondents who were above 41 to 55 years of age (Table 24).

Table 33: Scheffe's test showing the mean significant in the extent of Postural Discomfort experienced by the respondents with their Situational Variables Duration of Driving (per day).

Sr. No.	Selected Variable	Mean	df	Level of significance
Duration of Driving (per day)				
1.	6 – 8 hours	102.937	118	0.05
2.	9 – 10 hours	111.031		
3.	11 – 12 hours	106.538		
Significantly differed pairs: 2) 9 – 10 hours and 3) 11 – 12 hours				

The statistical analysis in Scheffe's test on various categories of Duration of Driving (per day) of the respondents stated that respondents between 11 – 12 hours of Duration of Driving (per day) significantly differed in the Postural Discomfort experienced by

the respondents with 9 – 10 hours Duration of Driving (per day). Hence, it can be conjectured that the extent of Postural Discomfort experienced by the respondents with their Duration of Driving (per day) was more among respondents who had 9 – 10 hours of Duration of Driving (per day) (Table 24).

H₀₃: There exists no relationship between the Extent of Musculoskeletal and Postural Discomfort experienced by the respondents

Co-efficient of correlation was computed to find out relationship between the Extent of Musculoskeletal and Postural Discomfort experienced by the respondents.

Table 34: Co-efficient of correlation showing relationship between the Extent of Musculoskeletal and Postural Discomfort experienced by the respondents

Sr. No.	Selected variables	n	r - value	Level of significance
1.	Extent of Musculoskeletal Discomfort experienced by the respondents.	120	0.994	0.05
	Extent of Postural Discomfort experienced by the respondents.			

The results revealed there was a significant positive relationship between the Extent of Musculoskeletal Discomfort experienced by the respondents and Extent of Postural Discomfort experienced by the respondents (Table 28). Since the relationship was found positive, it can be concluded that more the Extent of Musculoskeletal Discomfort more will be the Extent of Postural Discomfort experienced by the respondents. Hence the null hypothesis was rejected.

Conclusion

It was observed that 63.33 per cent of the respondents belonged to the age group of 26 to 40 years, and 43.33 per cent of the respondents had attained secondary education. The data also revealed that 34.16 per cent of the respondents had normal weight (18.5 - 24.9) and 60.84 per cent of the respondents had 3-16 years of experience of driving an auto rickshaw. Furthermore, 69.16 per cent of the respondents owned their auto rickshaw. The data also revealed that 35.84 per cent of the respondents worked for 6 to 8 hours per day, and 91.67 per cent of the respondents worked the morning shift (6:00

AM – 2:00 PM). Additionally, 67.51 per cent of the respondents took a break once during their work hours. Notably, 62.50 per cent of the respondents did not consult any healthcare professional regarding their discomfort, while 58.33 per cent of the respondents did not engage in exercises to alleviate their discomfort. Furthermore, 50.00 per cent of the respondents reported that they always smoked, 45.00 per cent of the respondents consumed alcohol sometimes and 70.00 per cent of the respondents always consumed tobacco. The study revealed that 35.83 per cent of the respondents experienced musculoskeletal discomfort in the lower back several times a day. Additionally, 48.33 per cent of the respondents experienced high level of discomfort in the lower back, and 45.00 per cent of respondents always experienced interference with their work ability due to discomfort in their lower back. It was also observed that 23.33 per cent of the respondents experienced Musculoskeletal Discomfort since 1-2 times per week in the thenar eminence of the right hand, whereas 85 per cent of the respondents experienced moderate level of discomfort in the radial region of the right hand, while 76.66 per cent of the respondents sometimes experienced interference in their work due to musculoskeletal discomfort in the radial region of their right hand. The data reported that 31.67 per cent of the respondents experienced high psychosocial stress due to passenger behavior, especially when passengers were rude or difficult. Additionally, 75.00 percent of the respondents reported always experienced postural discomfort due to frequent adjustments of the steering wheel while driving. Furthermore, 68.33 per cent of the respondents sometimes experienced postural discomfort from bending their trunk to the side while driving. In terms of physical factors related to neck, 45.00 per cent of the respondents reported always experiencing postural discomfort from tilting their neck while driving, while 40.00 percent reported experiencing it sometimes. Moreover, 51.66 per cent of the respondents consistently experienced postural discomfort in their ankles while driving, and the same percentage of the respondents reported discomfort in their legs. The data also revealed that 51.66 per cent of the respondents always experienced postural discomfort in their hips while driving, and 50.00 per cent of the respondents always experienced postural discomfort due to vibrations affecting specific parts of the body while driving. The data also revealed that 73.33 per cent of the respondents always experienced postural discomfort due to seat design. It was also observed that 46.66 per cent of the respondents always adopted an arm posture wherein, the elbows were bent at 120°, and the arms were always extended forward while driving. Additionally, 66.66 per cent of the respondents

sometimes adopted a wrist posture wherein, the wrist was slightly bent upwards while driving. Furthermore, 46.66 per cent of the respondents sometimes adopted leaned backward posture while sitting, whereas 75.00 per cent of the respondents sometimes adopted posture wherein, the trunk leaned to one side while driving and 71.66 per cent of the respondents sometimes adopted posture wherein, the neck bent at one side while driving. The study also reported that 55.00 per cent of the respondents always adopted a posture where their feet rested on the pedals while driving, and 48.33 per cent of the respondents always adopted posture wherein, the legs were spread apart while driving. The data revealed that the mean height of the respondents was 168.69 cm, while their mean weight was 70.57 kg.

A significant relationship was found between the extent of Musculoskeletal Discomfort experienced by the respondents and age (in years) of the respondents. It was inferred that the respondents between the age group of 41 – 55 years had experienced more Musculoskeletal Discomfort. A significant relationship was found between the extent of Postural Discomfort experienced by the respondents and age (in years) and Duration of Driving (per day) of the respondents. It was inferred that the age group of 41 – 55 years and driving duration of 9 – 10 hours had experienced more Postural Discomfort. Therefore, it can be concluded that the respondents between the age group of 41 – 55 years and driving duration of 9 – 10 hours had experienced more Musculoskeletal and Postural Discomfort. The results revealed that there was a significant positive relationship between the Extent of Musculoskeletal Discomfort experienced by the respondents and Extent of Postural Discomfort experienced by the respondents. Since, the relationship was found positive, it can be concluded that more the Extent of Musculoskeletal Discomfort more will be the Extent of Postural Discomfort experienced by the respondents.

SECTION VI

4.6 Development and Design of an Ergonomic Solution for Auto Rickshaw

Drivers

Auto Rickshaw Drivers are required to maintain static postures for extended hours, often in poorly designed seats. Continuous exposure to vibrations, inadequate lumbar support, and repetitive movements such as steering and throttle control contribute to Musculoskeletal Discomfort. The data in the present study revealed that the respondents were experiencing pain in lower back, upper back, neck, shoulders, and wrists, leading to chronic pain and reduced productivity.

The product development process was carried out in two distinct phases:

Phase 1: Design Development

The design phase was initiated based on the findings from ergonomic. Several key factors influenced the design process:

a. Designing the Ergonomic Seat:

The research findings indicated that prolonged driving hours, poor seat support, and inadequate cushioning contributed to musculoskeletal strain, lower back pain, and postural discomfort. Existing seat designs lacked lumbar support, leading to increased fatigue and long-term health issues for drivers.

Based on musculoskeletal and postural discomfort experienced by the respondents, the need for an ergonomically improved seat became evident.

1. Anthropometric Data Collection:

The seat dimensions were designed based on the 5th and 95th percentile measurements of 120 CNG operated Auto Rickshaw Drivers, ensuring an ergonomic fit. Anthropometric measurements considered for the design included Height, Weight, Sitting Height (from seat to top of head), Sitting Eye Height (from seat to eyes), Shoulder Breadth (distance between the two outermost points of the shoulders), Elbow Rest Height (from seat to the bottom of the elbow), Thigh Clearance (from seat to the top of the thigh), Buttock-Popliteal Length (horizontal distance from the back of the buttocks to the back of the knee), Knee Height (from the floor to the top of the knee when sitting), Popliteal Height (from the floor to the underside of the thigh just behind the

knee), Forearm-Hand Length (from the elbow to the tip of the middle finger), Hip Breadth (distance across the widest part of the hips when sitting), Sitting Shoulder Height (from seat to the top of the shoulder), Backrest Contact Point (distance from the seat to the point where the back contacts the backrest) and Foot Length (from the heel to the tip of the longest toe). All these measurements were collected by using an anthropometric kit.

2. 3D Model Development:

A 3D model of the ergonomic seat was developed using SketchUp to facilitate design visualization and refinement before fabrication.

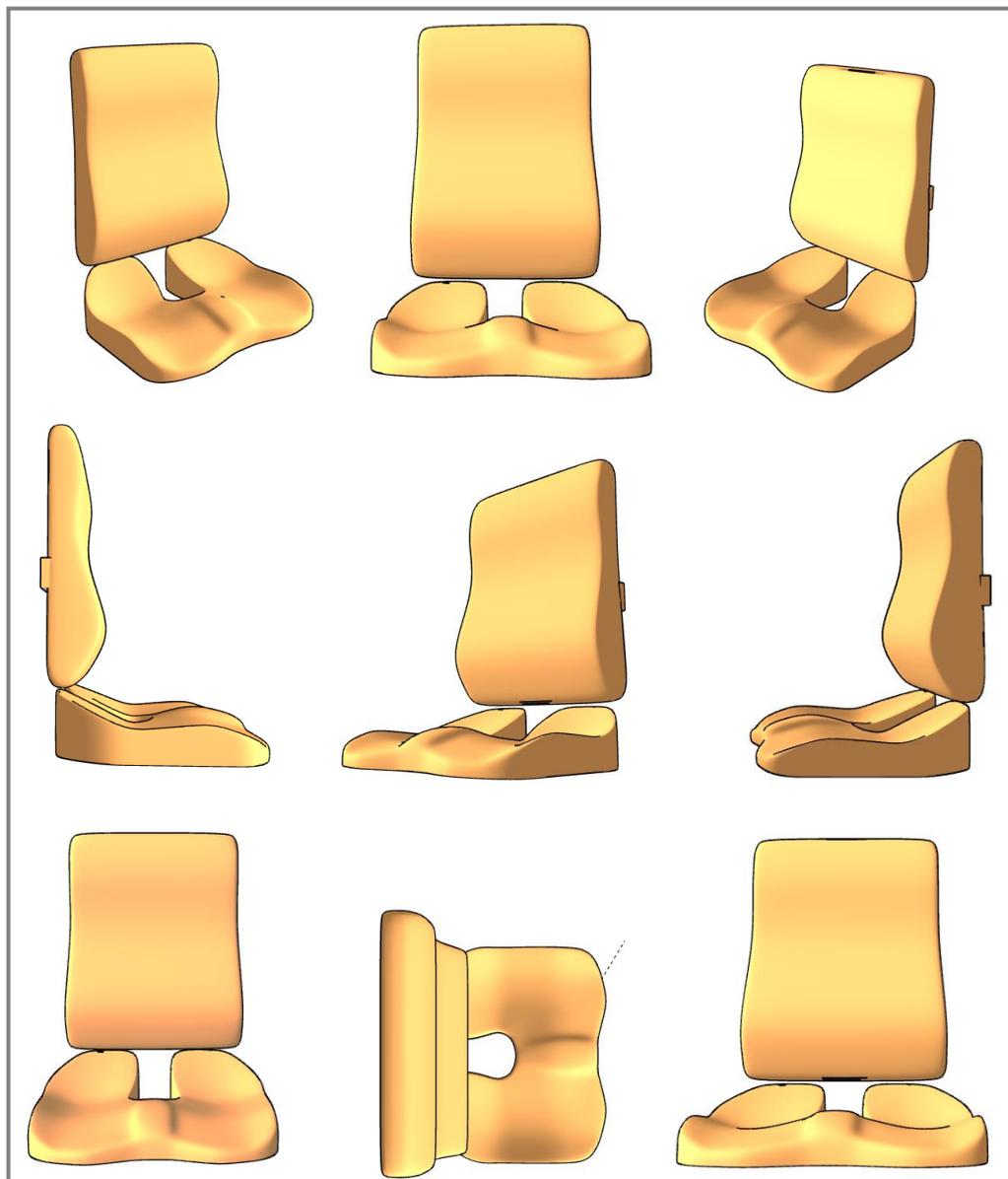


Plate 17: 3D Model of the Ergonomic seat design for the Auto Rickshaw Drivers

3. Ergonomic Features:

The seat was designed with an ergonomic curvature to provide optimal support for the hips, lumbar region, and tailbone. The base seat featured contoured shaping to conform to the body's natural structure, ensuring even weight distribution and minimizing pressure points. Additionally, a slight back-to-front slope was integrated into the base to reduce pressure behind the knees and enhance blood circulation.

The backrest was designed to mimic the natural curvature of the spinal cord, offering enhanced lumbar support. Furthermore, a specialized duct was incorporated in the hip area of the base seat to accommodate and relieve pressure on the tailbone (coccyx), promoting overall comfort and ergonomic efficiency.

