



# EFFECT OF COVID-19 ON PSYCHOSOCIAL BEHAVIOUR OF AUTOMOBILE WORKERS PERFORMANCE - AN ERGONOMIC STUDY

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## ABSTRACT

*The COVID-19 lockdown has had a significant negative impact on the automotive industry, particularly on the small and medium-sized businesses and daily wage workers who rely on autonagar industrial area as their main source of income. Employees experienced increased physiological and psychological stress during the lockdown period. Many people lost their jobs, finding work and surviving for food and shelter became worse for daily wagers. To suggest the behavioural changes needed to improve the quality of worker performance there is need of worker motivation during the work that suits the type of work and design of work including adequate rest period needed during a working shift. Consequently, it is felt necessary to study the behaviour including estimation the heart rates of various groups of workers after determining their maximum heart rate including maximum limit of continued work. This comparison can help workers achieve better performance at their workplaces having prescribed training to enhance their work efficiency and health conditions. Out of 307 samples, 110 participants had a limit of continuous work that was less than their maximum working heart rate while performing a task, demonstrating the need for better posture, work rest breaks, and customised work study models to improve performance, persistence and to lower stress levels. Continuous employee monitoring is a challenging task. However, improved worker productivity and employee health benefits support socio-cultural advancement of the firm's products and services.*



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## 1. INTRODUCTION

According to 2021 data, India is fourth largest automobile producer in the world with a target of 4.4 million and has

the fifth-highest GDP in the world. Due to the industry's extensive applications in the fields of manufacturing, product development, marketing, mining, road and transportation, petroleum and gasoline, many new employment avenues have generated in these sectors. The

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quick economic growth of India has resulted in an enormous rise in the demand for exports. In addition, the government's most well-known programs, such as Digital India, Made in India, Start-up India, the Smart City Mission, and the Atal Mission for Urban Transformation and Rejuvenation, have given momentum. According to the automotive mission plan, the Indian automotive industry currently accounts for roughly 7% of the nation's GDP and is soon predicted to reach 12%. The National Health Mission (NHM), which is divided into the National Rural Health Mission (NRHM) and the National Urban Health Mission (NUHM), is a government-funded healthcare initiative, assists States and UTs in improving their health care systems to ensure that everyone has access to economical, cost-effective, and high-quality healthcare services. These programmes involve infant care, nutrition assistance, and communicable and non-communicable diseases. A total of 2 996 635 hospitals fights these illnesses, and the total number of households that benefited was 8.03 crores across India under various standard deprivation parameters and total families covered and Ayushman Bharat - Pradhan Mantri Arogya Yojana (AB-PMJAY) provided benefits to 10.74 crore rural and urban families.

The anticipated loss per day during the lockdown was 2300 crores, and the 3.45 lakh job losses indicate a sharp decline in the number of workers in this industry. All major original component manufacturers reduced their production to 18–20% as recommended by the committee of the auto industry association (Shanahan et al., 2022).

According to surveys, 65% of families had an improvement in their quality of life during lockdown, but many people also experienced loneliness, worry, and discomfort, and 40% of respondents stated they missed their regular social and working lives (Shanahan et al., 2022).

In September 2021, the Union Cabinet approved the INR 26,058 Crore production linked incentive (PLI) Programme to increase domestic production of drones and fuel cell and electric vehicles shows the importance of automobile and manufacturing sector growth in India. Hence, as World Health Organization (WHO) Statistics 2018 in detail it was cited, however, not much research was made an attempt on covid-19 on psychosocial behavior of Automobile workers performance in ergonomic perspective.

## **2. THE TYPE OF EMPLOYMENT AND CONTRIBUTING FACTORS FOR MUSCULOSKELETAL DISORDERS**

The automobile supply chain is dependent on manufacturers, manufacturing, dealers, and customers. It is complicated and susceptible owing to general transportation concerns based on demand and supply (Ali et al., 2018).

