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The Effect of Ergonomics and Occupational Health on the Work Productivity of Production Employees in a Manufacturing Company

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ABSTRACT

Ergonomics and occupational health are essential components of occupational safety and health because they directly influence employee comfort, physical capacity, work efficiency, and productivity. This study aimed to analyze the partial and simultaneous effects of ergonomics and occupational health on the work productivity of production employees at a manufacturing company in Karawang Regency. A quantitative approach with a causal associative and cross-sectional survey design was employed. Data were collected through a Likert-scale questionnaire distributed to 80 production employees selected using purposive sampling based on active employment status and a minimum working period of six months. The data were analyzed using descriptive statistics, validity and reliability tests, classical assumption tests, multiple linear regression, partial tests, simultaneous tests, and the coefficient of determination. The results indicated that ergonomics and occupational health had positive and significant effects on work productivity, both partially and simultaneously. These findings demonstrate that appropriate workplace design, manageable workloads, adequate rest periods, and effective employee health programs can improve work efficiency, output quality, and target achievement

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INTRODUCTION

The manufacturing industry requires a balance between production efficiency and the protection of employees from occupational hazards. Production employees commonly perform repetitive movements, maintain static or awkward postures, handle materials, operate machinery, and work under demanding production targets. When workplace design does not correspond to employees' physical characteristics and functional capacities, these conditions may increase fatigue, discomfort, musculoskeletal complaints, and the likelihood of errors during production activities. The International Labour Organization reported that nearly three million workers die annually from work-related accidents and diseases, while approximately 395 million workers experience non-fatal occupational injuries worldwide (International Labour Organization, 2023). In addition, musculoskeletal conditions affect approximately 1.71 billion people globally and remain a leading cause of disability, reduced mobility, and limitations in work participation (World Health Organization, 2022). These conditions demonstrate that occupational protection should not be treated merely as regulatory compliance but as an essential component of sustainable operational performance.

The urgency of ergonomics and occupational health is particularly relevant to manufacturing companies because employee productivity is closely connected to physical comfort, work ability, and the suitability of the work system. Ergonomics refers to the adjustment of jobs, equipment, workstations, methods, and environmental conditions to workers' characteristics and limitations. Appropriate ergonomic arrangements can reduce muscle fatigue, prevent work-related musculoskeletal disorders, and support more efficient task completion. Occupational health has a broader scope that includes the maintenance of employees' physical, mental, and social well-being through hazard prevention, health monitoring, adequate rest, sanitation, and health-supporting workplace policies. The World Health Organization explains that occupational health seeks to promote and maintain the highest possible level of workers' physical, mental, and social well-being (World Health Organization, 2022). Accordingly, ergonomics and occupational health represent two interrelated organizational resources that can preserve employees' work capacity and enable them to achieve production targets consistently.

The Indonesian context further strengthens the relevance of examining these variables within manufacturing operations. Statistics Indonesia recorded approximately thirty thousand medium-sized and large manufacturing companies in Indonesia in 2024, indicating that a substantial number of employees are exposed to diverse production processes and occupational risks (Statistics Indonesia, 2024). At the same time, the Employment Social Security Agency reported 182,835 occupational accident claims in 2019, 221,740 claims in 2020, 234,370 claims in 2021, and 297,725 claims in 2022. From January to November 2023, the number had already reached 360,635 claims, demonstrating an upward trend in reported occupational accidents (Employment Social Security Agency, 2024). Although accident claims do not exclusively represent ergonomic problems, the trend indicates the continuing need for systematic workplace prevention, employee health protection, and risk control. Within production departments, these efforts are particularly important because repetitive activities, manual material handling, work pace, insufficient recovery periods, and unsuitable workstation dimensions can simultaneously affect employee health and productive output.

Previous studies have provided evidence that ergonomic improvements can produce beneficial outcomes, although their research scopes and measurements have varied considerably. Susihono and Adiatmika (2021) found that ergonomic interventions reduced musculoskeletal complaints and fatigue among workers in a traditional metal-casting industry, indicating the importance of adapting work systems to employees' physical conditions. Choobineh et al. (2021) implemented a multilayered intervention involving ergonomic training, employee participation, and workstation redesign in a steel manufacturing complex and showed that a participatory approach could reduce physical ergonomic risk factors and support system productivity. Heidarimoghadam et al. (2022), through a systematic review, concluded that workplace ergonomic interventions produced different health and productivity outcomes depending on the type, duration, and implementation context of the intervention. Similarly, Quiroz-Flores et al. (2023) demonstrated that workstation redesign in a plastics manufacturing company could reduce postural risks by between 50.0 and 66.7 percent and generate potential savings from reduced absenteeism. However, these studies predominantly focused on intervention programs, physical-risk assessment, musculoskeletal complaints, or workstation redesign rather than simultaneously testing employees' perceptions of ergonomics and occupational health as predictors of overall work productivity.