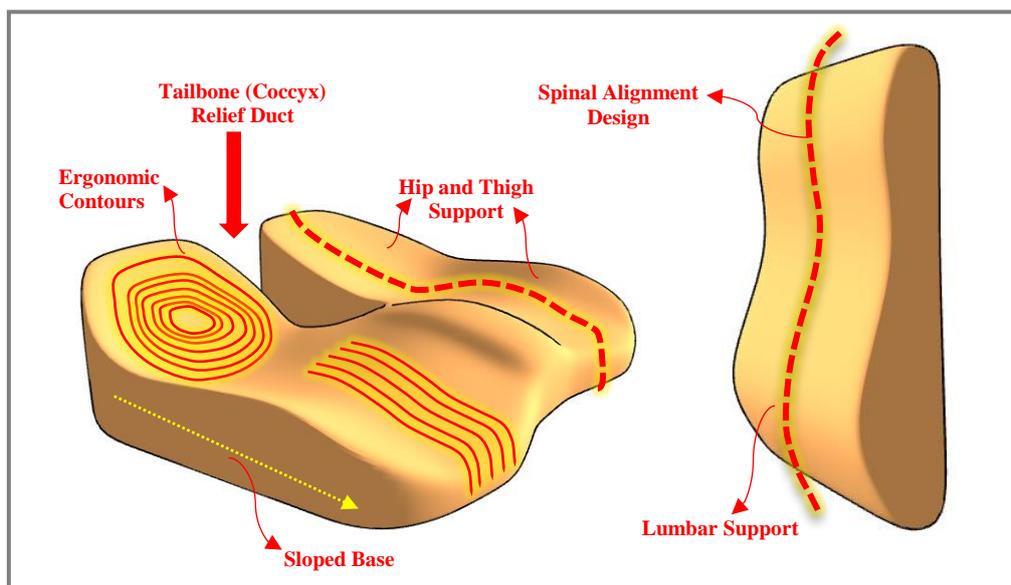


Plate 18: Ergonomic Features of the Seat for the Auto Rickshaw Drivers

4. Measurements of the seat:

The finalized design measurements were determined based on anthropometric principles, utilizing the 5th and 95th percentile data to ensure suitability for a diverse range of users. The seat dimensions were carefully developed to accommodate varying body sizes while maintaining ergonomic efficiency. Additionally, the design was guided by principles of applied anthropometry, workspace design, and seating ergonomics, as outlined in *Human Factors in Engineering and Design* (7th ed.) by Sanders and McCormick (1993, p. 415).

Base seat:

The seat measures 18.5" in length and 22" in breadth. Its side profile features a sloped contour, with a height of 2.5" at the hip area, 3" at the thigh support, 1.8" at the front edge forming a smooth sloping curve and 5" at the back edge of the seat.

Back rest:

The backrest has a height of 17" and a breadth of 18.5", divided into three sections: a 3" cervical section, an 8" thoracic section, and a 6" lumbar section. Its side profile follows the natural spine curvature, with a depth of 2.3" at the cervical region, 1.8" at the thoracic region, and 4.7" at the lumbar region.

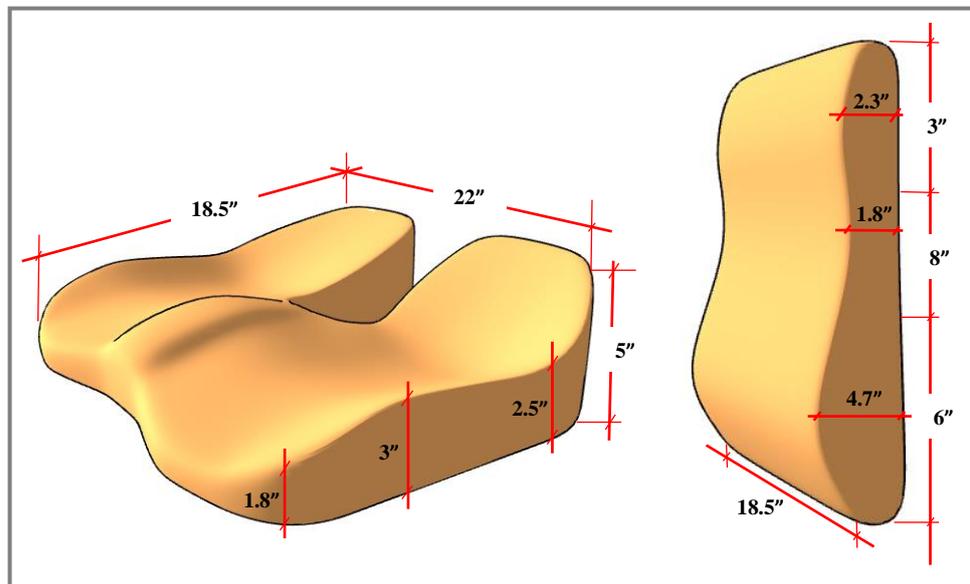


Plate 19: Measurements of the Ergonomic seat design for the Auto Rickshaw Drivers

5. Material Selection:

High-density foam for structural strength, soft-density foam for cushioning, and EVA foam for vibration dampening were chosen. PU leather was used as a cost-effective and durable top covering.

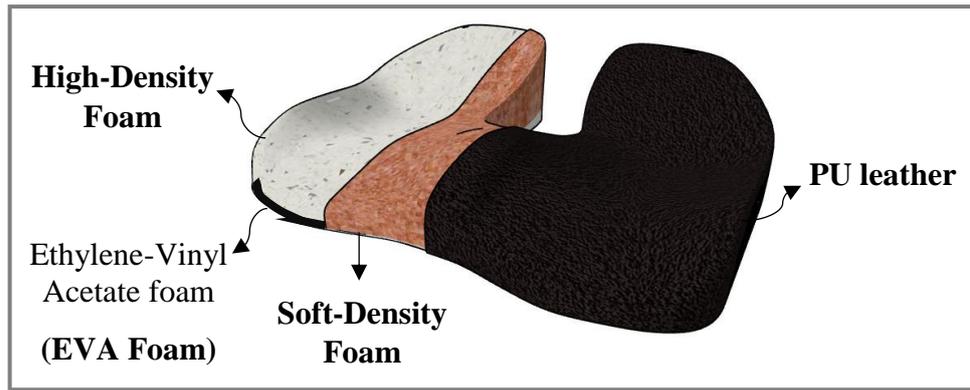


Plate 20: Materials of the Ergonomic seat for the Auto Rickshaw Drivers

Phase 2: Product Development and Trials

After finalizing the design, the product was developed and tested in real-world conditions to assess its effectiveness.

a. Product Fabrication:

The final seat was manufactured using high-density foam for structural strength, soft-density foam for cushioning, and Ethylene-Vinyl Acetate foam (EVA foam) for vibration dampening. PU leather was used as a cost-effective and durable top covering. Design refinements were made based on expert recommendations to enhance user comfort.



Plate 21: Product Fabrication of the Ergonomic seat for the Auto Rickshaw Drivers

b. Cost estimation:

c. Table 35: Cost estimation of the Ergonomic seat design

Sr. No.	Item	Material	Quantity	Unit Cost (₹)	Total Cost (₹)
1.	Structural Strength Foam	High-Density Foam	1 unit	500	500
2.	Cushioning Foam	Soft-Density Foam	1 unit	250	250
3.	Vibration Dampening Layer	EVA Foam	1 unit	200	200
4.	Top Covering	PU Leather	1 unit	250	250
5.	Stitching & Assembly	Labour & Materials	1 unit	200	200
6.	Miscellaneous Costs	Adhesives, Threads, etc.	-	100	100
Total					₹1500

d. Real-Time Testing and Feedback:

The ergonomic seat was given to Auto Rickshaw Drivers for real-time trials. Drivers provided feedback, reporting that the seat was highly comfortable and expressing their willingness to use or purchase it for their vehicles.



Plate 22: Auto Rickshaw Drivers assessing ergonomic seat designed by the researcher

c. Exhibition:

The design was showcased at Meraki, an exhibition-cum-sale held on 30th and 31st January 2025 in the Department of Family and Community Resource Management, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda.

The Honorable Vice-Chancellor, Prof. (Dr.) Dhanesh Patel, of The Maharaja Sayajirao University of Baroda, Vadodara, graced the occasion. The exhibition was also attended by Registrar Dr. K. M. Chudasama, University Engineer Mr. Rudresh Kumar R. Sharma, and esteemed alumni.



Plate 23: Display of the ergonomic seat design in Meraki, an exhibition-cum-sale

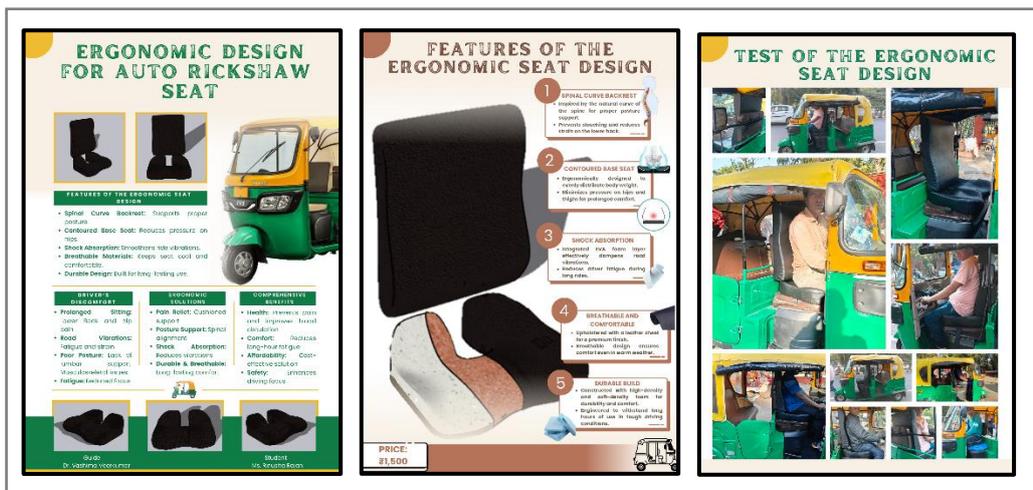


Plate 24: Display of the posters of ergonomic seat design in Meraki, an exhibition-cum-sale



Plate 25: Presentation of Ergonomic Seat Design to Registrar Dr. K. M. Chudasama at Meraki 2025



Plate 26: Presentation of Ergonomic Seat Design to University Engineer Mr. Rudresh Kumar R. Sharma at Meraki 2025

d. Media Coverage

The event was covered by various media platforms, including Gujaratmitr, Lokdarpan, Sandesh, Gujarat Samachar, and Loksatta Jansatta.

અકોટાના રાધાકૃષ્ણ ગાર્ડનમાં શેરી કૂતરાનો બાળક પર હુમલો
 વાંસનાં 10 થી 12 કુતરા વિદ્યાર્થીની યાં પણ ખાત્ર ખાત્ર વળી

અકોટા શહેરમાં રાધાકૃષ્ણ ગાર્ડનમાં શેરી કૂતરાનો બાળક પર હુમલો થયો હતો. આ ઘટના બંધારણના અંગેની નોંધણી કરવામાં આવી છે. આ ઘટના બંધારણના અંગેની નોંધણી કરવામાં આવી છે. આ ઘટના બંધારણના અંગેની નોંધણી કરવામાં આવી છે.

MSUના ફેમિલી એન્ડ કોમ્યુનિટી રિસોર્સ મેનેજમેન્ટની વિદ્યાર્થીનીનું રિસર્ચ વડોદરાના ૧૨૦ રિક્ષા ચાલકોનો સરવે કરીને સ્પેશિયલ સીટ ડિઝાઇન કરાઈ

બેસવામાં પડતી અગવડતામાં એગોનોમિક્સ રૂપરેખાવાળી સીટ રાહત આપશે

સીટની ડિઝાઇનથી રિક્ષા ચાલકો સંતુષ્ટ થયાં

સીટ ડિઝાઇન કરી વાહ અને એટો-રિક્ષા ડ્રાઇવરને મનોબલ પણ ઊભા રાખે. જેના એક સાથે સીટ ડેઝાઇન માટે અગવડતાઓ છે તેને પરાવર્તીત કરીને એક સીટ ડેઝાઇન આપવામાં આવે છે. આ સીટ ડેઝાઇનને આધારે રિક્ષા ડ્રાઇવરને મનોબલ પણ ઊભા રાખે છે. આ સીટ ડેઝાઇનને આધારે રિક્ષા ડ્રાઇવરને મનોબલ પણ ઊભા રાખે છે.

Source: Sandesh Newspaper

તારીખ ૧૧-૦૨-૨૦૨૫ મંગળવાર LOKDARPAN પાન નં.૪

એમ.એસ.સુનિ.ના એક સિનિયર એમ.એસ.સી.. વિદ્યાર્થીએ ઓટો-રિક્ષા ચાલકોમાં મરજ્યુલોરેક્ટેટલ પીડા અને પોસ્ટરલ અસ્વસ્થતા ઘટાડવા માટે એક એગોનોમિક ઓટો-રિક્ષા સીટ ડિઝાઇન કરી છે.

વડોદરા તા. ૧૦

મહાનગર પાલિકાના મુનિસિપલ ઓફિસમાં ઓટો-રિક્ષા સીટ ડિઝાઇન કરવામાં આવી છે. આ ઘટના બંધારણના અંગેની નોંધણી કરવામાં આવી છે.

Source: Lokdarpan Newspaper

શહેરના રિક્ષા ચાલકોની મદદે હોમસાયન્સની વિદ્યાર્થીની ડાઈવિંગ કરતી વખતે આરામ મળે તેવી રિક્ષાની સીટ ડિઝાઇન કરી

વડોદરા શહેરમાં રાધાકૃષ્ણ ગાર્ડનમાં શેરી કૂતરાનો બાળક પર હુમલો થયો હતો. આ ઘટના બંધારણના અંગેની નોંધણી કરવામાં આવી છે.

Source: Gujarat Samachar Newspaper

CITY

વિદ્યાર્થીએ ઓટોરિક્ષા ચાલકોને ઘરેણા, કિચન, હેસ્ટકલના પેસ્ટુ આકર્ષણનું કેન્દ્ર બની

એક પેન સમસ્યાને દૂર કરવા માટે બોડી પ્રમાણે બે ભાગમાં વહેંચી સીટ તૈયાર કરી

એગોનોમિક ડિઝાઇન કરેલી સીટ ઓટોરિક્ષા માટે છે, જે ખાસ કરીને ઓટો રિક્ષાવાળાની જે સીટ હોય છે. એ સ્ટેટ હોય છે ફ્લેટ હોય છે એના લીધે ચાલકો આનો દિવસ ગાડી ચલાવવા હોય છે. એને સા જે સીટ છે એનામાં બે સીટ છે. આ સીટમાં બોડીના સેલનું કટ આપ્યું છે કે જેના લીધે બોડીના સ્પાઇલને કોન્ટ્રોલ હેલ હોય છે. એને કોન્ટ્રોલ હેલ હોય છે એને કોન્ટ્રોલ હેલ હોય છે એને કોન્ટ્રોલ હેલ હોય છે.