The production of two-wheelers has significantly expanded as young, middle-class Indians have transitioned into rural market segments and in fiscal year 2022(FY-2022), India produced 22.93 million vehicles (Gupta, 2013). Due to multiple initiatives, government funding, and predicted future growth, India has risen to the leading two-wheeler and four-wheeler manufacturer and developing supplier. Occupational stress grew as a result impact of COVID-19 on staff accessibility and increasing demand. This led to spike in workload to compensate for the increased demand and enhance the production of automobiles (Dennerlein, 2008; Yassierli, 2017). As a result, physiological, psychological, and psychosocial pressures developed due to increased commitment in the industrial sector and concurrently increased work pressure on the available workforce. Long working hours contributed to the development of musculoskeletal disorders (Boudet et al., 2019; Bertera, 1990; Mandal et al., 2018; Shanahan et al., 2012)

## **3. MORBIDITY AND MORTALITY AS A RESULT OF MUSCULOSKELETAL DISORDERS**

The majority of those who work in the automotive industry, including drivers, mechanics, assemblers, repairers, load pullers, and other personnel who operate on machinery and vehicles, suffer from musculoskeletal disorders and psychological issues (Das et al., 2022; Dennerlein, 2008; Mačuzić & Lukić 2017; Philip et al., 2014; Valirad et al., 2015). Due to different working culture and requirements in the industry the administrative, executive, and operational levels of the automobile hierarchy encounter work-related musculoskeletal disorders, physical, psychosocial, and psychological stress (Dianat et al., 2017; Engineering 2016; James et al., 2019; Luger et al., 2019). The automobile manufacturing companies are showing exponential growth. At the operational and maintenance level employees are more prone to cardiac stress during their task in the shift. Assessment of their cardiac stress gives estimation of levels of works that can be assigned and the requirement of work breaks (Cortes-Ramirez et al., 2018; James et al., 2019).

## **4. INCREASE IN THE POVERTY LEVEL IN THE INDIA DURING LOCKDOWN AND ITS EFFECT ON WORK RELATED STRESSES**

The World Health Organization estimates that more than half a billion individuals fell below the poverty line as a result of having to pay for health care services with the increase in population of India at a rate of 2.2% per year, decrease in agriculture productivity, and rising unemployment number of below the poverty line(BPL) has increased (Dennerlein, 2008). Lack of proper medical facilities at the operational level as a result of the pandemic have made the situation worse. Significant changes in the auto industry brought on by the increased use of automation, constantly changing safety and environmental regulations, new developments in manufacturing, and

applications of robotics, the industry has an unprecedented need for training as a requirement. Despite the fact that adequate training can avoid physical injuries, industries are under enormous pressure to cut corners on safety, making employees in these industries more susceptible to occupational risks (Luger et al., 2019). Sustained stress has a negative impact on health. Training can give motivation to handle the job and stresses. Unlike distress, eustress has positive effects on health that increases the efficiency of employees (Lavie et al., 2019; Scott et al., 2012). It is important to apply the concept of Astrand to evaluate job heaviness for all such work categories. This will help increase profile of workers more accurately to prescribe befitting conditions to achieve workers comfort and safety in the automotive supply chain (Åstrand et al., 1960; WSH Council 2014).

### 5. EFFECT OF WORKING ENVIRONMENT ON FATIGUE LEVELS OF EMPLOYEE

The environmental conditions play a crucial role in the work performance of the worker. Around 12 million individuals die each year as a result of the unsanitary conditions in the workplace and domiciles (Brusseau et al., 2019; Das et al., 2022; Dey and Sharma 2013; Engineering, 2016). Due to the difficult working circumstances, more workers are suffering from accidents and cuts as well as musculoskeletal diseases in the automotive manufacturing and operating industries, which are under intense pressure (Lin 2016; Valirad et al., 2015; Yassierli 2017).

The human body adjusts its temperature in response to the environment and working conditions in order to maintain homeostasis while achieving a new dynamic equilibrium. People survive if homeostasis is successful but are prone to serious health problems if it is not maintained (Cortes-Ramirez et al., 2018; James et al., 2019).

### 6. DATA COLLECTION

Data collecting for the study began in the Autonagar region of Vijayawada, which is situated on the bank of the River Krishna in Andhra Pradesh. Daily high temperatures are around 40°C. Various parameters were used to assess the cardiac stress including demographic details, height, weight, body mass index, body surface area, resting heart rate, working heart rate. From these parameters, the net cardiac cost (NCC), relative cardiac costs are calculated using the formulas as follows.