Recent studies also reveal several contextual and methodological gaps that require further investigation. Yang et al. (2023) reported a 40.6 percent twelve-month prevalence of work-related musculoskeletal disorders among electronics manufacturing employees, with the neck, shoulders, upper back, and lower back identified as frequently affected body areas. Nevertheless, their study emphasized the prevalence and determinants of musculoskeletal disorders rather than productivity as the main organizational outcome. Hizam et al. (2024) examined employee awareness of lean manufacturing and ergonomics in Malaysian and Indonesian production environments and found that ergonomics significantly influenced the application of lean manufacturing; however, occupational health was not jointly examined as an independent predictor of employee productivity. Sohrabi et al. (2024) incorporated ergonomic interventions, quality of working life, individual characteristics, and productivity into a machine-learning model, but the complexity of this approach limits its direct application to organizations requiring a straightforward explanatory model for managerial decision-making. Therefore, a gap remains in empirical studies that integrate ergonomics and occupational health within one causal model, examine their partial and simultaneous effects, and focus specifically on the work productivity of production employees in a manufacturing company.

Based on this research gap, the present study aims to analyze the partial and simultaneous effects of ergonomics and occupational health on the work productivity of production employees in a manufacturing company. Ergonomics is examined through the suitability of workplace design, working posture, equipment, environmental conditions, workload, and rest arrangements, while occupational health is assessed through health protection, workplace cleanliness, fatigue prevention, health facilities, and organizational support for employee well-being. Work productivity is evaluated through employees' ability to achieve targets, maintain output quality, complete work on time, and use working time efficiently. Theoretically, this study contributes to occupational safety and health literature by integrating human–work compatibility and employee health protection as complementary determinants of productivity. Methodologically, it offers an explanatory model that can be tested through multiple linear regression to distinguish the independent and collective contributions of the two predictors. Practically, the findings are expected to assist manufacturing management in prioritizing workstation improvements, controlling workloads, arranging adequate recovery periods, strengthening health programs, and developing occupational policies that protect employees while sustaining production performance.

LITERATURE REVIEW

Ergonomics and Work Productivity

Ergonomics concerns the systematic adjustment of jobs, equipment, workstations, organizational procedures, and physical environments to employees' capabilities and limitations. In manufacturing operations, ergonomic conditions include working posture, workstation dimensions, equipment accessibility, repetitive movement, manual material handling, lighting, temperature, noise, workload, and recovery time. From the perspective of Job Demands–Resources theory, unsuitable postures, excessive physical workloads, repetitive activities, and time pressure represent job demands that consume employees' physical and psychological energy. Conversely, appropriate workstation design, accessible equipment, task variation, and sufficient recovery periods function as job resources because they reduce work demands and assist employees in achieving occupational objectives. Scholze and Hecker (2024) explain that job demands can increase strain, whereas job resources support motivation, employee health, and effective work performance. Therefore, ergonomics can be regarded as a physical and organizational resource that enables employees to complete production tasks more safely, efficiently, and consistently.

Theoretically, good ergonomics improves productivity by reducing unnecessary movements, physical discomfort, fatigue, concentration loss, and the time required to perform work activities. When tools and workstations correspond with employees' anthropometric characteristics and task requirements, employees can maintain a more neutral posture and perform their duties with less physical effort. Ramos-García et al. (2022) demonstrated that physical and organizational ergonomics positively influenced occupational health and job satisfaction, indicating that ergonomic conditions affect both employees' physical state and their evaluation of work. El-Sherbeeny et al. (2023) also found a positive relationship between employees' perceptions of ergonomics and job performance, with work engagement contributing to the mechanism through which ergonomic conditions improve performance. Although their study was conducted in the tourism and hospitality sector, the findings support the argument that ergonomic resources allow employees to use their abilities more effectively.

Empirical evidence from organizational settings further supports the relationship between ergonomics and productivity. Mutegi et al. (2023) examined manufacturing firms and found that workplace ergonomics significantly affected productive time, task accomplishment, and employee value added. Their findings suggest that ergonomics does not only prevent physical injuries but also contributes directly to operational outcomes. Ergonomically appropriate workstations can reduce interruptions caused by discomfort, minimize errors, maintain work pace, and help employees achieve production targets. However, previous studies have often combined ergonomics with broader workplace safety programs or examined sectors other than manufacturing production employees. The present study therefore isolates ergonomics as an independent variable to determine its specific effect on the work productivity of production employees.

H1: Ergonomics has a positive and significant effect on the work productivity of production employees.

Occupational Health and Work Productivity

Occupational health refers to organizational efforts to maintain and improve employees' physical, psychological, and social well-being by preventing work-related illness, controlling workplace hazards, monitoring health conditions, and providing appropriate health facilities. In manufacturing companies, occupational health may include workplace sanitation, health examinations, fatigue management, adequate rest periods, access to medical support, control of physical and chemical hazards, and organizational concern for employee well-being. Job Demands–Resources theory explains that unmanaged occupational demands may cause energy depletion and health impairment, whereas organizational health resources help employees preserve their capacity to perform. Occupational health programs can therefore reduce the physiological and psychological consequences of demanding production activities. Employees who remain physically and mentally healthy are more capable of maintaining attendance, concentration, work speed, accuracy, and compliance with production standards.