Source: Gujarat Mitra Newspaper

Plate 27: Media Coverage in Print Media

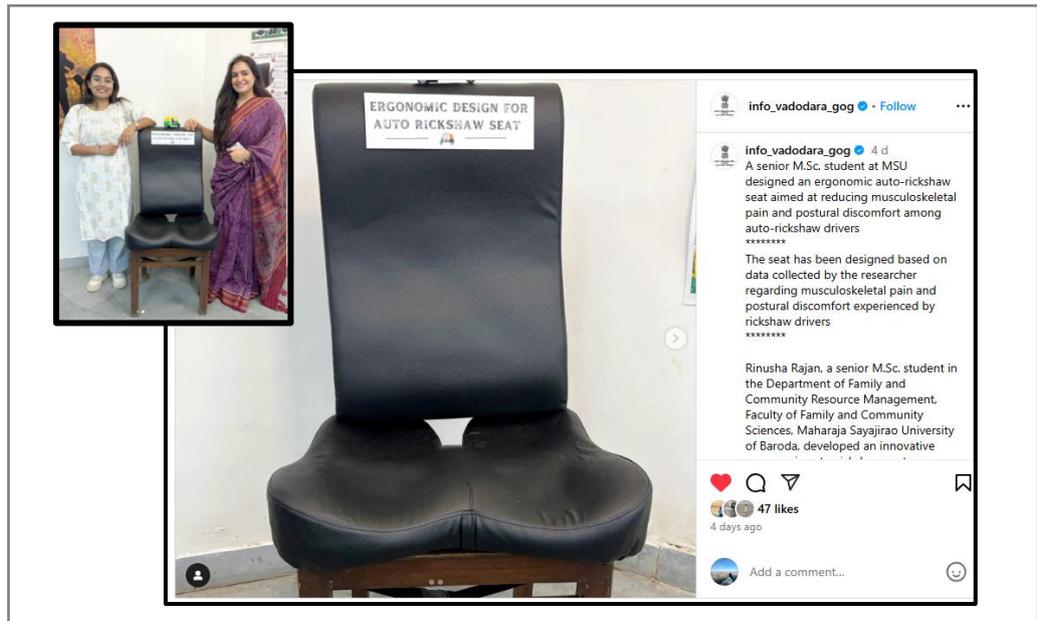


Plate 28: Media Coverage in Regional Information Vadodara, Government of Gujarat [28]

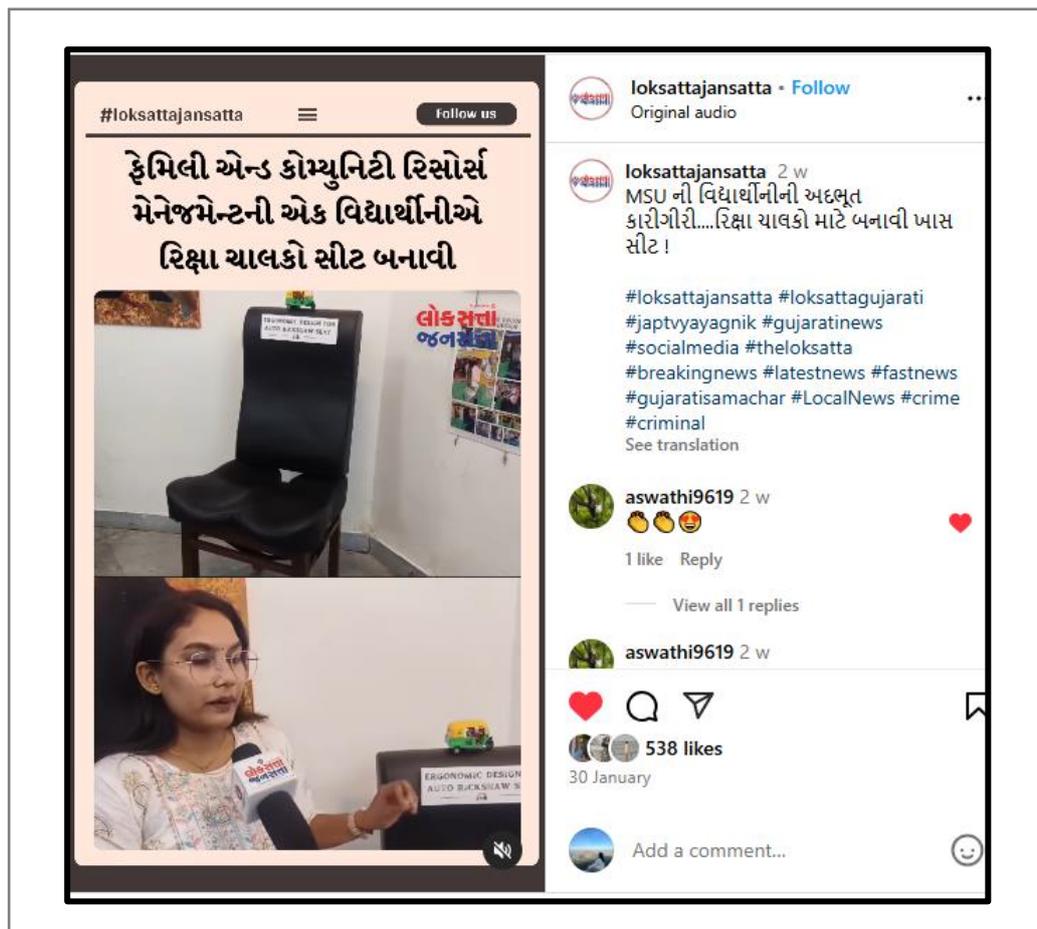


Plate 29: Media coverage in Electric Media [29]

SUMMARY, CONCLUSION AND RECOMMENDATIONS



CHAPTER - V

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Auto Rickshaw Drivers play a crucial role in the urban transport system, providing an essential means of mobility for millions. However, their profession exposes them to significant physical strain, leading to Musculoskeletal and Postural Discomfort. The nature of their work, which involves prolonged sitting, repetitive hand movements, and frequent exposure to vibrations, contributes to various health issues, including back pain, neck stiffness, and joint discomfort.

One of the primary challenges faced by Auto Rickshaw Drivers is the lack of ergonomic seating and design, which exacerbates their physical strain. Poor posture, extended driving hours, and inadequate seat cushioning further increase the risk of Musculoskeletal Discomfort. Additionally, a lack of awareness regarding posture correction and physical exercises to alleviate strain contributes to the deterioration of their health conditions.

The study highlights that addressing these ergonomic concerns is crucial not only for the well-being of drivers but also for ensuring sustainable livelihoods. By implementing a seat design that incorporates ergonomic features, such as contoured curves and lumbar and tailbone support for both the seat base and backrest, the severity of musculoskeletal issues can be significantly reduced.

Improving the work environment and ergonomics for Auto Rickshaw Drivers will not only enhance their productivity but also contribute to their long-term economic stability. Ensuring their health and well-being is essential for the smooth functioning of urban transportation and the overall socioeconomic development of the city.

Statement of the problem

The present study aimed to analyse the Extent of Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city.

Objectives of the Study

1. To assess the Extent of Musculoskeletal Discomfort experienced by the Auto Rickshaw Drivers of Vadodara city.
2. To assess the Extent of Postural Discomfort experienced by the respondents.
3. To design and develop an Ergonomic seat for reducing Musculoskeletal and Postural Discomfort experienced by the Auto Rickshaw Drivers

Hypotheses of the Study

1. The extent of Musculoskeletal Discomfort experienced by the respondents varies with their Personal Variables (Age in years and Body Mass Index) and Situational Variables (Duration of Driving per day and Driving experience in years).
2. The extent of Postural Discomfort experienced by the respondents varies with their Personal Variables (Age in years and Body Mass Index) and Situational Variables (Duration of Driving per day and Driving experience in years).
3. There exists a relationship between Extent of Musculoskeletal and Postural Discomfort experienced by the respondents.

Delimitations of the Study

1. The present study was limited to those the Auto Rickshaw Drivers, who had driving experience of at least 2 years.
2. The present research was limited to the Auto Rickshaw Drivers, those who were not suffering from any chronic disease.
3. The present study was limited to the Auto Rickshaw Drivers of Vadodara city only.
4. The present study was limited to the CNG operated Auto Rickshaw Drivers.

Methodology

The research design for the present study was descriptive in nature. The sample of the study comprised of 120 CNG operated Auto Rickshaw Drivers of Vadodara City, selected through purposive sampling technique. Consent was obtained from the respondents, and they were requested to cooperate in providing the necessary information for the study. The data collection tools included a questionnaire and an observation sheet. The questionnaire comprised of four sections: "Background Information," "Extent of Musculoskeletal Discomfort," "Extent of Discomfort in Hands," and "Extent of Postural Discomfort." The "Background Information" section gathered data on the respondents, focusing on demographic details, work-related factors, and health and well-being. Demographic details included name, age, and educational level. The work-related factors covered driving experience, ownership status, daily working hours, work schedule, and frequency of breaks. The health and well-being section explored consultation with healthcare professionals, and the use of exercises to alleviate discomfort. The section "Extent of Musculoskeletal Discomfort" assessed the musculoskeletal discomfort, level of discomfort experienced and interference of discomfort on daily work ability by the respondents in different body regions using the Cornell Musculoskeletal Discomfort Questionnaire (Sedentary Worker,

Male Version), developed by Dr. Alan Hedge and his team at Cornell University in 1999. A high score reflected a greater extent of Musculoskeletal Discomfort among Auto Rickshaw Drivers. The "Extent of Discomfort in Hands" section assessed discomfort levels in both the right and left hands separately using the Cornell Hand Discomfort Questionnaire. It measured frequency, intensity, and the interference of discomfort on daily driving activities. The "Extent of Postural Discomfort" section utilized the Postural Discomfort Survey Tool for Three-Wheeler Drivers (PDST), which was developed by the researcher to comply with the objectives of the study. The tool was divided into four subsections: "Individual Factors," "Psychosocial Factors," "Physical Factors," and "Postures Adopted by Drivers." The "Individual Factors" subsection examined exercise habits, smoking, tobacco consumption, and drinking status. The "Psychosocial Factors" subsection assessed work-related stressors such as hazardous conditions, traffic congestion, fatigue, and job dissatisfaction. The "Physical Factors" subsection analyzed ergonomic aspects, including physical factors related to arm, wrist, sitting, trunk, neck, feet, leg, hip, vibration exposure and seat design and comfort factors. The "Postures Adopted by Drivers" subsection focused on arm, wrist, neck, trunk, feet, leg and sitting postures. Hand-drawn images were included in the questionnaire to aid respondent understanding. The PDST utilized a 3-point Likert scale ("Always," "Sometimes," "Never") to measure discomfort frequency, with higher scores indicating greater Postural Discomfort. Additionally, an observation sheet was used to record anthropometric measurements of the Auto Rickshaw Drivers with the help of anthropometric kit. These measurements included height, weight, sitting height, sitting eye height, shoulder breadth, elbow rest height, thigh clearance, buttock-popliteal length, knee height, popliteal height, forearm-hand length, hip breadth, sitting shoulder height, backrest contact point, and foot length.

The content validity of the scales was established by consulting experts from the Department of Family and Community Resource Management, The Maharaja Sayajirao University of Baroda, Vadodara. Necessary corrections were made by the researcher as per the expert's suggestions. The data collection was carried out by the researcher from October 2024 to December 2024.

Major Findings

The major findings of the study are presented here.

Section 1: Background Information of the Respondents

The findings regarding personal and situational variables of the respondents are presented here.

Demographic Information of the respondents

It was observed that age of the respondents ranged between 26 to 70 years, with a mean age of 41.21 years, with a standard deviation of 11.89. A majority 63.33 per cent of the respondents belonged to the age group of 26 to 40 years. It was also observed that a total of 43.33 per cent of the respondents had attained secondary education.

Work Related Information of the respondents

The study revealed that driving experience of the respondents ranged from 3 to 45 years, with a mean of 17.90 years. A majority 60.84 per cent of the respondents had driving experience between 3 to 16 years. The study also revealed that 69.16 per cent of the respondents owned the Auto Rickshaw. The average daily working hours of the respondents was 9.70 hours. Among them, 35.84 per cent of the respondents reported working for 6 to 8 hours per day. The data revealed that 91.67 per cent of the respondents worked in the morning shift (6:00 am – 2:00 pm). The study also revealed that 67.51 per cent of the respondents took a break once during their work hours.

Health and Wellbeing of the respondents

The findings revealed that 62.50 per cent of the respondents did not consult any healthcare professional regarding their discomfort and 58.33 per cent of the respondents never engaged in any form of exercise to alleviate their discomfort. In terms of smoking habits, 50.00 per cent of the respondents smoked regularly, and 45.00 per cent of the respondents consumed alcohol occasionally. The findings also revealed that 70.00 per cent of the respondents consumed tobacco frequently.

Section 2: Extent of Musculoskeletal Discomfort experienced by the respondents

The findings regarding the extent of Musculoskeletal Discomfort among Auto Rickshaw Drivers, focusing on three key aspects: Musculoskeletal Discomfort

during the last work week, the level of discomfort experienced, and its interference with work ability are presented here.

Musculoskeletal Discomfort during the Last Work Week by the Respondents

It was observed that 35.83 per cent of the respondents experienced discomfort in lower back several times a day. Additionally, 25.00 per cent of the respondents experienced discomfort in upper back several times a day. The findings also revealed that 26.67 per cent of the respondents experienced discomfort in the right shoulder, while 27.50 per cent of the respondents experienced discomfort in the left shoulder once a day. Furthermore, 3.33 per cent of the respondents experienced discomfort in neck several times a day. The data revealed that 21.67 per cent of the respondents experienced discomfort in right upper arm, followed by 25.00 per cent of the respondents experienced discomfort in left upper arm several times a day. Additionally, 15.00 per cent of the respondents experienced discomfort in right forearm, while 13.33 per cent of the respondents experienced discomfort in left forearm several times a day. The data also reported that 24.16 per cent of the respondents experienced discomfort in right wrist several times a day, followed by 15.00 per cent of the respondents experienced discomfort in left wrist 3-4 times last week. Moreover, 33.33 per cent of the respondents experienced discomfort in right knee, while 23.34 per cent of the respondents experienced discomfort in left knee once a day. Additionally, 31.67 per cent of the respondents experienced discomfort in right thigh pain once a day, whereas 20.83 per cent of the respondents experienced discomfort in left thigh several times a day. Finally, the data indicated that 13.33 per cent of the respondents experienced discomfort in both the right and left lower legs several times a day.