Body mass Index (BMI)

$$= \text{Weight (kg)} / (\text{height (m)})^2 \quad (1)$$

Body Surface area (BSA)

$$= \sqrt{\text{Height (Cm)} * \text{weight (kg)} / 3600} \quad (2)$$

$$\text{The maximum heart rate (MHR)} = 220 - \text{age} \quad (3)$$

$$\text{The heart rate reserve (HRR)} = \text{Maximum heart rate (MHR)} - \text{Resting heart rate (RHR)} \quad (4)$$

$$\text{Net cardiac cost(NCC)} = \text{Average Working heart rate (WHR)} - \text{Resting Heart Rate (RHR)} \quad (5)$$

$$\text{Relative Cardiac Cost (RCC)} = (\text{NCC}/\text{HRR}) * 100 \quad (6)$$

$$\text{Limit of continuous work (LCW)} = \text{Resting hear rate (RHR)} + 35 \quad (7)$$

For a healthy adult, the BMI ranges from 18.5 to 24.9 kg/m<sup>2</sup>, with a BMI of 18.5 kg/m<sup>2</sup> or less indicating underweight, 25.0 to 29.9 kg/m<sup>2</sup> indicating overweight, and 30 kg/m<sup>2</sup> or more being considered obese. Due to decreased activity levels, a lack of motivation to lose weight, and the use of steroids as a component of medications, the prevalence of obesity has grown during the pandemic (Bhaskaran et al., 2022; Lavie et al., 2019; Scott et al., 2012).

The environmental parameters such as temperature, humidity, are taken from Continuous Air Quality Measuring System (CAQMS) to calculate the heat index temperature. An average individual has 1.9m<sup>2</sup> of surface area; the larger the surface, the greater the heat loss or gain by conduction, convection, and radiation. Thermal radiation can damage human cells, diminishing the worker performance and propensity to unsafe work behaviour (Dey & Sharma 2013; Sharma et al., 2016; Valirad et al., 2015).

Employees working at the operational level in the automobile industry are more prone to tobacco and alcohol habits due to high stress from the working environment and the influence of the surrounding people (Bhaskaran et al., 2022; Dey et al., 2007). A healthy person's heart rate typically ranges from sixty beats to one hundred per minute. Lower heart rate is an indication of a strong heart and good health. However, factors such as age, degree of exercise and fitness, smoking, cardiovascular disease, high cholesterol, diabetes, air temperature, posture, emotions, body size, and medication affects heart rate (Chung, 2018; Scott et al., 2012; Shanahan et al., 2022).

The relative cardiac cost values indicate the strain on the workers' hearts. 0–19 is described as light, 20–39 as moderate, and 40–69 as severe (Pancardo et al., 2015). People exhibiting high RCC values, which fall under the vigorous category, they needing work breaks in between to bring the level down to the light work group.

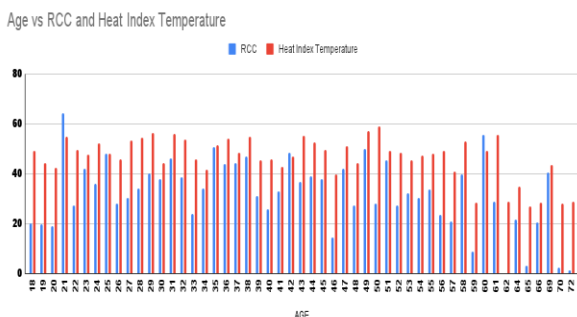
According to a National Geographic research of major towns in India, Vijayawada will experience an increase in temperature over the next 50 years, with average maximum temperatures rising to 35°C and minimum average temperatures rising to 18°C or higher.

### 7. RESULTS AND DISCUSSION

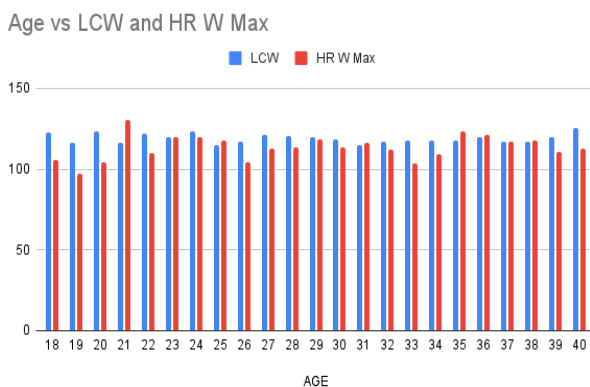
The recorded and derived data were analyzed to predict the overall performance of the employees and to increase their productivity.

According to the present study conducted on Autonagar employees, the average resting heart rate (RHR) is 84.6 beats per minute (BPM), which is higher than the average heart rate of 80 BPM. This indicates that the majority of people do not have healthy heart rates. Employees with  $LCW < HR W_{max}$ , have average heart rate of 81.21 BPM, which is also higher than the average and indicates high levels of stress. RHR and HRR vary in parallel, the values were 96.07 BPM for 307 samples and 101.67 BPM for 110 samples of the people having  $LCW < HR W_{max}$  in the present study.