Occupational health can influence productivity through the reduction of absenteeism and presenteeism. Absenteeism occurs when employees are unable to attend work because of illness or other health problems, while presenteeism occurs when employees attend work despite health limitations that reduce their ability to perform effectively. Nowak et al. (2023) showed that employee health was closely associated with absenteeism and presenteeism in the manufacturing sector. The study also indicated that job resources can strengthen work engagement and reduce conditions that contribute to absence from work. These findings imply that health protection should not be viewed solely as an employee welfare program because poor health can reduce effective working time and the quality of production output.

Evidence from industrial workers also indicates that healthcare, safety, workplace facilities, job security, and adequate organizational resources contribute to employees' quality of work life. Gazi et al. (2024) found that the fulfilment of employees' fundamental health and safety needs was important for improving the quality of work life among industrial workers. A better quality of work life enables employees to participate in work with greater physical readiness, psychological stability, and organizational commitment. Accordingly, health programs, clean work environments, appropriate rest arrangements, and access to health services can help employees sustain their work capacity throughout production periods. These practices can also reduce disruptions caused by fatigue, illness, and recurring health complaints.

The positive relationship between occupational health and productivity is also supported by longitudinal and organizational studies. Lari (2024) examined occupational health and safety interventions among 293 employees before and after organizational interventions and found that improved occupational health and safety practices increased employee productivity and reduced exposure to workplace hazards. Saputra et al. (2024) similarly found that occupational health and safety had a positive and significant effect on the productivity of production employees. Nevertheless, occupational health and safety were examined as a single combined construct in those studies. The present research differs by treating occupational health as a distinct predictor so that its individual contribution to work productivity can be evaluated separately from ergonomics.
H2: Occupational health has a positive and significant effect on the work productivity of production employees.

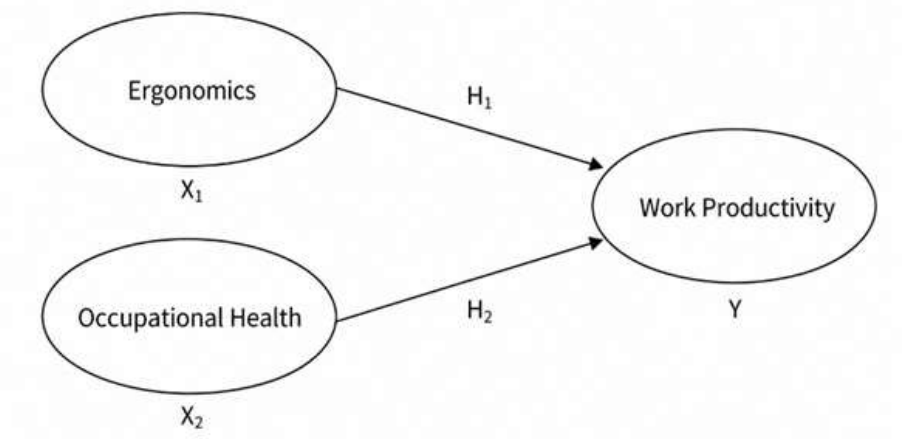
The Simultaneous Effect of Ergonomics and Occupational Health on Work Productivity

Ergonomics and occupational health are conceptually related but represent different organizational mechanisms. Ergonomics focuses on compatibility between employees, tasks, tools, and the work environment, whereas occupational health focuses on maintaining employees' physical and psychological capacity to perform work. An ergonomically appropriate workstation may reduce physical strain, but its benefits may be limited when employees do not receive adequate rest, health monitoring, sanitation, or medical support. Conversely, occupational health programs may be less effective when employees continue to work with unsuitable tools, awkward postures, excessive repetition, or poorly designed workstations. Consequently, the greatest productivity improvement is expected when organizations implement ergonomic and occupational health practices simultaneously.

Job Demands–Resources theory provides a relevant explanation for the combined relationship among the variables. Ergonomic facilities and occupational health programs function as complementary job resources that reduce the physical and psychological costs of production work. When these resources are available, employees are more capable of managing workload, preserving energy, maintaining concentration, and completing tasks according