Level of Discomfort Experienced Due to Musculoskeletal Discomfort During the Last Work Week by the respondents

It was observed that 48.33 per cent of the respondents experienced high discomfort in the lower back, followed by 31.67 per cent of the respondents experienced high discomfort in the upper back. The data also revealed that 25.00 per cent of the respondents experienced high discomfort in the left wrist,

and 28.33 per cent of the respondents experienced high discomfort in the left knee. Furthermore, the data revealed that 40.00 per cent of the respondents experienced moderate discomfort in the neck, followed by 30.00 per cent of the respondents experienced moderate discomfort in the left shoulder, and 36.34 per cent of the respondents experienced moderate discomfort in the right knee, followed by 32.51 per cent of the respondents experienced moderate discomfort in the left knee. The data revealed that 60.01 per cent of the respondents experienced low discomfort in their left forearm, followed by 56.67 per cent of the respondents experienced low discomfort in the right lower leg, and 55.84 per cent of the respondents experienced low discomfort in the left lower leg. The findings also revealed that 55.00 per cent of the respondents experienced low discomfort in their neck.

Interference with Work Ability Due to Musculoskeletal Discomfort Experienced During the Last Work Week by the Respondents

The study revealed that 45.00 per cent of respondents always experienced interference with their work ability due to discomfort in the lower back, followed by 28.33 per cent of the respondents always experienced interference with their work ability due to discomfort in the left shoulder and 26.66 per cent of the respondents always experienced interference with their work ability due to discomfort in the right knee. Additionally, 23.33 per cent of the respondents always experienced interference with their work ability due to discomfort in the upper back discomfort, followed by 21.67 per cent of the respondents reported the same for the right shoulder and left knee. Furthermore, the findings revealed that 56.67 per cent of the respondents sometimes experienced interference with their work ability due to discomfort in the right forearm, followed by 48.33 per cent of the respondents sometimes experienced interference with their work ability due to discomfort in the neck and 45.00 per cent of the respondents sometimes experienced interference with their work ability due to discomfort in the right shoulder, upper back, right upper arm, left upper arm, left forearm, and left lower leg. Additionally, 41.66 per cent of the respondents experienced interference with their work ability due to discomfort in the right knee. The findings also revealed that 50.00 per cent of the respondents never experienced interference with their work ability due to

discomfort in the right lower leg, followed by 46.67 per cent of the respondents never experienced interference with their work ability due to discomfort in the left forearm and left thigh.

Extent of Discomfort experienced in the Hands by the Auto Rickshaw Drivers

The findings regarding the psychosocial and physical factors contributing to postural discomfort among Auto Rickshaw Drivers, covers stress-related factors, discomfort caused by physical strain, and the adopted driving postures of the respondents are presented here.

Musculoskeletal Discomfort in the Hands during Last Work Week

It was observed that 23.33 per cent of respondents experienced Musculoskeletal Discomfort 1-2 times per week in the thenar eminence of the right hand. Followed by 21.67 per cent of respondents experienced Musculoskeletal Discomfort 1-2 times per week in the radial, ulnar and metacarpophalangeal regions of the right hand.

Level of Discomfort Experienced in the Hands

It was observed that 85 per cent of the respondents experienced a moderate level of discomfort in the radial region of the right hand. Followed by 76.66 per cent of respondents who experienced a moderate level of discomfort in the ulnar region of their right hand. A similar percentage (75.00 per cent) of respondents experienced a moderate level of discomfort in the entire thumb and pisiform area of their right hand.

Interference with Work Ability due to Musculoskeletal Discomfort experienced in the Hands during the last work week by the respondents

The findings revealed that 76.66 per cent of respondents experienced interference in work due to Musculoskeletal Discomfort in the right hand. The findings also showed that 75.00 per cent of respondents experienced interference in work due to Musculoskeletal Discomfort in the ulnar region of the right hand. Followed by 71.67 per cent of respondents experiencing interference in work due to Musculoskeletal Discomfort in the entire thumb of both the right and left hand, as well as the pisiform area of the right hand.

Section 3: Extent of Postural Discomfort experienced by the respondents

The findings regarding psychosocial, physical factors contributing to Postural Discomfort among Auto Rickshaw Drivers and the adopted driving postures of the respondents are presented here.

Psychosocial Factors affecting respondents

It was observed that 31.67 per cent of respondents experienced high psychosocial stress due to passenger behavior, especially when rude or difficult. The data also reported that very high stress was experienced among 30 per cent of respondents due to worry about the potential impact of illness or injury on their ability to work. The data also revealed that 29.17 per cent of respondents experienced very high psychosocial stress due to physical discomfort experienced while driving.

Extent of Postural Discomfort experienced due to Physical Factors of the respondents

It was observed that 75.00 per cent of the respondents always experienced postural discomfort due to frequent adjustments of the steering while driving, followed by 68.33 per cent of the respondents sometimes had Postural Discomfort due to bending their trunk to the side while driving. Additionally, 45.00 per cent of the respondents always and 40.00 per cent of the respondents sometimes experienced Postural Discomfort due to tilting their neck while driving whereas, 51.66 per cent of the respondents always experienced postural discomfort in the ankles while driving, followed by 48.33 per cent of the respondents always experienced postural discomfort due to pain in feet while driving. Furthermore, 51.66 per cent of the respondents always experienced discomfort in the legs while driving, while 51.66 per cent of the respondents always experienced postural discomfort in the hips while driving and 50.00 per cent of the respondents always experienced postural discomfort due to vibrations affected specific parts of the body while driving. The data also revealed that 73.33 per cent of the respondents always experienced postural discomfort due to seat design, followed by 61.66 per cent of the respondents never adjusted their seat to achieve a comfortable driving position. The data also revealed that 50.00 per cent of the respondents never

reduced the impact of vibrations while driving, followed by 46.66 per cent of the respondents never experienced adequate support for the back and thighs.

Extent of Postural Discomfort experienced due to Postures adopted while driving by the respondents

It was observed that 46.66 per cent of the respondents always adopted arms posture wherein, the elbows were bent at elbows at 120° and the arms were always extended forward while driving respectively. The data also revealed that 66.66 per cent of the respondents sometimes adopted wrist posture wherein, the wrist was slightly bent upwards while driving and 46.66 per cent of the respondents sometimes adopted leaning backward sitting posture while driving. Additionally, 75.00 per cent of the respondents sometimes adopted leaning to one side trunk posture while driving. The data also revealed that 71.66 per cent of the respondents sometimes adopted one side bent neck posture while driving, followed by 55.00 per cent of the respondents always adopted posture wherein, the feet rested on the pedal posture while driving and 48.33 per cent of the respondents always adopted legs spread apart posture while driving.

Section 4: Anthropometric Measurements Primarily Sitting of the respondents

The study revealed that the mean height of respondents was 168.69 cm, while their mean weight was 70.57 kg. Sitting height, sitting eye height, and sitting shoulder height were logged as 89.40 cm, 81.35 cm, and 74.20 cm, respectively. Measurements such as shoulder breadth 38.79 cm, elbow rest height 21.42 cm, and thigh clearance 10.71 cm were analyzed to assess upper body posture and arm positioning during driving. Lower body dimensions, including buttock-popliteal length 57.35 cm, knee height 48.07 cm, and popliteal height 40.86 cm, were measured to evaluate legroom and seating ergonomics. Additionally, hip breadth 33.73 cm, foot length 25.30 cm, and backrest contact point 60.79 cm were recorded to determine seat fit and lumbar support.

Testing of Hypothesis

- a. A significant relationship was found between extent of Musculoskeletal Discomfort experienced by the respondents with their Age (in years) at ($\alpha=0.05$). The results of Scheffe's test revealed that the extent of Musculoskeletal Discomfort experienced by the respondents was more among respondents who were between the age group 41 – 55 years of age.
- b. A significant relationship was found between extent of Postural Discomfort experienced by the respondents with their Age (in years) and Duration of Driving (per day) at ($\alpha=0.05$). The results of Scheffe's test revealed that the extent of Postural Discomfort experienced by the respondents was more among respondents who were between the age group 41 – 55 years of age and who had 9 – 10 hours of Duration of Driving (per day).
- c. The results revealed there was a significant positive relationship between the Extent of Musculoskeletal Discomfort experienced by the respondents and Extent of Postural Discomfort experienced by the respondents.

Development and Design of an Ergonomic Solution for Auto Rickshaw Drivers

Auto Rickshaw Drivers endure prolonged static postures, poor seat design, and continuous exposure to vibrations, leading to significant musculoskeletal discomfort. The study highlighted that drivers commonly experienced pain in the lower back, upper back, neck, shoulders, and wrists, reducing their efficiency and overall well-being. To address these issues, an ergonomic seat was designed and developed in two phases. In the design phase, anthropometric data from 120 drivers was collected, ensuring an ergonomic fit by considering measurements such as sitting height, shoulder breadth, thigh clearance, and hip breadth. A 3D model was created using SketchUp, allowing visualization and refinement of the seat before fabrication. The design incorporated essential ergonomic features, including lumbar support, contoured cushioning, and spine support backrest to minimize spinal strain. Material selection focused on comfort and durability, utilizing high-density foam for structural integrity, soft-density foam for cushioning, and EVA foam for vibration dampening, with PU leather as a protective covering. The final design was showcased at “Meraki, an exhibition-cum-sale” held on 30th and 31st January 2025 at the Department of Family and Community Resource Management, Faculty of Family and Community

Sciences, The Maharaja Sayajirao University of Baroda. The seat design along infographics successfully demonstrated that a well-designed ergonomic seat can significantly enhance driver comfort, reduce musculoskeletal strain, and improve work efficiency, emphasizing the need for widespread adoption in the transportation sector.

Conclusion

The background information of the respondents included demographic, work-related, and health and well-being. The data revealed that 63.33 per cent of the respondents were aged between 26 to 40 years. In terms of work-related information, 60.84 per cent of the respondents had driving experience of 3 to 16 years, and 69.16 per cent of the respondents owned their vehicle. Additionally, 35.84 per cent of the respondents worked for 6 to 8 hours per day, and 91.67 per cent of the respondents worked the morning shift (6:00 am – 2:00 pm). Regarding health and wellbeing, 62.50 per cent of the respondents did not consult any healthcare professional for discomfort. In lifestyle habits, 58.34 per cent of the respondents never engaged in exercise, 50.00 per cent of the respondents smoked regularly, 70.00 per cent of the respondents frequently consumed tobacco, and 45.00 per cent of the respondents consumed alcohol occasionally. The study on Musculoskeletal Discomfort indicated that lower back discomfort was the most reported issue, with 35.83 per cent of the respondents experiencing it several times a day, and 48.33 per cent of the respondents reporting high discomfort in this area. Moderate discomfort was reported in the neck and right shoulder by 40.00 per cent of the respondents, while 60.01 per cent of the respondents experienced low discomfort in their left forearm. Work interference due to discomfort was reported by 45.00 per cent of the respondents due to lower back pain, and 56.67 per cent of the respondents due to right forearm pain, whereas 50.00 per cent of the respondents did not experience interference from right lower leg discomfort. Discomfort in the hands was prevalent, with 23.33 per cent of the respondents reporting it 1-2 times per week in the thenar eminence of the right hand, and 85.00 per cent of the respondents experiencing moderate discomfort in the radial region. Additionally, 76.66 per cent of the respondents reported interference in work due to right-hand discomfort. High psychosocial stress due to passenger behavior was reported by 31.67 per cent of the respondents. Postural Discomfort due to frequent steering adjustments was experienced by 75.00 per cent of the respondents, wrist discomfort by 36.67 per cent of the respondents, and trunk bending to the side by 68.33 per cent of the respondents. Neck posture discomfort was experienced by 45.00 per cent of the respondents, while discomfort in the ankles, legs, and hips was always present in 51.66 per cent of the respondents. Half of the respondents experienced

discomfort due to vibrations while driving, and 73.33 per cent of the respondents attributed Postural Discomfort to seat design. Arm posture issues were noted, with 46.66 per cent of the respondents adopting a 120° bent elbow position, while 66.66 per cent of the respondents sometimes bent their wrists slightly upwards. Sitting posture discomfort was prevalent, with 46.66 per cent of the respondents leaning backward and 75.00 per cent of the respondents leaning to one side. Neck posture discomfort due to one-side bending was reported by 71.66 per cent of the respondents, and 55.00 per cent of the respondents always rested their feet on the pedals. Additionally, 48.33 per cent of the respondents adopted a legs-spread-apart posture. The study recorded the mean anthropometric measurements of Auto Rickshaw Drivers, with a mean height of 168.69 cm and mean weight of 70.57 kg. Sitting height (89.40 cm), sitting eye height (81.35 cm), and sitting shoulder height (74.20 cm) were logged. Upper body dimensions, including shoulder breadth (38.79 cm), elbow rest height (21.42 cm), and thigh clearance (10.71 cm), were analyzed for posture and arm positioning. Lower body dimensions, such as buttock-popliteal length (57.35 cm), knee height (48.07 cm), and popliteal height (40.86 cm), were measured for legroom and seating ergonomics. Hip breadth (33.73 cm), foot length (25.30 cm), and backrest contact point (60.79 cm) were recorded to assess seat fit and lumbar support.

Implications of the Study

The findings of the present study had the following implications:

For the Field of Family and Community Resource Management

The Department of Family and Community Resource Management within the Faculty of Family and Community Sciences at The Maharaja Sayajirao University of Baroda offers specialized courses in ergonomics. At the undergraduate level, the course “Basics of Ergonomics” is available, while at the postgraduate level, the courses “Ergonomics in the Hospitality Industry” and “Ergonomics in Interiors”. The findings of this study contribute significantly to the field by enriching the existing knowledge base and strengthening the curriculum. Specifically, the research provides valuable insights for students in Family and Community Resource Management regarding the implications of ergonomics on occupational health. It highlights critical concerns related to Musculoskeletal and Postural Discomfort among Auto Rickshaw Drivers, emphasizing the impact of prolonged sitting, repetitive tasks, and awkward postures on their well-being. Moreover, the information gathered through this study will enhance the students' understanding of work-related

ergonomic challenges, fostering awareness and encouraging the development of practical solutions to improve workplace conditions.

