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Ergonomic assessment of block-making industry in Nigeria: A review

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Abstract

The block-making industry is a critical component of Nigeria's construction sector, providing essential materials for housing and infrastructure while employing thousands within the informal economy. Despite its economic significance, the sector is characterized by poor mechanization, inadequate safety practices, and high physical demands that expose workers to severe ergonomic risks. This review synthesizes empirical studies and policy documents to examine the ergonomic and occupational health challenges prevalent in Nigeria's block-making enterprises. Key findings reveal widespread musculoskeletal disorders, respiratory ailments from cement dust exposure, and vibration-induced fatigue resulting from repetitive manual handling, awkward postures, and poorly designed locally fabricated equipment. Underlying determinants include low ergonomic awareness, weak institutional regulation, technological stagnation, and socio-cultural perceptions that valorize endurance over safety. The study identifies systemic factors economic informality, infrastructural deficits, and insufficient policy enforcement that perpetuate these hazards. It recommends a multi-level intervention framework encompassing ergonomic machine redesign, worker training, participatory safety education, and policy integration within Nigeria's National Occupational Safety and Health framework. Embedding ergonomics in design, education, and governance is crucial for transforming block-making from a labour-intensive, high-risk trade into a sustainable and productivity-enhancing enterprise aligned with Sustainable Development Goals.

Keywords: Ergonomics; Block-Making Industry; Musculoskeletal Disorders; Occupational Health; Informal Sector; Nigeria

1. Introduction

The block-making industry is one of the most vital components of Nigeria's construction sector, providing a ready supply of sandcrete blocks used for walls, foundations, and fencing in residential, commercial, and infrastructural developments. The sector is a key driver of urbanization and employment, supporting thousands of small and medium scale entrepreneurs and unskilled labourers across the country (Sholanke et al., 2015; Ajayeoba, 2019). In Nigeria's rapidly expanding cities, such as Lagos, Ibadan, and Abuja, block production serves as both a livelihood for informal workers and a critical input for the booming housing market (Ojo et al., 2024; Kingsley-Elewa et al., 2025). Despite its economic importance, the industry remains largely informal, characterized by unregulated working conditions, limited mechanization, and high physical demands (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Ugbosu et al., 2025).

The process of block production involves several labour-intensive operations, including the manual mixing of sand, cement, and water; mould filling; compaction through vibration; and the stacking of freshly cast blocks for curing. Each of these tasks exposes workers to high levels of physical exertion, repetitive motions, awkward postures, and environmental stressors such as dust and heat (Adedoyin et al., 2022; Kingsley-Elewa et al., 2024). Due to the absence

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of ergonomic intervention and safety regulation, block making workers are among the most vulnerable occupational groups within Nigeria's construction value chain (Osita et al., 2024; Aaron et al., 2022). The combination of manual handling and poor posture contributes to widespread musculoskeletal disorders (MSDs), while prolonged exposure to cement dust and vibration creates additional risks of respiratory and neurological complications (Ahmad et al., 2021; Jibiri et al., 2024)

Ergonomics, as a discipline, seeks to optimize the relationship between people, equipment, and their working environment by adapting work systems to human physical and cognitive capabilities (Principles and Guidelines for Human Factors / Ergonomics (HFE) Design and Management of Work Systems., 2024). The central premise is that well-designed workplaces not only enhance productivity but also prevent fatigue and injury (Adebiyi et al., 2018; Nari et al., 2020). In industrially advanced economies, ergonomics has become a foundational aspect of occupational safety management and engineering design (Rayhan, 2023; Priyoko et al., 2021). However, in Nigeria and much of sub-Saharan Africa, ergonomic awareness remains limited, especially within the informal manufacturing and construction sectors where most workers operate (Ajayeoba, 2019; Ugbosu et al., 2025).

Several studies highlight the absence of ergonomics integration in Nigeria's small-scale industries and construction enterprises (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Kingsley-Elewa et al., 2024). Many enterprises lack structured health and safety programs, exposing workers to cumulative trauma and chronic fatigue (Hermawati et al., 2014; Osita et al., 2024). Ajayeoba (2019) observed that over 80% of workers in small industrial operations reported pain in at least one body region related to work posture. Similarly, Adedoyin et al. (2022) reported that musculoskeletal complaints were most prevalent among bricklayers and block-makers compared to other artisan groups. These findings align with global literature showing that low-income economies face disproportionate ergonomic risks due to poor automation, weak regulation, and low safety awareness (WHO and ILO, 2017; Howe et al., 2024).