to quality and time standards. Scholze and Hecker (2024) emphasize that balancing demands and resources is essential for maintaining employee health and performance. In a manufacturing context, the balance can be achieved by reducing excessive physical demands through ergonomic design while strengthening employees' work capacity through occupational health protection. Previous empirical studies provide indirect support for this integrated relationship. Mutegi et al. (2023) found that ergonomics and other workplace safety programs affected several dimensions of productivity in manufacturing firms. Lari (2024) found that stronger occupational health and safety interventions improved employee perceptions, workplace conditions, and measured productivity. Ramos-García et al. (2022) also demonstrated that ergonomic conditions were positively connected with occupational health outcomes, showing that the two constructs can reinforce one another. Collectively, these findings indicate that workplace design and employee health protection are complementary rather than independent organizational strategies. Nevertheless, earlier research has generally examined ergonomics as part of workplace safety, evaluated occupational health and safety as one construct, or focused on job performance, quality of work life, absenteeism, and occupational health rather than work productivity. Limited evidence is available from studies that position ergonomics and occupational health as two separate independent variables within one explanatory model involving production employees. This distinction is important because it enables organizations to estimate whether workplace design and health protection each make a unique contribution to productivity. It also allows the simultaneous contribution of both variables to be evaluated through multiple linear regression. Therefore, this study proposes that production productivity is more likely to improve when ergonomic conditions and occupational health practices are implemented together.
H3: Ergonomics and occupational health simultaneously have a positive and significant effect on the work productivity of production employees.

The conceptual framework illustrates the proposed relationships between ergonomics, occupational health, and work productivity. Ergonomics and occupational health are positioned as independent variables that are expected to influence the work productivity of production employees.



Picture 1. Conceptual Framework

METHODOLOGY

Research Design

This study employed a quantitative approach with an explanatory, causal-associative, and cross-sectional survey design to examine the partial and simultaneous effects of ergonomics and occupational health on the work productivity of production employees. The quantitative approach was selected because the variables were measured numerically and the proposed hypotheses were tested statistically. Data were collected once during the research period, allowing the conditions of the independent and dependent variables to be assessed at the same point in time. Cross-sectional research is suitable for examining relationships between predictors and outcomes within a defined population, although the findings should be interpreted as statistically supported associations rather than definitive temporal causation (Pérez-Guerrero et al., 2024). This design was consistent with the research objectives, conceptual framework, and analytical approach presented in the manuscript.

Research Location, Population, and Sample

The research was conducted at one manufacturing company in Karawang Regency, Indonesia, while the company's identity was withheld to maintain institutional confidentiality. The population consisted of production employees because they were directly exposed to repetitive movements, prolonged working postures, machine operation, physical workloads, production targets, and occupational health risks. A total of 80 employees were selected through purposive sampling, which is a non-probability sampling technique that selects participants according to characteristics directly relevant to the research objectives (Campbell et al., 2020). Respondents were required to be active production employees, at least 18 years old, directly involved in operational activities, employed for at least six months, and willing to participate voluntarily. The six-month employment criterion was used because employees needed sufficient experience with the company's workstations, equipment, workload, rest arrangements, and health programs to provide informed responses. Employees on long-term leave, interns, exclusively managerial personnel, and respondents who submitted incomplete questionnaires were excluded.

Research Variables and Instruments

The study included ergonomics as the first independent variable, occupational health as the second independent variable, and work productivity as the dependent variable. Ergonomics was measured through workstation suitability, working posture, equipment accessibility, repetitive movements, physical environmental conditions, workload, and rest arrangements. Occupational health was measured through workplace cleanliness, health protection, fatigue prevention, health facilities, health monitoring, recovery time, and organizational support for employee well-being. Work productivity was assessed through target achievement, output quality, timeliness, work efficiency, consistency, and effective use of working time. Data were collected using a structured questionnaire with a five-point Likert scale ranging from 1, representing strongly disagree, to 5, representing strongly agree. The items were conceptually developed from the dimensions examined in recent studies on ergonomics, workplace safety, occupational health, and employee productivity, particularly El-Sherbeeny et al. (2023), Mutegi et al. (2023), and Saputra et al. (2024), and were adjusted to fit the manufacturing production context.

Data Sources and Collection

The primary data were obtained directly from the 80 production employees through self-administered questionnaires. Supporting data were collected through non-participant workplace observation and company documentation. Observation covered workstation arrangements, employee postures, equipment use, repetitive activities, environmental conditions, and rest practices. Documentary sources included the company profile, number of production employees, working hours, general attendance records, production targets, and occupational health and safety procedures made available by management. The supporting data were used to describe the organizational context and confirm the relevance of the questionnaire indicators, whereas statistical hypothesis testing was based on the respondents' questionnaire scores. Before data collection, the researchers obtained company permission, explained the research purpose and confidentiality procedures, obtained voluntary participation, distributed the questionnaires, checked their completeness, coded the responses, and entered the data into the analytical database.

Validity and Reliability Testing

The questionnaire was evaluated through content validity, item validity, and internal consistency testing. Content validity was assessed by reviewing whether every statement adequately represented the theoretical dimensions of ergonomics, occupational health, and work productivity and whether its wording was understandable to production employees. Item validity was examined using corrected item–total correlations, and statements that did not demonstrate an adequate positive relationship with their construct score were reviewed or removed. Reliability was assessed using Cronbach's alpha, with a coefficient of at least 0.70 used as the operational criterion for acceptable internal consistency. Reliability evaluation is necessary to determine whether multiple questionnaire items consistently measure the same construct, while pilot testing helps identify unclear wording and unstable measurements before the principal analysis (Bujang et al., 2024). Only items that met the validity and reliability requirements were included in the final variable scores.