For Government

The findings of the study can assist authorities in utilizing the information for restructuring and developing policies that improve the working conditions of Auto Rickshaw Drivers. By understanding the extent of Musculoskeletal and Postural Discomfort experienced by drivers due to prolonged sitting, repetitive tasks, and awkward postures, policymakers can formulate ergonomic interventions and occupational health regulations.

This research can contribute to the development of driver-friendly policies by promoting improved seat design and vehicle ergonomics to reduce physical strain. Additionally, awareness programs on proper posture and movement strategies can help drivers maintain better health and reduce discomfort. Health and wellness initiatives, such as access to medical check-ups and physiotherapy, can further support their well-being. Moreover, infrastructure enhancements, including designated rest stops for drivers, can provide necessary breaks and improve overall working conditions.

By implementing such measures, the government can promote the well-being, productivity, and safety of Auto Rickshaw Drivers, ultimately contributing to a more sustainable urban transport system.

For Auto Rickshaw Drivers

Auto Rickshaw Drivers often experience Musculoskeletal and Postural Discomfort due to prolonged sitting, poor seat design, and inadequate spinal support. To address these challenges, an ergonomic seat design has been developed based on the findings of this study. This improved seat design includes ergonomic curves that support the body's natural posture, ensuring greater comfort for drivers. It also incorporates lumbar support to reduce lower back strain and spinal alignment features to help maintain a healthy posture. Additionally, tailbone support is integrated to minimize pressure and discomfort during long driving hours, enhancing overall driving ergonomics and well-being.

This innovative seat design aims to enhance comfort, reduce physical stress, and improve overall driving efficiency. By adopting this ergonomic solution, Auto Rickshaw Drivers can experience better health, reduced fatigue, and increased productivity, ultimately leading to a more sustainable and comfortable working environment.

For libraries and documentation centers

The findings of the present research would serve as a ready reference for documentation on the related subject. This study provides insights into the Musculoskeletal and Postural Discomfort experienced by Auto Rickshaw Drivers and presents an ergonomic seat design with lumbar, spine, and tailbone support. The documented information can be useful for students, researchers, and professionals working in the field of ergonomics, occupational health, and transportation studies.

Recommendations for the Future Studies

1. An investigation can be conducted in other cities of Gujarat or different states in India to analyze the extent of Musculoskeletal and Postural Discomfort experienced by Auto Rickshaw Drivers in different geographical and climatic conditions.
2. A similar study can be conducted on a larger sample size to gain a more comprehensive understanding of the ergonomic challenges faced by drivers and ensure broader applicability of the findings.
3. Comparative research can be undertaken on Auto Rickshaw Drivers operating in urban and rural areas to identify variations in work-related discomfort, seating needs, and driving conditions.
4. A study of similar nature can be conducted for drivers of different age groups and experience levels to understand how musculoskeletal issues vary with age, driving years, and adaptability to ergonomic interventions.
5. Research can be conducted to examine the impact of existing seat designs on the health and comfort of Auto Rickshaw Drivers, comparing them with the proposed ergonomic seat design to assess its effectiveness.
6. A study of similar nature can be conducted for various vehicles such as buses, trucks, and taxis, allowing for a comparative analysis of ergonomic challenges across different modes of transportation.
7. A study can be conducted to identify problems faced by Auto Rickshaw Drivers related to vehicle design, working hours, road conditions, and economic factors, helping develop further ergonomic interventions and policy recommendations.
8. Research can be conducted to explore the awareness and acceptance of ergonomic interventions among Auto Rickshaw Drivers and assess the feasibility of large-scale implementation of ergonomic seat designs.

9. A study can be conducted to examine government policies and regulations related to the occupational health and safety of Auto Rickshaw Drivers and explore ways to integrate ergonomic improvements into transport policies.
10. Future studies can investigate the role of additional vehicle modifications, such as shock-absorbing materials, adjustable seating, or climate-adaptive features, in further enhancing driver comfort and reducing health risks.

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APPENDICES



APPENDIX I

Ethical Compliance Certificate



Institutional Ethics
Committee for Human
Research
(IECHR)

FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

Ethical Compliance Certificate 2024-2025

This is to certify Ms. Rinusha Rajan study titled; "Extent of Musculoskeletal and Postural Discomfort Experienced by the Auto Rickshaw Drivers of Vadodara City." from Department of Family and Community Resource Management has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number IECHR/FCSc/M.Sc./10/2024/19.

Prof. Komal Chauhan
Member Secretary
IECHR

Prof. Mini Sheth
Chairperson
IECHR

**Chair Person
IECHR**

Faculty of Family & Community Sciences
The Maharaja Sayajirao University of Baroda

APPENDIX II

Data Collection Tool: Questionnaire

Section I: Background Information of the respondents

Kindly provide the necessary details below:

A. Demographic Information

1. Name of the respondent: _____
2. Age (in years): _____
3. Educational Level:
 - a. Illiterate
 - b. Primary
 - c. Secondary
 - d. Higher Secondary
 - e. Graduate

B. Work-Related Information

1. Driving Experience (in years): _____
2. Ownership Status
 - a. Owned
 - b. Hired
3. Average Daily Working Hours (per day): _____
4. Usual Working Schedule: _____
5. Do you take regular breaks during your work hours?
 - a. Yes
 - b. No
6. If yes, how often do you take breaks?

C. Health and Well-being

1. Do you experience any Musculoskeletal pain or discomfort?

a. Yes

b. No

2. Did you have any Musculoskeletal problems before driving profession?

a. Yes

b. No

3. Have you ever consulted a healthcare professional for your musculoskeletal discomfort?

a. Yes

b. No

4. If yes, what type of treatment did you receive?

a. Medication

b. Physical therapy

c. Surgery

d. Other (please specify):

5. Do you practice any exercises or stretches to alleviate your discomfort?

a. Yes

b. No

6. If yes, how often do you practice them?

a. Daily

b. Weekly

c. Occasionally

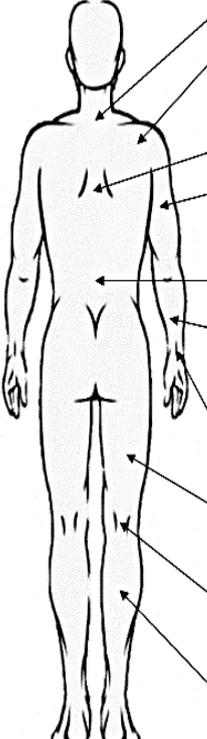
d. Rarely

Section II: Extent of Musculoskeletal Discomfort experienced by the Auto Rickshaw Drivers (CNG)

Cornell Musculoskeletal Discomfort Questionnaire

(Sedentary Worker, Male Version)

Kindly respond based on your pain experienced in various parts of the body by marking the appropriate checkbox provided below:

The diagram below shows the approximate position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.	During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with ability to work?		
	Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly Uncomfortable	Moderately Uncomfortable	Very Uncomfortable	Not at all	Slightly Interfered	Substantially Interfered
	Neck										
	Shoulder (Right)										
	Shoulder (Left)										
	Upper Back										
	Upper Arm (Right)										
	Upper Arm (left)										
	Lower Back										
	Forearm (Right)										
	Forearm (Left)										
	Wrist (Right)										
	Wrist (Left)										
	Thigh (Right)										
	Thigh (Left)										
	Knee (Right)										
	Knee (Left)										
	Lower Leg (Right)										
Lower Leg (Left)											

Extent of Hand Discomfort experienced by the Auto Rickshaw Drivers (CNG)

A. Right Hand Discomfort experienced by the respondents

Kindly mention the pain experienced in the right hand by marking the appropriate checkbox provided below:

The shaded areas in the diagrams below show the position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.		During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with ability to work?		
Complete only for RIGHT HAND		Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly Uncomf ortable	Moderat ely Uncomfo rtable	Very Uncomfo rtable	Not at all	Slightly Interfere d	Substanti ally Interfere d
1.	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> <p style="font-size: small;">Ring Pinkie</p> </div> <div> <p style="font-size: small;">Area A (Shaded area)</p> </div> </div>											
2.	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> </div> <div> <p style="font-size: small;">Area B (Shaded area)</p> </div> </div>											
3.	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> </div> <div> <p style="font-size: small;">Area C (Shaded area)</p> </div> </div>											
4.	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> </div> <div> <p style="font-size: small;">Area D (Shaded area)</p> </div> </div>											
5.	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> </div> <div> <p style="font-size: small;">Area E (Shaded area)</p> </div> </div>											
6.	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> </div> <div> <p style="font-size: small;">Area F (Shaded area)</p> </div> </div>											

B. Left Hand Discomfort experienced by the respondents

Kindly mention the pain experienced in the left hand by marking the appropriate checkbox

provided below:

<p>The shaded areas in the diagrams below show the position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.</p> <p>Complete only for LEFT HAND</p> <p>Middle Index Ring Thumb Pinkie</p>	During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with ability to work?		
	Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly Uncomfortable	Moderately Uncomfortable	Very Uncomfortable	Not at all	Slightly Interfered	Substantially Interfered
<p>1.</p>  <p>Area A (Shaded area)</p>											
<p>2.</p>  <p>Area B (Shaded area)</p>											
<p>3.</p>  <p>Area C (Shaded area)</p>											
<p>4.</p>  <p>Area D (Shaded area)</p>											
<p>5.</p>  <p>Area E (Shaded area)</p>											
<p>6.</p>  <p>Area F (Shaded area)</p>											

**Section III: Extent of Postural Discomfort experienced by the Auto Rickshaw
Drivers (CNG)**

Postural Discomfort Survey Tool for Three-Wheeler Drivers (PDST)

A. Individual Factors of the respondents

Kindly provide the necessary information by marking the appropriate checkbox provided below:

1. How often do you exercise?

- a. Regularly exercise
- b. Sometimes exercise
- c. Do not exercise

2. Do you smoke?

- a. Yes
- b. No

3. Do you drink alcohol?

- a. Yes
- b. No

4. Do you consume tobacco?

- c. Yes
- d. No

B. Psychosocial Factors of the respondents: Work-Related Stress Assessment

Kindly review the following statements and select the column that best represents your stress level, with Level 1 indicating no stress and Level 5 indicating the highest level of stress:

Sr. No.	Statements regarding Psychosocial Factors	Stress Score				
		1	2	3	4	5
1.	Stress is experienced due to uncertainty in daily income.					
2.	Long driving hours contribute to significant stress.					
3.	Heavy traffic and congestion increase stress levels while driving.					
4.	Passenger behavior, especially when rude or difficult, causes stress.					
5.	Physical discomfort experienced while driving adds to stress.					
6.	Safety concerns, such as the risk of accidents or crime, cause stress.					
7.	Competition with other auto rickshaw drivers for passengers increases stress.					
8.	Earning enough money to cover daily expenses is a source of stress.					
9.	The costs of maintaining and repairing the auto rickshaw contribute to stress.					
10.	Driving in extreme weather conditions (e.g., heat, rain) elevates stress levels.					
11.	Lack of sufficient rest or breaks during the workday leads to stress.					
12.	Balancing work with family responsibilities contributes to stress.					
13.	Interactions with traffic police or other authorities add to stress levels.					
14.	Unpredictability in the number of passengers or trips per day causes stress.					
15.	Worry about the potential impact of illness or injury on the ability to work contributes to stress.					

C. Physical Factors of the respondents

Kindly review the following statements related to physical factors of the Auto Rickshaw Drivers. For each statement, indicate your experience by marking the appropriate checkbox provided below by using the 3 point Likert scale (Always, Sometimes and Never).

Sr. No.	Statements	Always	Sometimes	Never
A. Arm				
1.	Ability to adjust the seat while driving.			
2.	Ability to adjust the steering column while driving.			
3.	Presence of an armrest or a place to rest the arm while driving.			
B. Wrist				
1.	Steering wheel grip is comfortable.			
2.	A lot of force is applied to the steering wheel while driving.			
3.	Discomfort is experienced in hands or arms due to steering the auto rickshaw.			
C. Trunk				
1.	Trunk is tilted while driving.			
2.	Trunk bends to the side while driving.			
D. Neck				
1.	Neck is tilted while driving.			
2.	Neck bends to the side while driving.			
E. Vibration				
1.	Feeling severe vibrations while driving.			
2.	Vibrations while driving affect specific parts of the body (e.g., hands, arms, feet).			
F. Feet				
1.	Vehicle's floor provides adequate support for the feet.			

Sr. No.	Statements	Always	Sometimes	Never
2.	Pain is experienced in the feet while driving.			
3.	Discomfort or stiffness is experienced in the ankles while driving.			
G.	Leg			
1.	Pain or discomfort is experienced in the legs while driving.			
2.	Fatigue is felt in the legs after driving for an extended period.			
3.	Circulation issues (e.g., numbness or tingling) are experienced in the legs while driving.			
4.	Discomfort is experienced in the knees while driving.			
5.	Seat provides adequate support for the thighs.			
H.	Hip			
1.	Hips are properly aligned while driving.			
2.	Frequent adjustments of the hip position are made while driving.			
3.	Discomfort is experienced in the hips while driving.			
I.	Vibration Exposure			
1.	Feeling severe vibrations while driving.			
2.	Vibrations while driving affect specific parts of the body.			
J.	Seat Design and Comfort Factors of the Work Station			
1.	Seat in the auto rickshaw is comfortable.			
2.	Seat requires modifications.			

Sr. No.	Statements	Always	Sometimes	Never
3.	Seat provides adequate support for the back and thighs.			
4.	Seat effectively reduces the impact of vibrations while driving.			
5.	Seat can be easily adjusted to achieve a comfortable driving position.			
6.	Seat is durable in terms of wear and tear.			
7.	Seat design affects driving posture.			
8.	Seat requires modifications.			
9.	Additional supports e.g., cushions, lumbar support are used to improve sitting posture.			