The informal structure of Nigeria's block-making industry exacerbates the problem. Without institutional oversight, safety audits, or standardized equipment design, most operators fabricate machines locally without ergonomic specifications (Adebiyi et al., 2018; Ugbosu et al., 2025). This often results in inappropriate working heights, excessive vibration, and uneven ground conditions, which in turn heighten postural stress and increase the risk of injuries (Muraina et al., 2024; Ajayeoba, 2019). The lack of training further limits workers' ability to adopt safe lifting and handling techniques (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Aaron et al., 2022). Globally, research has demonstrated that ergonomically sound work design reduces work-related injuries and improves output quality. For example, studies in India, Indonesia, and Ghana have documented significant reductions in MSD prevalence following ergonomic training and workstation redesigns in small manufacturing industries (Priyoko et al., 2021; Acquah et al., 2021). In contrast, the Nigerian context remains underexplored despite similar risk exposures. The lack of comprehensive ergonomic assessment in block-making industries represents a major research gap with implications for occupational health, economic productivity, and national development (Ajayeoba, 2019; Osita et al., 2024).

Given these realities, this review aims to synthesize existing studies on ergonomic hazards, determinants, and interventions in Nigeria's block-making industry, situating them within the broader context of occupational safety and informal-sector dynamics. Specifically, it identifies the major ergonomic and health challenges facing block-making workers, examines their underlying determinants, and explores contextual factors that sustain these risks. Finally, it proposes evidence-based pathways for achieving safer and more sustainable block production systems in Nigeria.

2. Ergonomic and Health Challenges in the Block-Making Industry

The Nigerian block-making industry, while vital to the construction sector, presents one of the most ergonomically demanding work environments. The production process comprising the manual mixing of sand, cement, and water; moulding and compacting the mixture; and stacking the blocks for curing requires sustained physical effort, often performed in poorly designed spaces with minimal mechanization (Ajayeoba, 2019; Adedoyin et al., 2022). Workers frequently endure long hours under direct sunlight or in poorly ventilated sheds, handling heavy loads repetitively without mechanical aids (Aaron et al., 2022; Kingsley-Elewa et al., 2024). Such conditions create multiple overlapping ergonomic stressors, including awkward postures, excessive lifting, vibration, noise, and chemical exposure as shown in Figure 1. The convergence of these factors generates significant biomechanical strain, leading to fatigue, discomfort, and an increased risk of work-related musculoskeletal disorders (Osita et al., 2024; Priyoko et al., 2021).

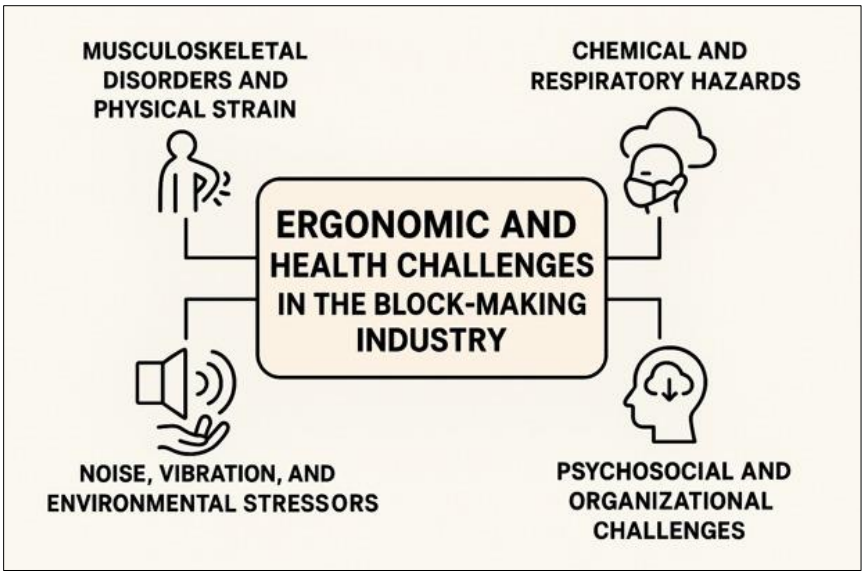

Figure 1 Ergonomic and Health Challenges in the Block-Making Industry

2.1. Musculoskeletal Disorders and Physical Strain

Musculoskeletal disorders (MSDs) remain the most pervasive health problem among block-making workers in Nigeria. These disorders arise primarily from repetitive lifting of heavy materials, continuous bending during mould filling, and awkward trunk postures when stacking blocks (Kingsley-Elewa et al., 2024; Muraina et al., 2024). Research indicates that block-making tasks often involve lifting loads ranging from 25 to 50 kilograms exceeding the 23-kilogram threshold recommended by the National Institute for Occupational Safety and Health (NIOSH, 2015). The resulting mechanical overload places stress on the lower back, shoulders, and upper limbs, causing cumulative trauma injuries such as lumbago, tendonitis, and carpal tunnel syndrome (Ajayeoba, 2019; Howe et al., 2024).