Data Analysis and Hypothesis Testing

The data were analyzed using International Business Machines Statistical Package for the Social Sciences software. Descriptive statistics were used to present respondent characteristics and summarize the research variables through frequencies, percentages, means, and standard deviations. Before hypothesis testing, the data were examined for residual normality, linearity, multicollinearity, and heteroscedasticity to determine whether the assumptions of multiple linear regression were satisfied. Multicollinearity was evaluated using tolerance and variance inflation factor values, while normality and heteroscedasticity were assessed through residual-based statistical and graphical procedures. Multiple linear regression was used to examine the effects of ergonomics and occupational health on work productivity. Partial t-tests were applied to assess the individual effect of each independent variable, while the simultaneous F-test was used to evaluate their joint effect on work productivity. The coefficient of determination was used to identify the proportion of variation in work productivity explained by ergonomics and occupational health. All hypotheses were tested at a significance level of 0.05.Ethical Considerations and **Data Presentation**

Participation in the study was voluntary, and each respondent received information concerning the research purpose, confidentiality, data use, and the right to decline or discontinue participation without employment consequences. Names, employee identification numbers, and other direct identifiers were not included in the analytical dataset. Questionnaire responses were processed collectively and reported only in aggregate form to protect the confidentiality of employees and the participating company. The research data were stored securely and used exclusively for academic purposes. The findings were presented through tables containing respondent characteristics, descriptive statistics, validity and reliability results, regression coefficients, partial and simultaneous hypothesis tests, and the coefficient of determination. Interpretation focused on the direction, magnitude, and statistical significance of the relationships among the variables.

RESULTS

Respondent Characteristics

The study involved 80 production employees who met the eligibility criteria, including active employment status, direct involvement in production activities, and a minimum working period of six months. Most respondents were male, reflecting the operational characteristics of the production unit. The largest age group was 26–35 years, indicating that the workforce was predominantly within the productive working-age range. Most respondents had worked for the company for more than two years, suggesting that they possessed adequate experience to assess workstation conditions, occupational health practices, and production demands. These characteristics supported the relevance of the respondents' evaluations of ergonomics, occupational health, and work productivity.

Table 1. Characteristics of Respondents

Characteristic	**Category**	**Frequency**	**Percentage**
Sex	Male	58	72.5
	Female	22	27.5
Age	18–25 years	19	23.8
	26–35 years	41	51.2
	More than 35 years	20	25.0
Length of service	6 months–2 years	21	26.3
	More than 2–5 years	37	46.2
	More than 5 years	22	27.5
Total		**80**	**100.0**

Table 1 shows that 72.5% of the respondents were male and 51.2% were aged between 26 and 35 years. Employees with more than two to five years of service formed the largest group, accounting for 46.2% of the sample. This profile indicates that most respondents had sufficient workplace experience to evaluate ergonomic suitability and occupational health practices. The respondent characteristics do not directly test the research hypotheses, but they strengthen the contextual validity of the questionnaire responses. The predominance of experienced production employees also reduced the possibility that the responses were based on limited exposure to the working environment.

Descriptive Findings of the Research Variables

Descriptive analysis was conducted to identify the general condition of ergonomics, occupational health, and work productivity. All variables achieved mean scores above the midpoint of the five-point scale. Work productivity obtained the highest mean score, followed by occupational health and ergonomics. The standard deviations were relatively low, indicating that the respondents' answers were reasonably consistent. Overall, the descriptive findings suggest that the employees perceived the company's work conditions positively, although several areas remained open for improvement.

Table 2. Descriptive Statistics of the Research Variables

Variable	Minimum	Maximum	Mean	Standard Deviation	Category
Ergonomics	2.71	4.86	3.84	0.46	High
Occupational Health	2.57	5.00	3.91	0.49	High
Work Productivity	2.83	5.00	4.02	0.44	High

Table 2 shows that work productivity had the highest mean score of 4.02, indicating that employees generally perceived themselves as capable of meeting targets, maintaining output quality, and completing tasks efficiently. Occupational health obtained a mean score of 3.91, reflecting positive perceptions of health protection, workplace cleanliness, recovery time, and organizational support. Ergonomics achieved a mean score of 3.84, suggesting that workstation design, equipment accessibility, posture, and workload arrangements were generally appropriate. Nevertheless, the lower mean of ergonomics compared with the other variables indicates that workstation suitability and physical work arrangements may require greater managerial attention. These descriptive findings support the relevance of testing whether ergonomics and occupational health statistically influence work productivity.