D. Postures adopted while driving by the respondents

Kindly review the following visual references related to postures adopted by the Auto Rickshaw Drivers. For each Postures adopted while Driving, indicates your experience by marking the appropriate checkbox provided below by using the 3 point Likert scale (Always, Sometimes and Never).

Sr. No.	Postures adopted while Driving	Always	Sometimes	Never
A.	Arm Posture			
1.	 Bent at elbows at 90°			
2.	 Bent at elbows at 120°			
3.	 Arm extended forward			

Sr. No.	Postures adopted while Driving	Always	Sometimes	Never
B. Wrist Posture				
1.	 Slightly bent upwards			
2.	 Neutral (Straight)			
3.	 Slightly bent downwards			
C. Sitting Posture				
1.	 Upright with support			
2.	 Upright with support			
3.	 Slightly slouched			
4.	 Leaning forward			
5.	 Leaning backward			

Sr. No.	Postures adopted while Driving	Always	Sometimes	Never
D. Trunk Posture				
1.	 Straight and aligned with the seat			
2.	 Leaning to one side			
E. Neck Posture				
1.	 Neutral and aligned			
2.	 Slightly forward			
3.	 Slightly backward			
4.	 Bent to one side			
F. Feet Posture				
1.	 Flat on the floor			
2.	 Resting on the pedal			
3.	 Hovering above the pedal			

Sr. No.	Postures adopted while Driving	Always	Sometimes	Never
4.	 Slightly pointed upwards			
5.	 Slightly pointed downwards			
6.	 Alternating between positions			
Leg Posture				
1.	 Straight with knees slightly bent			
2.	 Knees bent at 90°			
3.	 Legs spread apart			

Data Collection Tool: Observation Sheet**Section IV: Anthropometric Measurements (Primarily Sitting) of the respondents**

Kindly provide the anthropometric measurements for the following body parts:

Sr. No.	Data	Measurements	Unit
1.	Height		cm
2.	Weight		kg
3.	Sitting Height (from seat to top of head)		cm
4.	Sitting Eye Height (from seat to eyes)		cm
5.	Shoulder Breadth (distance between the two outermost points of the shoulders)		cm
6.	Elbow Rest Height (from seat to the bottom of the elbow)		cm
7.	Thigh Clearance (from seat to the top of the thigh)		cm
8.	Buttock-Popliteal Length (horizontal distance from the back of the buttocks to the back of the knee)		cm
9.	Knee Height (from the floor to the top of the knee when sitting)		cm
10.	Popliteal Height (from the floor to the underside of the thigh just behind the knee)		cm
11.	Forearm-Hand Length (from the elbow to the tip of the middle finger)		cm
12.	Hip Breadth (distance across the widest part of the hips when sitting)		cm
13.	Sitting Shoulder Height (from seat to the top of the shoulder)		cm
14.	Backrest Contact Point (distance from the seat to the point where the back contacts the backrest)		cm
15.	Foot Length (from the heel to the tip of the longest toe)		cm

APPENDIX III

પ્રશ્નાવલી

પ્રકરણ I: પ્રતિસાદકર્તાઓની પૃષ્ઠભૂમિ માહિતી

કૃપા કરીને નીચે જરૂરી વિગતો પ્રદાન કરો:

A. લોકસાંખ્યિક માહિતી

1. પ્રતિસાદકર્તાનું નામ: _____
2. ઉંમર (વર્ષોમાં): _____
3. શૈક્ષણિક સ્તર:
 - a. કોઈ ઔપચારિક શિક્ષણ નહીં
 - b. પ્રાથમિક
 - c. માધ્યમિક
 - d. ઉચ્ચતર માધ્યમિક
 - e. ગ્રેજ્યુએશન

B. કાર્ય સંબંધિત માહિતી

1. ચાલનનો અનુભવ (વર્ષોમાં): _____
2. માલિકીની સ્થિતિ
 - a. માલિક
 - b. કર્મચારી
3. દિવસે સરેરાશ કામના કલાકો (દરરોજ): _____
4. સામાન્ય કામકાજનું જમણવાર: _____
5. શું તમે તમારા કામના કલાકોમાં નિયમિત વિરામ લો છો?
 - a. હા
 - b. ના
6. જો હા, તો તમે કેટલી વાર વિરામ લો છો?

C. આરોગ્ય અને સુખ-સમૃદ્ધિ

1. શું તમને કોઈ મસ્ક્યુલોસ્કેલેટલ પીડા અથવા અગવડતા અનુભવાય છે?
 - a. હા
 - b. ના
2. શું તમને ડ્રાઈવિંગ વ્યાવસાયથી પહેલા કોઈ મસ્ક્યુલોસ્કેલેટલની સમસ્યાઓ હતી?
 - a. હા
 - b. ના
3. શું તમે તમારા મસ્ક્યુલોસ્કેલેટલ અગવડતા માટે ક્યારેક આરોગ્ય સેવકનો સંપર્ક કર્યો છે?
 - c. હા
 - a. ના
4. જો હા, તો તમને કઈ પ્રકારની સારવાર મળી?
 - a. દવા
 - b. શારીરિક સારવાર
 - c. શસ્ત્રક્રિયા
 - d. અન્ય (કૃપા કરીને સ્પષ્ટ કરો): _____
5. શું તમે તમારી અગવડતા દૂર કરવા માટે કોઈ કસરત અથવા ખીંચાણનો અમલ કરો છો?
 - c. હા
 - d. ના
6. જો હા, તો તમે કેટલીવાર તેનો અમલ કરો છો?
 - e. રોજ
 - f. સાપ્તાહિક
 - g. ક્યારેક
 - h. કદીકદી

પ્રકરણ II: સીએનજી ઓટો રિક્ષા ડ્રાઇવરો દ્વારા અનુભવાયેલ મસ્ક્યુલોસ્કેલેટલ અગવડતાની હદ

**કોર્નેલ મસ્ક્યુલોસ્કેલેટલ અગવડતા પ્રશ્નાવલી
(સ્થિર કાર્યકર, પુરુષ સંસ્કરણ)**

કૃપા કરીને તમારા શરીરના વિવિધ ભાગોમાં અનુભવાયેલા દુખાવા પર આધારિત નીચે આપવામાં આવેલા યોગ્ય ચેકબોક્સમાં નિશાની કરીને જવાબ આપો:

નીચેનો ચિત્ર પ્રશ્નાવલીમાં ઉલ્લેખ કરાયેલા શરીરના ભાગોના અંદાજિત સ્થાનને દર્શાવે છે. કૃપા કરીને યોગ્ય બોક્સમાં નિશાની કરીને જવાબ આપો.	ગયા કાર્ય સપ્તાહ દરમિયાન તમે કેટલાં વખત દુખાવો, પીડા, અથવા અગવડતા અનુભવ્યા હતા:				જો તમે દુખાવો, પીડા, અથવા અગવડતા અનુભવો છો, તો આ કેટલી અસ્વસ્થતા છે?			જો તમે દુખાવો, પીડા, અથવા અગવડતા અનુભવો છો, તો આ તમારા કાર્ય કરવાની ક્ષમતામાં ખલેલ પહોંચાડી?			
	કદી નહીં	ગયા સપ્તાહ માં 1-2 વખત	ગયા સપ્તાહ માં 3-4 વખત	દરેક દિવસમાં એકવાર	દરેક દિવસમાં ઘણા વખત	થોડું અસ્વસ્થ	મધ્યમ અસ્વસ્થ	ખૂબ જ અસ્વસ્થ	કોઈપણ રીતે નહીં	થોડું ખલેલ પહોંચાડ્યું	પ્રમાણિત રીતે ખલેલ પહોંચાડ્યું
ગળું											
ખભો (જમણું)											
ખભો (ડાબો)											
ઉંચું પીઠ											
ઉપરનો હાથ (જમણું)											
ઉપરનો હાથ (ડાબો)											
નીચું પીઠ											
કેળવણ (જમણું)											
કેળવણ (ડાબો)											
કને (જમણું)											
કને (ડાબો)											
જાંઘ (જમણું)											
જાંઘ (ડાબો)											
ઘૂંટણ (જમણું)											
ઘૂંટણ (ડાબો)											
નીચું પગ (જમણું)											
નીચું પગ (ડાબો)											

સીએનજી ઓટો રિક્ષા ડ્રાઇવરો દ્વારા અનુભવાયેલ હાથની અગવડતાની હદ

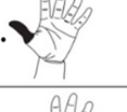
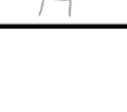
A. પ્રતિસાદકર્તાઓ દ્વારા અનુભવામાં આવેલા જમણા હાથની અગવડતા

કૃપા કરીને નીચે આપવામાં આવેલ યોગ્ય ચેકબોક્સમાં નિશાની કરીને જમણા હાથે અનુભવાયેલા દુખાવાને દર્શાવો:

જમણા હાથ માટે જ પૂરું કરો		ગયા કાર્ય સપ્તાહ દરમિયાન તમે કેટલાં વખત દુખાવો, પીડા, અથવા અગવડતા અનુભવ્યા હતા:					જો તમે દુખાવો, પીડા, અથવા અગવડતા અનુભવતા, તો આ કેટલી અસ્વસ્થતા હતી?			જો તમે દુખાવો, પીડા, અથવા અગવડતા અનુભવો છો, તો આ તમારા કાર્ય કરવાની ક્ષમતામાં ખલેલ પહોંચાડ્યું?		
		કદી નહીં	ગયા સપ્તાહ માં 1-2 વખત	ગયા સપ્તાહ માં 3-4 વખત	દરેક દિવસ માં એકવાર	દરેક દિવસમાં ઘણા વખત	થોડું અસ્વસ્થ	મધ્યમ અસ્વસ્થ	ખૂબ જ અસ્વસ્થ	કોઈપણ રીતે નહીં	થોડું ખલેલ પહોંચાડ્યું	પ્રમાણિત રીતે ખલેલ પહોંચાડ્યું
1.	 ક્ષેત્ર A (થોડું વિસ્તાર)											
2.	 ક્ષેત્ર B (થોડું વિસ્તાર)											
3.	 ક્ષેત્ર C (થોડું વિસ્તાર)											
4.	 ક્ષેત્ર D (થોડું વિસ્તાર)											
5.	 ક્ષેત્ર E (થોડું વિસ્તાર)											
6.	 ક્ષેત્ર F (થોડું વિસ્તાર)											

B. પ્રતિસાદકર્તાઓ દ્વારા અનુભવવામાં આવેલી ડાબા હાથની અગવડતા

કૃપા કરીને નીચે આપવામાં આવેલ યોગ્ય ચેકબોક્સમાં નિશાની કરીને ડાબા હાથે અનુભવાયેલા દુખાવાને દર્શાવો:

નીચેના આકૃતીઓમાં શેડેડ વિસ્તારમાં પ્રશ્નાવલીમાં ઉલ્લેખિત શરીરના ભાગોનું સ્થાન દર્શાવવામાં આવ્યું છે. કૃપા કરીને યોગ્ય બોક્સમાં નિશાની કરીને જવાબ આપો.		ગયા કાર્ય સપ્તાહ દરમિયાન તમે કેટલાં વખત દુખાવો, પીડા, અથવા અગવડતા અનુભવ્યા હતા:					જો તમે દુખાવો, પીડા, અથવા અગવડતા અનુભવતા, તો આ કેટલી અસ્વસ્થતા હતી?			જો તમે દુખાવો, પીડા, અથવા અગવડતા અનુભવો છો, તો આ તમારા કાર્ય કરવાની ક્ષમતામાં ખલેલ પહોંચાડ્યું?		
ડાબા હાથ માટે જ પૂરું કરો		કદી નહીં	ગયા સપ્તાહ માં 1-2 વખત	ગયા સપ્તાહ માં 3-4 વખત	દરેક દિવસ માં એકવાર	દરેક દિવસમાં ઘણા વખત	થોડું અસ્વસ્થ	મધ્યમ અસ્વસ્થ	ખૂબ જ અસ્વસ્થ	કોઈપણ રીતે નહીં	થોડું ખલેલ પહોંચાડ્યું	પ્રમાણિત રીતે ખલેલ પહોંચાડ્યું
<p>મધ્યમા અનામિકા</p> <p>તર્જની અંગૂઠો</p> <p>1. </p> <p>ક્ષેત્ર A (શેડેડ વિસ્તાર)</p>												
<p>2. </p> <p>ક્ષેત્ર B (શેડેડ વિસ્તાર)</p>												
<p>3. </p> <p>ક્ષેત્ર C (શેડેડ વિસ્તાર)</p>												
<p>4. </p> <p>ક્ષેત્ર D (શેડેડ વિસ્તાર)</p>												
<p>5. </p> <p>ક્ષેત્ર E (શેડેડ વિસ્તાર)</p>												
<p>6. </p> <p>ક્ષેત્ર F (શેડેડ વિસ્તાર)</p>												

પ્રકરણ III: સીએનજી ઓટો રિક્ષા ડ્રાઇવરો દ્વારા અનુભવાયેલ પોઝિટિવ અગવડતાની હદ

A. પ્રતિસાદકર્તાઓના વ્યક્તિગત ઘટકો

કૃપા કરીને નીચે આપેલા યોગ્ય ચેકબોક્સમાં નિશાની કરીને જરૂરી માહિતી પૂરી પાડો:

1. તમે કેટલી વાર વ્યાયામ કરો છો?

- a. નિયમિત વ્યાયામ કરું છું
- b. ક્યારેક વ્યાયામ કરું છું
- c. વ્યાયામ કરતો નથી

2. શું તમે ધુમ્રપાન કરો છો?

- a. હા
- b. ના

3. શું તમે મદિરા સેવન કરો છો?

- a. હા
- b. ના

B. પ્રતિસાદકર્તાઓના મનોવૈજ્ઞાનિક ઘટકો: કાર્ય સંબંધિત તણાવનું મૂલ્યાંકન

કૃપા કરીને નીચેના નિવેદનોની સમીક્ષા કરો અને તે કતાર પસંદ કરો જે તમારા તણાવના સ્તરને શ્રેષ્ઠ રીતે દર્શાવે છે, જ્યાં સ્તર 1 તણાવ ન હોવું દર્શાવે છે અને સ્તર 5 સૌથી વધુ તણાવ દર્શાવે છે.