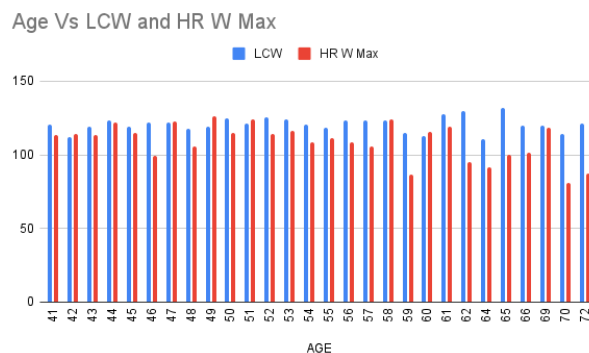
From the bar graphs shown in figures 1, 2, and 3 and tables 2 and 3, it is observed that there is no proper linear relationship between height and weight to age, but BMI has a direct relationship with both height and weight. However, Ding et al., (2020) observed a conflicting correlation between BMI and cardiovascular endurance, with an increase in BMI leading to a decrease in cardiovascular endurance (Ding and Jiang n.d.). From the results shown average BMI is 25.94 kg/m<sup>2</sup> which is an indication of increased sedentary behavior, decreased activity levels and cardiovascular endurance. Employees having  $LCW < HR W_{max}$ , the average BMI was 26.05 kg/m<sup>2</sup>. This is indicative of drop in exercise levels and an increase in sedentary behavior. These in turn are indicators of increased risk for heart-related disorders due to reduced cardiovascular strength.



**Figure 1.** Age vs Relative Cardiac Cost (RCC) and Heat Index temperature (°C).



**Figure 2.** People (Age < 40 Years) with limit of continuous work less than working maximum heart rate



**Figure 3.** People (Age > 40 Years) with limit of continuous work less than working maximum heart rate

The general perception is that the summer temperatures of up to 45°C are the only element contributing to heat stress. People experience higher temperatures than expected because temperature and relative humidity are inversely related. In the present study, it was found that in addition to work-related stress and psychological strain, participants experienced temperatures of up to 62°C, a symptom of significant heat stress and an increased risk of heart-related disorders. The minimum, maximum and average values of different parameters are shown in the Table 1. The bar graphs (figures 1, 2 and 3) depict that RCC is directly related to employee attitude and performance during the working hours. Also, it was observed that the exposure to sunlight can cause high heat stress irrespective of the age and employee attitude. During working hours, dehydration is also a severe problem in order to maintain the homeostasis of the body.

To cope with physiological and work-related stress, majority of employees addict to unhealthy habits. Therefore, to minimize work pressure and other job-related musculoskeletal problems, the working intensity should be kept within the range that allows for continuous work, with short breaks in the work process (Bhaskaran et al., 2022; Dey et al., 2007; James et al., 2019).

**Table 1.** The Average, minimum and maximum values of different parameters

Parameter	Avg. value	Min. Value	Max. Value
Age (years)	39.32	18	72
RHR(BPM)	84.6	60	104
HR W <sub>max</sub> (BPM)	112.89	69	145
Max. HR(BPM)	180.68	148	202
NCC(BPM)	28.26	0	68
RCC	34.48	0	93.33
LCW (BPM)	119.62	95	139
DBT(°C)	36	25	41
RH(%)	51.99	45.6	54.7
WBT(°C)	28.2	17.3	32.9
WBGT (°C)	30.61	19.61	35.33
HI(°C)	48.06	25	62

Table gives the details of the different categories of people with the parameters- considered and the effect of work-related stress in terms of net cardiac cost (NCC), relative cardiac cost (RCC), Thermal stress in terms of Heat index (HI) are shown during the working shift.

Light pollution is also a significant factor for human health and wildlife

## 8. CONCLUSIONS

Excessive work stress can cause cumulative trauma disorder (CTD) having lasting damage to various body parts including development of psychological stresses, excessive cardiac strain and musculoskeletal disorders. The working and resting heart rates play a significant part in determining the employee limit of continuous work. The application of ergonomics is of utmost importance in these sectors. Also increased number of

short breaks in between work spells would create improvement. Consequently, job adherence would increase bringing forth job interest and team spirit. To maintain the homeostasis of the body drinking sufficient amount of water is also must during working.

BMI= Body Mass Index

BSA=Body Surface Area (m<sup>2</sup>)

HRR=heart rate reserve

NCC = Net Cardiac cost

RCC =Relative cardiac cost

LCW = Limit of continuous work

RHR= Resting heart rate

HR W<sub>max</sub> =maximum working hear rate

DBT =Dry bulb temperature

WBGT= Wet bulb globe temperature

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