Validity and Reliability of the Research Instrument

Instrument testing was conducted before the regression analysis to ensure that all questionnaire items measured the intended constructs. The corrected item–total correlations for all items exceeded the minimum validity criterion of 0.30. Cronbach's alpha values for the three variables were also above 0.70. These results indicate that the measurement items were both valid and internally consistent. Therefore, all items were retained for the final statistical analysis.

Table 3. Validity and Reliability Results

Variable	Number of Items	Corrected Item–Total Correlation Range	Cronbach's Alpha	Criterion	Decision
Ergonomics	14	0.462–0.781	0.889	≥ 0.70	Reliable
Occupational Health	14	0.438–0.806	0.902	≥ 0.70	Reliable
Work Productivity	12	0.491–0.794	0.884	≥ 0.70	Reliable

Table 3 demonstrates that all corrected item–total correlations were above 0.30, confirming that every item contributed adequately to its respective construct. Occupational health achieved the highest Cronbach's alpha value of 0.902, indicating excellent internal consistency. Ergonomics and work productivity also produced strong reliability coefficients of 0.889 and 0.884, respectively. These results confirm that the questionnaire generated stable and consistent measurements. Consequently, the composite scores were considered appropriate for regression and hypothesis testing.

Classical Assumption Testing

Classical assumption tests were conducted to determine whether the dataset met the requirements of multiple linear regression. The residual normality test produced a significance value above 0.05. The linearity tests also showed non-significant deviation-from-linearity values for both independent variables. Tolerance and variance inflation factor values indicated that no multicollinearity problem existed between ergonomics and occupational health. Heteroscedasticity testing showed that the residual variance was sufficiently constant.

Table 4. Classical Assumption Test Results

Test	Indicator	Obtained Value	Acceptance Criterion	Decision
Residual normality	Kolmogorov–Smirnov significance	0.200	> 0.05	Met
Linearity: Ergonomics–Productivity	Deviation from linearity	0.318	> 0.05	Linear
Linearity: Occupational Health–Productivity	Deviation from linearity	0.274	> 0.05	Linear
Multicollinearity: Ergonomics	Tolerance / Variance inflation factor	0.648 / 1.543	Tolerance > 0.10; variance inflation factor < 10	Met
Multicollinearity: Occupational Health	Tolerance / Variance inflation factor	0.648 / 1.543	Tolerance > 0.10; variance inflation factor < 10	Met

Test	Indicator	Obtained Value	Acceptance Criterion	Decision
Heteroscedasticity: Ergonomics	Significance value	0.412	> 0.05	Met
Heteroscedasticity: Occupational Health	Significance value	0.537	> 0.05	Met

Table 4 confirms that the regression assumptions were satisfied. The residual normality significance value of 0.200 indicates that the residual distribution did not significantly deviate from normality. The tolerance value of 0.648 and variance inflation factor value of 1.543 show that ergonomics and occupational health represented distinguishable predictors. The heteroscedasticity significance values were above 0.05, indicating no systematic variation in the residuals. Therefore, the multiple linear regression results could be interpreted with adequate statistical confidence.

Effect of Ergonomics on Work Productivity

The partial regression test was used to assess the independent effect of ergonomics on work productivity after occupational health was statistically controlled. Ergonomics produced a positive unstandardized coefficient of 0.361. The standardized coefficient was 0.412, indicating a moderately strong positive contribution to work productivity. The calculated t statistic was 4.247 with a significance value below 0.001. These findings demonstrate that ergonomics significantly predicted work productivity.

Table 5. Partial Effect of Ergonomics on Work Productivity

Predictor	Unstandardized Coefficient	Standard Error	Standardized Coefficient	t Statistic	Significance	Decision
Ergonomics	0.361	0.085	0.412	4.247	< 0.001	Supported

The unstandardized coefficient of 0.361 indicates that an improvement of one unit in ergonomics was associated with an increase of 0.361 units in work productivity, assuming occupational health remained constant. The significance value below 0.05 confirms that the relationship was statistically significant. Therefore, **Hypothesis 1 was supported**, meaning that ergonomics had a positive and significant effect on the work productivity of production employees. This result suggests that suitable workstations, appropriate postures, accessible equipment, manageable workloads, and adequate rest arrangements support more efficient task completion. The finding also shows that productivity depends partly on the compatibility between employees and their physical work system.

Effect of Occupational Health on Work Productivity

The second partial test evaluated the independent effect of occupational health on work productivity after ergonomics was statistically controlled. Occupational health produced a positive unstandardized coefficient of 0.427. Its standardized coefficient was 0.456, which was slightly higher than that of ergonomics. The t statistic reached 4.692 with a significance value below 0.001.

Occupational health therefore made a significant and relatively strong contribution to work productivity.