ક્રમ	નિવેદનો	દબાણ સ્કોર				
		1	2	3	4	5
1.	દરરોજની આવકમાં અવિશ્વસનિયતાને કારણે માનસિક દબાણ અનુભવાય છે.					
2.	લાંબા ડ્રાઇવિંગ ક્લાકો મહત્વપૂર્ણ દબાણમાં યોગદાન આપે છે.					
3.	ભારે ટ્રાફિક અને ભીડ ડ્રાઇવિંગ કરતી વખતે દબાણના સ્તરો વધારવામાં મદદ કરે છે.					
4.	મુસાફરોનું વર્તન, ખાસ કરીને જો તે રુઢિચુસ્ત હોય અથવા મુશ્કેલ હોય, દબાણનો કારણ બને છે.					
5.	ડ્રાઇવિંગ કરતી વખતે અનુભવવામાં આવતી શારીરિક અસુવિધા માનસિક દબાણ ઉમેરે છે.					
6.	સલામતીની ચિંતા, જેમ કે અકસ્માતો અથવા ગુનાના જોખમ, દબાણનું કારણ બને છે.					
7.	અન્ય ઓટોરિક્ષા ડ્રાઇવરો સાથે મુસાફરો માટે સ્પર્ધા દબાણ વધારવામાં મદદ કરે છે.					
8.	દૈનિક ખર્ચને ઢંકી લેવાના પુરતા પૈસાની કમાણી દબાણનું એક સ્ત્રોત છે.					
9.	ઓટોરિક્ષાની જાળવણી અને મરામતના ખર્ચ દબાણમાં યોગદાન આપે છે.					
10.	અતિગરમી હવામાનની પરિસ્થિતિઓમાં (જેમ કે ગરમી, વરસાદ) ડ્રાઇવિંગ કરવાથી દબાણના સ્તરો વધે છે.					
11.	કાર્ય દિવસ દરમિયાન પૂરતું આરામ અથવા બ્રેક નહીં લેવાને કારણે દબાણ થાય છે.					
12.	કામને પરિવારના જવાબદારી સાથે સંતુલિત કરવાથી દબાણ થાય છે.					
13.	ટ્રાફિક પોલીસ અથવા અન્ય સત્તાધીશો સાથેની ક્રિયાઓ દબાણના સ્તરોમાં વધારો કરે છે.					
14.	દૈનિક મુસાફરો અથવા સફરોની સંખ્યા અંગેની અનુમાન્યતા દબાણનું કારણ બને છે.					
15.	બીમારી અથવા ઇજાના કારણે કામ કરવાની ક્ષમતામાં અસરના સંભવિત પ્રભાવની ચિંતા દબાણમાં યોગદાન આપે છે.					

C. પ્રતિસાદકર્તાઓના શારીરિક ઘટક

કૃપા કરીને ઓટો રિક્ષા ડ્રાઇવરોની શારીરિક ઘટકો સંબંધિત નીચેના નિવેદનોની સમીક્ષા કરો. દરેક નિવેદન માટે, નીચેના ચેકબોક્સમાં નિશાની કરીને તમારું અનુભવ દર્શાવો, 3-પોઇન્ટ લિકર્ટ સ્કેલ (હંમેશા, ક્યારેક, અને ક્યારેય) નો ઉપયોગ કરીને.

ક્રમ	નિવેદનો	હંમેશા	ક્યારેક	ક્યારેય નહિ
A.	હાથ			
1.	ડ્રાઇવિંગ કરતી વખતે સીટને એડજસ્ટ કરવાની ક્ષમતા.			
2.	ડ્રાઇવિંગ કરતી વખતે સ્ટીયરિંગ કોલમને એડજસ્ટ કરવાની ક્ષમતા.			
3.	ડ્રાઇવિંગ કરતી વખતે હાથને આરામ આપવાનો હાથમદક અથવા સ્થળની હાજરી.			
B.	કાંડા			
1.	સ્ટીયરિંગ કોલમનો પકડ આરામદાયક છે.			
2.	ડ્રાઇવિંગ કરતી વખતે સ્ટીયરિંગ કોલમ પર ઘણો દબાવો લાગુ પડે છે.			
3.	ઓટો રિક્ષા ચલાવવાના કારણે હાથ અથવા હાથમાં અગવડતા અનુભવાય છે.			
C.	ઘડ			
1.	ડ્રાઇવિંગ દરમિયાન ઘડ ઝુકેલું છે.			
2.	ડ્રાઇવિંગ દરમિયાન ઘડ બાજુએ વળે છે.			
D.	ગળું			
1.	ડ્રાઇવિંગ દરમિયાન ગળું ઝુકેલું છે.			
2.	ડ્રાઇવિંગ દરમિયાન ગળું બાજુમાં વળે છે.			

ક્રમ	નિવેદનો	હંમેશા	ક્યારેક	ક્યારેય નહિ
E.	કંપન			
1.	ડ્રાઇવિંગ કરતી વખતે ગંભીર કંપન અનુભવાતું છે.			
2.	ડ્રાઇવિંગ દરમિયાન કંપન શરીરના વિશિષ્ટ ભાગોને અસર કરે છે (ઉદાહરણ તરીકે, હાથ, હાથના ભાગો, પગ).			
F.	પગ			
1.	વાહનનો માળો પગ માટે પૂરતી આધાર આપે છે.			
2.	ડ્રાઇવિંગ દરમિયાન પગમાં દુખાવો અનુભવાય છે.			
3.	ડ્રાઇવિંગ દરમિયાન ઘૂંટણમાં અગવડતા અથવા સ્ફૂર્તિનો અનુભવાય છે.			
G.	પગર			
1.	ડ્રાઇવિંગ દરમિયાન પગમાં દુખાવો અથવા અગવડતા અનુભવાય છે.			
2.	લાંબા સમય સુધી ડ્રાઇવિંગ કર્યા પછી પગમાં થાક અનુભવાય છે.			
3.	ડ્રાઇવિંગ દરમિયાન પગમાં રક્તપ્રવાહની સમસ્યાઓ (જેમ કે સૂંસવવું અથવા ઝંખવું) અનુભવાય છે.			
4.	ડ્રાઇવિંગ કરતી વખતે ઘૂંટણમાં અગવડતા અનુભવાય છે.			
5.	સીટ જાંઘોને પૂરતું ટેકો આપે છે.			

ક્રમ	નિવેદનો	હંમેશા	ક્યારેક	ક્યારેય નહિ
H.	કાંખ			
1.	ડ્રાઇવિંગ દરમિયાન કૂન બરાબર સરખા છે.			
2.	ડ્રાઇવિંગ દરમિયાન કૂનની સ્થિતિમાં વારંવાર ફેરફાર કરવામાં આવે છે.			
3.	ડ્રાઇવિંગ દરમિયાન કૂનમાં અગવડતા અનુભવાય છે.			
I.	કંપનનો સંદિગ્ધ પ્રભાવ			
1.	ડ્રાઇવિંગ કરતી વખતે તીવ્ર કંપન અનુભવવું			
2.	ડ્રાઇવિંગ કરતી વખતે કંપન શરીરના વિશિષ્ટ ભાગોને અસર કરે છે			
J.	કાર્યસ્થળની બેઠક ડિઝાઇન અને આરામના ઘટકો			
1.	આટો રિક્ષાની બેઠક આરામદાયક છે.			
2.	બેઠકમાં ફેરફારની જરૂર છે.			
3.	બેઠક પીઠ અને જાંઘ માટે પૂરતો આધાર પ્રદાન કરે છે.			
4.	બેઠક ડ્રાઇવિંગ કરતી વખતે કંપનો પ્રભાવ અસરકારક રીતે ઘટાડે છે.			
5.	બેઠકને આરામદાયક ડ્રાઇવિંગ પોઝિશન પ્રાપ્ત કરવા માટે સરળતાથી એડજસ્ટ કરી શકાય છે.			
6.	બેઠક પહેરાવાની અને ફાટવાની દૃષ્ટિએ ટકાઉ છે.			

ક્રમ	નિવેદનો	હંમેશા	ક્યારેક	ક્યારેય નહિ
7.	બેઠક ડિઝાઇન ડ્રાઇવિંગ પોસ્ટરને અસર કરે છે.			
8.	બેઠકમાં ફેરફારની જરૂર છે.			
9.	અતિરિક્ત આધાર, જેમ કે કમ્બલ, લંબાર સપોર્ટ, બેઠવાનો પોસ્ટર સુધારવા માટે વપરાય છે.			

D. પ્રતિસાદકર્તાઓ દ્વારા ડ્રાઇવિંગ દરમિયાન અપનાવવામાં આવેલા સ્થિતિઓ

કૃપા કરીને ઓટો રિક્ષા ડ્રાઇવરો દ્વારા અપનાવવામાં આવેલી સ્થિતિઓ સંબંધિત નીચે આપેલ દૃષ્ટાંકોની સમીક્ષા કરો. દરેક દૃષ્ટાંક માટે, આપનો અનુભવ દર્શાવવા માટે નીચે આપેલા 3 પોઇન્ટ લિકર્ટ સ્કેલનો (હંમેશા, ક્યારેક અને કદી નથી) નો ઉપયોગ કરીને યોગ્ય ચેકબોક્સમાં નિશાન કરો.

ક્રમ	ડ્રાઇવિંગ દરમિયાન અપનાવવામાં આવેલા સ્થિતિઓ	હંમેશા	ક્યારેક	ક્યારેય નહીં
A.	હાથની સ્થિતિ			
1.	 કોણ 90° પર કોલીતાં			
2.	 કોલીતાં 120° પર વાંકડા			
3.	 હાથ આગળ વિસ્તરેલ			

ક્રમ	ડ્રાઇવિંગ દરમિયાન અપનાવવામાં આવેલા સ્થિતીઓ	હંમેશા	ક્યારેક	ક્યારેય નહીં
B.	કરતની સ્થિતિ			
1.	 થોડું ઉપર વાંકડું			
2.	 સામાન્ય (સિધો)			
3.	 થોડું નીચે વાંકડું			
C.	બેઠકનો આકાર			
1.	 સમભાગ સાથે સીધું			
2.	 થોડું ઢળેલું			
3.	 આગળ વળકવાનું			
4.	 પાછળ વળકવાનું			

ક્રમ	ડ્રાઇવિંગ દરમિયાન અપનાવવામાં આવેલા સ્થિતિઓ	હંમેશા	ક્યારેક	ક્યારેય નહીં
D. ધડનો આકાર				
1.	 <p>સીટ સાથે સીધું અને સહી સમીકરણમાં</p>			
2.	 <p>એક બાજુ પર વળકવું</p>			
E. ગળાનો આકાર				
1.	 <p>સામાન્ય અને સમસીલ</p>			
2.	 <p>થોડું આગળ</p>			
3.	 <p>થોડું પાછળ</p>			
4.	 <p>એક બાજુ પર વાંકડું</p>			
F. પગના પંજાનો આકાર				
1.	 <p>જમીન પર સમતલ</p>			

ક્રમ	ડ્રાઇવિંગ દરમિયાન અપનાવવામાં આવેલા સ્થિતીઓ	હંમેશા	ક્યારેક	ક્યારેય નહીં
2.	 <p>પેડલ પર આરામ કરવું</p>			
3.	 <p>પેડલના ઉપર તૈરવું</p>			
4.	 <p>થોડું ઉપર તરફ એડજસ્ટ કરવું</p>			
5.	 <p>થોડું નીચે તરફ એડજસ્ટ કરવું</p>			
6.	 <p>પદવિઓ વચ્ચે બદલાવ</p>			
G.	પગનો આકાર			
1.	 <p>સીધું સાથે ઘૂંટણો થોડું વાંકડું</p>			
2.	 <p>ઘૂંટણો 90° પર વાંકડા</p>			
3.	 <p>પગો ફેલાવેલા</p>			

પ્રકરણ IV: પ્રતિસાદકર્તાઓના માનવશાસ્ત્રીય માપ (પ્રાથમિક રીતે બેસતી વખતે)

કૃપા કરીને નીચેના શરીરના ભાગો માટે માનવશાસ્ત્રીય માપ પ્રદાન કરો:

ક્રમ	ડેટા	માપ	એકમ
1.	ઊંચાઈ		સેન્ટીમીટર
2.	વજન		કિલોગ્રામ
3.	બેસવાની ઊંચાઈ (બેઠક પરથી માથાના ટોચ સુધી)		સેન્ટીમીટર
4.	બેસવાની આંખોની ઊંચાઈ (બેઠક પરથી આંખો સુધી)		સેન્ટીમીટર
5.	ખભાની પહોળાઈ (દોન ખભાના સૌથી બહારના બિંદુઓ વચ્ચેનું અંતર)		સેન્ટીમીટર
6.	કોણી આરામ ઊંચાઈ (બેઠક પરથી કોણીની નીચે સુધી)		સેન્ટીમીટર
7.	થાઈ ક્લિઅરન્સ (બેઠક પરથી જાંઘના ટોચ સુધી)		સેન્ટીમીટર
8.	બટોક-પોપ્લિટીઅલ લંબાઈ (નિતંબના પાછળથી ઘૂંટણના પાછળ સુધીનું આડું અંતર)		સેન્ટીમીટર
9.	ઘૂંટણની ઊંચાઈ (માળા પરથી ઘૂંટણના ટોચ સુધી)		સેન્ટીમીટર
10.	પોપ્લિટીઅલ ઊંચાઈ (માળા પરથી ઘૂંટણની પાછળ જાંઘના તળિયે સુધી)		સેન્ટીમીટર
11.	કર પગની લંબાઈ (કોણીથી મધ્યમ આંગળીની ટોચ સુધી)		સેન્ટીમીટર
12.	નિતંબની પહોળાઈ (બેસતી વખતે નિતંબના સૌથી પહોળા ભાગ વચ્ચેનું અંતર)		સેન્ટીમીટર
13.	બેસવાની ખભાની ઊંચાઈ (બેઠક પરથી ખભાના ટોચ સુધી)		સેન્ટીમીટર
14.	બેકરેસ્ટ સંપર્ક બિંદુ (બેઠકથી બેકરેસ્ટ સાથે પીઠના સંપર્કના બિંદુ સુધીનું અંતર)		સેન્ટીમીટર
15.	પગની લંબાઈ (એડીથી સૌથી લાંબી આંગળીની ટોચ સુધી)		સેન્ટીમીટર

APPENDIX- IV

INFORMED CONSENT FORM



NAAC Accredited 'A+' Grade

DEPARTMENT OF FAMILY AND COMMUNITY RESOURCE MANAGEMENT
FACULTY OF FAMILY & COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
VADODARA

સૂચિત સંમતિ ફોર્મ

પ્રિય પ્રતિસાદક,

ફેમિલી અને કોમ્યુનિટી રિસોર્સ મેનેજમેન્ટ વિભાગ, ફેકલ્ટી ઓફ ફેમિલી એન્ડ કોમ્યુનિટી સાયન્સીસ, મહારાજા સયાજીરાવ યુનિવર્સિટી ઓફ બરોડા, વડોદરા, સંશોધનમાં જોડાયેલા માનવ ભાગીદારોના સંરક્ષણને સુનિશ્ચિત કરવા માટે પ્રતિબદ્ધ છે. હું રિનુષા રાજન, આ વિભાગમાં સિનિયર એમ.એસ. સીની વિદ્યાર્થીની છું. મારી માસ્ટર્સ ડિગ્રીના ભાગરૂપે, હું "વડોદરા શહેરના ઓટો રિક્ષા ચાલકો દ્વારા અનુભવાયેલી મસ્ક્યુલોસ્કેલેટલ અને પોઝ્યુરલ અસુવિધાની હદ" વિષયક સંશોધન ચલાવી રહી છું.