Studies from Nigeria's southwestern states show that over 70% of block-making and masonry workers report pain in at least one major body region, primarily in the lower back and shoulders (Adedoyin et al., 2022; Kingsley-Elewa et al., 2024). Ajayeoba (2019) attributes this prevalence to improper workstation heights and non-mechanized lifting, while Rayhan (2023) emphasizes that insufficient rest periods and excessive work hours intensify ergonomic stress. Comparative studies from India and Indonesia reinforce these findings, showing that repetitive manual handling and inadequate mechanical assistance are among the leading causes of MSDs in developing countries (Hermawati et al., 2014; Priyoko et al., 2021). In Nigerian block-making enterprises, these physical stresses are further compounded by the use of locally fabricated moulding machines that lack ergonomic considerations such as adjustable handles or vibration control (Adebiyi et al., 2018; Ugbosu et al., 2025).

2.2. Chemical and Respiratory Hazards

Another major ergonomic challenge in the block-making industry stems from exposure to cement dust and other airborne particulates. Cement contains respirable crystalline silica, chromium, and lime substances known to cause respiratory irritation, bronchitis, silicosis, and contact dermatitis (Ahmad et al., 2021; Merenu et al., 2024). The absence of proper dust extraction systems or protective masks exposes workers to high concentrations of airborne particles during the dry-mixing process and block demoulding (Osita et al., 2024; WHO and ILO, 2017). Chronic inhalation of cement dust has been associated with diminished lung function and elevated respiratory symptoms such as coughing, wheezing, and chest tightness (Ahmad et al., 2021; Aaron et al., 2022).

Dermal exposure is equally concerning, as wet cement can cause alkaline burns, skin depigmentation, and allergic contact dermatitis due to its high calcium oxide and chromium content (Hermawati et al., 2014; Nari et al., 2020). Despite these hazards, the majority of block-makers in Nigeria work without gloves, boots, or respiratory protection (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Ugbosu et al., 2025). This negligence is partly due to low ergonomic awareness, cost of personal protective equipment (PPE), and misconceptions that PPE reduces productivity (Osita et al., 2024; Rayhan, 2023). In Sokoto and Ogun States, empirical assessments have reported cement dust levels in artisanal block-making yards that exceed WHO and ILO permissible exposure limits by over 200%, highlighting the severity of uncontrolled air quality in these workplaces (Ahmad et al., 2021; WHO and ILO, 2017).

2.3. Noise, Vibration, and Environmental Stressors

Noise and vibration represent additional but frequently overlooked ergonomic stressors in block-making operations. Diesel-powered vibrating moulders, compressors, and generators often emit noise levels between 90 and 100 decibels far above the occupational limit of 85 decibels recommended by WHO (Jibiri et al., 2024; Nari et al., 2020). Chronic exposure leads to auditory fatigue, hearing impairment, and reduced cognitive performance (Rayhan, 2023; Kingsley-Elewa et al., 2024). Moreover, continuous vibration from manually operated compactors and unstable working surfaces contributes to hand–arm vibration syndrome (HAVS), peripheral neuropathies, and chronic spinal conditions (Ajayeoba, 2019; Adebiyi et al., 2018).

Environmental factors such as heat, humidity, and poor ground stability further exacerbate ergonomic risks. Most block-making yards operate outdoors under direct sunlight, with limited access to water and shade, leading to dehydration, dizziness, and heat exhaustion (Aaron et al., 2022; Ugbosu et al., 2025). Prolonged standing on uneven terrain causes lower-limb fatigue and balance instability (Adedoyin et al., 2022; Osita et al., 2024). Additionally, the absence of paved or levelled surfaces contributes to the high incidence of slips and falls, particularly during the rainy season when work areas become slippery (Ajayeoba, 2019; Muraina et al., 2024).

2.4. Psychosocial and Organizational Challenges

While physical and chemical hazards dominate the ergonomic risk landscape, psychosocial stressors also play a significant role in shaping worker health. Long work hours, job insecurity, and piece-rate payment systems exert psychological pressure on workers to maximize production at the expense of safety (Kingsley-Elewa *et al.*, 2025; Rayhan, 2023). The lack of job autonomy and absence of formal supervision result in fatigue, reduced morale, and higher accident rates (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Ugbosu et al., 2025). Studies by Kingsley-Elewa et al. (2024) and Adedoyin et al., (2022) reveal that chronic pain and exhaustion frequently lead to absenteeism and lower productivity, creating a feedback loop where workers' health deterioration directly impacts industrial output. The interplay of physical, chemical, and psychosocial factors indicates that block-making work in Nigeria is not only physically demanding but also mentally and socially precarious. The cumulative effect of these ergonomic stressors leads to chronic injury patterns, reduced life expectancy among informal workers, and overall inefficiency in the construction supply chain. The persistence of such challenges underscores the urgency of comprehensive ergonomic assessment and intervention in this sector.