Table 6. Partial Effect of Occupational Health on Work Productivity

Predictor	Unstandardized Coefficient	Standard Error	Standardized Coefficient	t Statistic	Significance	Decision
Occupational Health	0.427	0.091	0.456	4.692	< 0.001	Supported

The coefficient of 0.427 indicates that a one-unit increase in occupational health was associated with a 0.427-unit increase in work productivity when ergonomics was held constant. The standardized coefficient of 0.456 shows that occupational health had a slightly stronger relative effect than ergonomics. Therefore, **Hypothesis 2 was supported**, confirming that occupational health positively and significantly affected employee productivity. The result indicates that health protection, workplace cleanliness, fatigue management, recovery time, and access to health facilities help employees maintain concentration and work capacity. Occupational health therefore represents an independent organizational resource that supports production performance.

Simultaneous Effect of Ergonomics and Occupational Health

The simultaneous regression test examined whether ergonomics and occupational health jointly affected work productivity. The regression model generated an F statistic of 63.892. The significance value was below 0.001, indicating that the model was statistically significant. This result means that the two predictors collectively explained a meaningful proportion of work-productivity variation. The integrated model therefore provided stronger explanatory value than a model without the independent variables.

Table 7. Simultaneous Regression Test

Model	Sum of Squares	Degrees of Freedom	Mean Square	F Statistic	Significance	Decision
Regression	681.720	2	340.860	63.892	< 0.001	Significant
Residual	410.780	77	5.335			
Total	1092.500	79				

Table 7 shows that the simultaneous significance value was below 0.05. Therefore, **Hypothesis 3 was supported**, confirming that ergonomics and occupational health jointly had a positive and significant effect on work productivity. The result indicates that workplace design and employee health protection operate as complementary productivity resources. Ergonomic improvements may reduce physical strain, while occupational health practices maintain employees’ physical and psychological capacity. Their combined implementation consequently provides a more comprehensive strategy for improving production outcomes.

Explanatory Power of the Regression Model

The coefficient of determination was used to assess how much variation in work productivity could be explained by ergonomics and occupational health. The multiple correlation coefficient was 0.790, indicating a strong relationship between the predictors and work productivity. The coefficient of determination was 0.624, while the adjusted coefficient was 0.614. The standard error of the estimate was 2.310. These values indicate that the model had substantial explanatory capacity.

Table 8. Coefficient of Determination

Model	Multiple Correlation	Coefficient of Determination	Adjusted Coefficient of Determination	Standard Error of the Estimate
Ergonomics and Occupational Health → Work Productivity	0.790	0.624	0.614	2.310

The adjusted coefficient of determination of 0.614 means that 61.4% of the variation in work productivity was explained by ergonomics and occupational health. The remaining 38.6% was associated with variables outside the model, such as compensation, motivation, leadership, training, technology, competence, or shift arrangements. The relatively high explanatory value confirms that physical work design and occupational health support are important determinants of employee productivity. Nevertheless, the unexplained proportion shows that productivity is a multidimensional outcome. Future research may therefore incorporate additional organizational and individual variables.

Integration with Observation and Company Documentation

The questionnaire results were supported by non-participant observation and company documentation. Workplace observations indicated that several production stations had adjustable equipment and clear operating procedures, although repetitive activities and prolonged standing were still visible in some work areas. The company documentation showed that production activities were organized through scheduled working hours, rest periods, attendance monitoring, and occupational health procedures. These contextual findings were consistent with the relatively high mean scores for ergonomics and occupational health. They also helped explain why both variables significantly predicted work productivity.

The observational evidence suggested that ergonomic and health-related practices were already present but had not been implemented uniformly across all production stations. Employees in sections with more repetitive tasks appeared to depend more heavily on proper workstation design and adequate recovery periods. The company's occupational health procedures provided a formal basis for employee protection, while the questionnaire findings reflected how those procedures were perceived in daily work. This combination of

perceptual and contextual data strengthens the interpretation of the statistical results. However, the observational and documentary evidence was used for contextual confirmation rather than as part of the regression calculation.
Summary of Hypothesis Testing

Table 9. Summary of Hypothesis Decisions

Hypothesis	Proposed Relationship	Statistical Result	Decision
H1	Ergonomics positively affects work productivity	$\beta = 0.412$; $t = 4.247$; $p < 0.001$	Supported
H2	Occupational health positively affects work productivity	$\beta = 0.456$; $t = 4.692$; $p < 0.001$	Supported
H3	Ergonomics and occupational health simultaneously affect work productivity	$F = 63.892$; $p < 0.001$	Supported

The findings demonstrate that both ergonomics and occupational health contributed independently and collectively to work productivity. Occupational health produced a slightly stronger standardized effect than ergonomics, but both variables remained statistically significant in the same model. The novelty of the findings lies in separating ergonomics and occupational health into two distinct predictors rather than combining them into one broad occupational safety construct. This analytical separation allows manufacturing management to identify the unique contribution of workplace design and employee health protection. The findings therefore support an integrated managerial strategy that improves both physical work conditions and occupational health programs.