અધ્યયનના ઉદ્દેશ્યો નીચે મુજબ છે:

1. વડોદરા શહેરના ઓટો રિક્ષા ચાલકો દ્વારા અનુભવાતા મસ્ક્યુલોસ્કેલેટલ અસુવિધાના વ્યાપનું મૂલ્યાંકન કરવું.
2. પ્રતિસાદકો દ્વારા અનુભવાતા પોષ્ટરલ અસુવિધાના વ્યાપનું મૂલ્યાંકન કરવું.
3. પ્રતિસાદકો દ્વારા અનુભવાતી સમસ્યાઓ માટે ઉકેલ પ્રદાન કરવા.

આ દસ્તાવેજ સંશોધન વિશે વિગતો પ્રદાન કરે છે, જે તમને ભાગ લેવા માટે જાણકાર નિર્ણય લેવાની મંજૂરી આપે છે. જો તમે ભાગ લેવા માટે સંમત છો, તો તમારે એક પ્રશ્નાવલી ભરવાની રહેશે જેની અંદર આપ શ્રી નું નામ, વય અને શૈક્ષણિક સ્તર જેવી મૂળભૂત માહિતી આપવાની વિનંતી કરવામાં આવશે. હું તમારા અનુભવને સમજવા અને તમારે ડાઇવિંગ દરમિયાન અનુભવાતી અસુવિધા અંગેની તમારી અનુમતિ પ્રાપ્ત કરવા માટે ખૂબ જ રસ ધરાવું છું.

ફૂપા કરીને નોંધો કે આ અભ્યાસમાં તમારો ભાગ સંપૂર્ણપણે વૈકલ્પિક છે. તમારી ઓળખની સુરક્ષા માટે તમામ પ્રયાસો કરવામાં આવશે અને તમારી માહિતી ગુપ્ત રાખવામાં આવશે. તમારી પ્રતિક્રિયાઓ સુધી ફક્ત સંશોધકને જ પહોંચ મળશે. તમારી વ્યક્તિગત માહિતી ફક્ત તમારો સંપર્ક કરવા માટે જ ઉપયોગમાં લેવાશે અને તમારી પાસેથી મળેલી માહિતીને સંશોધનના પરિણામો સાથે સંકળાશે નહીં. જો અભ્યાસ દરમિયાન કોઈ પણ સમયે તમને અસુવિધા લાગે, તો તમે કોઈ પણ કારણ આપ્યા વિના અભ્યાસમાંથી તાત્કાલિક બહાર નીકળી શકશો.

જો આ અભ્યાસ અંગે તમારી પાસે કોઈ વધારાની શંકા હોય, તો ફૂપા કરીને નીચે આપેલા સંપર્ક માધ્યમો દ્વારા મને સંપર્ક કરવા માટે નિઃસંકોચ બનો:

ફોન: 8160116381

ઇમેલ: rinusharajan265@gmail.com

અભ્યાસમાં ભાગ લેવા માટે, ફૂપા કરીને "હું સંમત છું" પર ટિક માર્ક મૂકીને ફોર્મ પૂર્ણ કરો. તમારા ભાગને હું ખૂબ પ્રશંસનીય માનું છું.

હું સંમત છું હું સંમત નથી



પ્રતિસાદકનું નામ અને સહી:

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તારીખ:

Research Guide
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INFORMED CONSENT FORM



NAAC Accredited 'A+' Grade

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સૂચિત સંમતિ ફોર્મ

પ્રિય પ્રતિસાદક,

ફેમિલી અને કોમ્યુનિટી રિસોર્સ મેનેજમેન્ટ વિભાગ, ફેકલ્ટી ઓફ ફેમિલી એન્ડ કોમ્યુનિટી સાયન્સીસ, મહારાજા સયાજીરાવ યુનિવર્સિટી ઓફ બરોડા, વડોદરા, સંશોધનમાં જોડાયેલા માનવ ભાગીદારોના સંરક્ષણને સુનિશ્ચિત કરવા માટે પ્રતિબદ્ધ છે. હું રિનુષા રાજન, આ વિભાગમાં સિનિયર એમ.એસ. સીની વિદ્યાર્થીની છું. મારી માર્સ્ટર્સ ડિગ્રીના ભાગરૂપે, હું "વડોદરા રાહરના ઓટો રિક્ષા ચાલકો દ્વારા અનુભવાયેલી મસ્ક્યુલોસ્કેલેટલ અને પોઝ્યરલ અસુવિધાની હદ" વિષયક સંશોધન યલાવી રહી છું.

અધ્યયનના ઉદ્દેશ્યો નીચે મુજબ છે:

1. વડોદરા શહેરના ઓટો રિક્ષા ચાલકો દ્વારા અનુભવાતા મસ્ક્યુલોસ્કેલેટલ અસુવિધાના વ્યાપનું મૂલ્યાંકન કરવું.
2. પ્રતિસાદકો દ્વારા અનુભવાતા પોષ્યરલ અસુવિધાના વ્યાપનું મૂલ્યાંકન કરવું.
3. પ્રતિસાદકો દ્વારા અનુભવાતી સમસ્યાઓ માટે ઉકેલ પ્રદાન કરવા.

આ દસ્તાવેજ સંશોધન વિશે વિગતો પ્રદાન કરે છે, જે તમને ભાગ લેવા માટે જાણકાર નિર્ણય લેવાની મંજૂરી આપે છે. જો તમે ભાગ લેવા માટે સંમત છો, તો તમારે એક પ્રશ્નાવલી ભરવાની રહેશે જેની અંદર આપ શ્રી નું નામ, વય અને શૈક્ષણિક સ્તર જેવી મૂળભૂત માહિતી આપવાની વિનંતી કરવામાં આવશે. હું તમારા અનુભવને સમજવા અને તમારે ડાઇવિંગ દરમિયાન અનુભવાતી અસુવિધા અંગેની તમારી અનુમતિ પ્રાપ્ત કરવા માટે ખૂબ જ રસ ધરાવું છું.

ફૂપા કરીને નોંધો કે આ અભ્યાસમાં તમારો ભાગ સંપૂર્ણપણે વૈકલ્પિક છે. તમારી ઓળખની સુરક્ષા માટે તમામ પ્રયાસો કરવામાં આવશે અને તમારી માહિતી ગુપ્ત રાખવામાં આવશે. તમારી પ્રતિક્રિયાઓ સુધી ફક્ત સંશોધકને જ પહોંચ મળશે. તમારી વ્યક્તિગત માહિતી ફક્ત તમારો સંપર્ક કરવા માટે જ ઉપયોગમાં લેવાશે અને તમારી પાસેથી મળેલી માહિતીને સંશોધનના પરિણામો સાથે સંકળાશે નહીં. જો અભ્યાસ દરમિયાન કોઈ પણ સમયે તમને અસુવિધા લાગે, તો તમે કોઈ પણ કારણ આપ્યા વિના અભ્યાસમાંથી તાત્કાલિક બહાર નીકળી શકશો.

જો આ અભ્યાસ અંગે તમારી પાસે કોઈ વધારાની શંકા હોય, તો ફૂપા કરીને નીચે આપેલા સંપર્ક માધ્યમો દ્વારા મને સંપર્ક કરવા માટે નિઃસંકીય બનો:

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અભ્યાસમાં ભાગ લેવા માટે, ફૂપા કરીને "હું સંમત છું" પર ટિક માર્ક મૂકીને ફીડબેક ફોર્મ પૂર્ણ કરો. તમારા ભાગને હું ખૂબ પ્રશંસનીય માનું છું.

હું સંમત છું હું સંમત નથી

રિનુષા રાજન

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ABSTRACT



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Auto Rickshaw Drivers play a crucial role in the urban transport system, providing essential mobility for millions. However, their profession subjects them to significant physical discomfort, leading to musculoskeletal and postural discomfort. Prolonged sitting, repetitive hand movements, and continuous exposure to vibrations contribute to various health issues, including back pain, neck stiffness, and joint discomfort.

A major challenge faced by the Auto Rickshaw Drivers is the lack of ergonomic seating, which exacerbates their physical discomfort. Poor posture, extended driving hours, and inadequate seat cushioning increase the risk of musculoskeletal and postural discomfort. Additionally, limited awareness of posture correction techniques and preventive exercises contributes to deteriorating health conditions among drivers. Thus, the present study was undertaken to analyse the extent of musculoskeletal and postural discomfort experienced by the Auto Rickshaw Drivers in Vadodara City.

A descriptive research design was adopted for this study. The data were collected from 120 CNG operated Auto Rickshaw Drivers with at least two years of driving experience using a purposive sampling technique. The data collection took place from October 2024 to December 2024. The tools used to collect data were a structured questionnaire and an observation sheet. The questionnaire consisted of three sections: Background information, Extent of musculoskeletal discomfort, and Extent of postural discomfort. The observation sheet recorded anthropometric measurements of the respondents.

The extent of musculoskeletal discomfort was assessed using the Cornell Musculoskeletal Discomfort Questionnaire (Sedentary Worker, Male Version). The Postural Discomfort Survey Tool for Three-Wheeler Drivers (PDST) was utilized to measure the extent of postural discomfort. The content validity was established. The data were analyzed using descriptive statistics (frequencies, percentages, means, and standard deviations) as well as relational statistics (Analysis of Variance (ANOVA) and correlation coefficient test).

The findings revealed that the mean age of the respondents was 41.21 years, with a standard deviation of 11.89. A total of 43.33 per cent of the respondents had attained secondary education. Additionally, 60.84 per cent had 3–16 years of the auto rickshaw driving experience, and 69.16 per cent owned the Auto Rickshaw. The respondents worked an average of 9.70 hours per day. A significant 91.67 per cent worked the morning shift (6:00

AM – 2:00 PM), and 67.51 per cent took only one break during their work hours. Notably, 62.50 per cent did not consult any healthcare professionals regarding their discomfort, and 70.00 per cent consistently consumed tobacco.

The majority of the respondents reported Musculoskeletal Discomfort in their lower back (35.83 per cent), right knee (33.33 per cent), neck (30.00 per cent), left shoulder (27.50 per cent), left upper arm, and upper back (25.00 per cent) during the last work week. Furthermore, respondents experienced a high level of discomfort in the lower back (48.33 per cent), upper back (31.67 per cent), left knee (28.33 per cent), left wrist, and right knee (25.00 per cent) due to Musculoskeletal Discomfort. The discomfort also interfered with work ability, with 45.00 per cent of the respondents reporting interference due to lower back pain, followed by left shoulder (28.33 per cent), right knee (26.66 per cent), upper back (23.33 per cent), right shoulder, right wrist, and left knee (21.67 per cent).

Additionally, 23.33 per cent of the respondents reported experiencing musculoskeletal discomfort 1–2 times per week in the thenar eminence of their right hand, and 21.67 per cent of the respondents experienced discomfort in the radial, ulnar, and metacarpophalangeal regions of the right hand. Moreover, 85.00 per cent of the respondents experienced moderate discomfort in the radial region of the right hand, followed by 76.66 per cent of the respondents in the ulnar region. About 76.66 per cent of the respondents sometimes experienced work interference due to musculoskeletal discomfort in the radial region of their right hand, while 75.00 per cent of the respondents experienced work interference due to discomfort in the ulnar region.

Further analysis revealed that 31.67 per cent of the respondents experienced high psychosocial stress due to passenger behavior, particularly when dealing with rude or difficult customers. Additionally, 25.00 per cent of the respondents experienced high psychosocial stress due to a lack of sufficient rest breaks and interactions with traffic police or other authorities.

The data also reported that 73.33 per cent of the respondents always experienced postural discomfort due to seat design. The majority of the respondents reported frequent adjustments of the steering wheel, bending their trunk sideways, and tilting their neck while driving. Moreover, 51.66 per cent of the respondents always experienced postural discomfort in their hips, while 50.00 per cent of the respondents reported discomfort due to vibrations affecting specific body parts. It was observed that most of the respondents

adopted postures with elbows bent at 120°, arms extended forward, wrists slightly bent upwards, and a leaned-back posture while driving. Additionally, 55.00 per cent of the respondents always kept their feet on the pedals, and 48.33 per cent spread their legs apart while driving.

The mean height of the respondents was 168.69 cm, while their mean weight was 70.57 kg. A significant relationship was found between the extent of Musculoskeletal Discomfort and the respondent's age ($\alpha = 0.05$). Similarly, a significant relationship was found between Postural Discomfort and both age and daily driving duration ($\alpha = 0.05$). The results also indicated a significant positive correlation between Musculoskeletal Discomfort and Postural Discomfort.