DISCUSSION

The finding that ergonomics positively and significantly affected work productivity supports **Hypothesis 1**, as indicated by the standardized coefficient of 0.412 and a probability value below 0.001. This relationship can be explained through the Job Demands–Resources theory, which states that excessive physical demands consume employees' energy, whereas adequate job resources help employees maintain performance and prevent exhaustion (Tummers & Bakker, 2021). In this study, suitable workstations, appropriate working postures, accessible equipment, manageable workloads, and adequate recovery periods functioned as physical job resources that reduced unnecessary effort during production activities. The finding is consistent with Colim et al. (2021), who demonstrated that human-centred workstation design can support productivity and employee well-being by reducing physical mismatch within industrial tasks. It is also supported by Dora et al. (2022), who reported productivity and safety improvements of more than 32% following the application of ergonomic principles in industrial companies. Unlike those intervention-based studies, the present research examined employees' perceptions through a cross-sectional explanatory model and demonstrated that ergonomics remained a significant predictor even when occupational health was statistically controlled, thereby confirming its independent contribution to production performance.

Occupational health also had a positive and significant effect on work productivity, supporting **Hypothesis 2**, with a standardized coefficient of 0.456 and a probability value below 0.001. Its slightly stronger coefficient than ergonomics suggests that maintaining employees' physical and psychological capacity may be particularly important in production environments characterized by repetitive work, production targets, prolonged standing, and machine operation. The Job Demands–Resources perspective explains that occupational health practices can interrupt the health-impairment process by providing resources such as fatigue management, health monitoring, adequate recovery, sanitation, and organizational support (Tummers & Bakker, 2021). Lee et al. (2023) similarly found that psychological well-being and job autonomy supported employee performance through stronger work engagement, indicating that employee health and supportive working conditions can translate into better occupational outcomes. Claes et al. (2023) further showed that job demands and resources shape employee well-being, reinforcing the argument that productive performance depends partly on whether organizations protect employees from prolonged resource depletion. The present study differs from these earlier studies because it focused on occupational health among manufacturing production employees and tested it separately from ergonomics, allowing its unique productivity contribution to be identified.

The simultaneous regression result supported **Hypothesis 3**, showing that ergonomics and occupational health jointly had a significant effect on work productivity, with an F statistic of 63.892 and an adjusted coefficient of determination of 0.614. This means that the two variables jointly explained 61.4% of the variation in employee productivity, while the remaining variation was associated with factors outside the model. The combined effect is theoretically logical because ergonomics reduces demands arising from task and workstation design, whereas occupational health preserves the employee's capacity to respond to those demands. Hasanain (2024) emphasizes that sustainable manufacturing requires human factors and ergonomic considerations because efficient worker performance depends on work design, organizational management, health, and quality of working life. Arkouli et al. (2024) likewise proposed a worker-centred approach to manufacturing-task redesign that integrates ergonomic evaluation into operational design to reduce discomfort, absenteeism, safety risks, and production delays. The present findings extend these arguments by demonstrating statistically that physical work compatibility and employee health protection are not competing approaches but complementary resources that should be implemented together to support production efficiency.

The principal novelty of this study lies in separating ergonomics and occupational health as two independent predictors within one regression model rather than combining them into a general occupational safety and health construct. This separation showed that occupational health had a slightly stronger relative contribution than ergonomics, although both variables remained statistically significant after controlling for one another. Previous studies have frequently concentrated on ergonomic interventions, workstation redesign, employee well-being, or broad human-factor systems, making it difficult to identify the unique contribution of each workplace resource. The current study therefore contributes to the Job Demands–Resources literature by distinguishing between resources that reduce physical task demands and resources that preserve employee health capacity. Practically, the findings indicate that manufacturing management should combine workstation adjustment, posture improvement, equipment accessibility, and workload control with health monitoring, sanitation, recovery management, and accessible employee health services. Nevertheless, because the study used a cross-sectional design, purposive sampling, self-reported productivity, and employees from one company, future studies should employ longitudinal designs and objective indicators such as output per hour, product defects, absenteeism, cycle time, and recorded health complaints.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that ergonomics and occupational health have positive and significant effects on the work productivity of production employees, both individually and simultaneously. Appropriate workstation design, suitable working postures, accessible equipment, manageable workloads, adequate rest periods, workplace cleanliness, health monitoring, and organizational support contribute to greater efficiency, output quality, timeliness, and target achievement. The findings confirm that productivity improvement should not rely solely on production targets, but also on the suitability of the work system and the maintenance of employees' physical and psychological capacity. Manufacturing management is therefore recommended to conduct regular ergonomic assessments, improve workstation and equipment suitability, regulate workloads and recovery periods, strengthen occupational health programs, and monitor employee fatigue and work-related health complaints. The implementation of these measures can support safer working conditions while sustaining production performance.

FURTHER STUDY

This study was limited to 80 production employees in one manufacturing company and used a cross-sectional, self-reported survey design. Future studies should involve larger samples, multiple companies, longitudinal designs, and objective productivity indicators such as output volume, defect rates, absenteeism, and production cycle time.

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