3. Underlying Determinants of Ergonomic Risks

The persistence of ergonomic and occupational health risks in Nigeria's block-making industry is rooted in a complex interplay of technological, organizational, and socioeconomic factors. These determinants reinforce one another, producing a cycle of poor work design, limited safety awareness, and chronic exposure to hazards. The industry's informality marked by unregistered enterprises, limited technical supervision, and lack of access to capital creates an enabling environment where ergonomics remains largely neglected (Ajayeoba, 2019; Osita et al., 2024; Ugbosu et al., 2025). Unlike large construction firms, where safety audits and mechanical aids are common, small-scale block-making enterprises rely almost entirely on manual labour, exposing workers to repeated physical strain and uncontrolled environmental conditions (Adedoyin et al., 2022; Kingsley-Elewa et al., 2025).

3.1. Manual Production Systems and Poor Work Design

A primary determinant of ergonomic risk is the industry's heavy reliance on manual block production systems. The process from material mixing and mould filling to block ejection and stacking is predominantly human-powered (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Kingsley-Elewa et al., 2024). Most block-making equipment in Nigeria is locally fabricated without consideration for anthropometric standards or ergonomic design principles (Adebiyi et al., 2018; Muraina et al., 2024). Consequently, machine vibration levels are excessive, handles are poorly positioned, and mould heights are non-adjustable, compelling workers to bend or stoop continuously (Ajayeoba, 2019; Ugbosu et al., 2025).

Research by Ajayeoba (2019) and Adedoyin et al., (2022) indicates that more than 60% of block making operators work with equipment that lacks vibration control or shock absorption features. This exposure results in hand–arm vibration syndrome (HAVS), muscle fatigue, and lower-back disorders. Similar findings in Asian and Latin American small industries reveal that locally produced tools often prioritize productivity over ergonomic comfort (Hermawati et al., 2014; Priyoko et al., 2021). The failure to integrate ergonomic design in locally manufactured machines thus represents a technological gap that perpetuates worker discomfort and inefficiency (Osita et al., 2024; Rayhan, 2023).

Workstation design also contributes significantly to postural strain. Most block-making yards operate without structured work zones or standardized heights, causing misalignment between the worker's body dimensions and the task layout (Adebiyi et al., 2018; Kingsley-Elewa et al., 2024). Materials are often stored on the ground, requiring repeated lifting from below knee level a task ergonomically associated with high spinal compression loads (Howe et al., 2024). The use of crude implements like shovels and pans for mixing further increases repetitive strain, while uneven terrain contributes to slips and lower-limb instability (Ahmad et al., 2021).

3.2. Technological and Economic Constraints

The informal nature of the industry limits access to modern technology and mechanization. Many block-making entrepreneurs operate with low capital and cannot afford semi-automated machines (Ajayeoba, 2019; Ojo et al., 2024). Consequently, workers rely on muscle power to achieve production quotas, performing physically taxing tasks repeatedly for long durations (Osita et al., 2024; Aaron, et al., 2022). Technological stagnation has been sustained by weak linkages between research institutions and industry practitioners. Despite several innovations in ergonomically improved tools by Nigerian universities and research centers, adoption remains minimal due to cost, awareness, and dissemination gaps (Adebiyi et al., 2018; Ugbosu et al., 2025). Energy constraints further limit mechanization. Frequent power outages compel many operators to use diesel-powered compactors, which produce high vibration and noise levels (Jibiri et al., 2024; Nari et al., 2020). The combination of poor technology, energy instability, and low financial capacity perpetuates manual work, thereby entrenching ergonomic risks (Kingsley-Elewa 2025; Adedoyin et al., 2022).

3.3. Weak Institutional and Regulatory Oversight

Institutional and policy weaknesses exacerbate ergonomic hazards. Although Nigeria's *National Policy on Occupational Safety and Health (2016)* mandates the adoption of preventive practices, enforcement within informal enterprises remains minimal (Lamai, 2021; WHO and ILO, 2017). Block-making operations rarely undergo safety inspections, and there is limited integration of ergonomic standards in national building or labour regulations (Osita et al., 2024; Ugbosu et al., 2025). Regulatory agencies such as the Standards Organisation of Nigeria (SON) and the National Environmental Standards and Regulations Enforcement Agency (NESREA) face logistical and funding constraints that hinder oversight of small-scale production (Rayhan, 2023; Ajayeoba, 2019). Moreover, the absence of ergonomic specialists in most regulatory frameworks limits the institutional capacity to identify and mitigate postural risks. In contrast, industrialized nations employ ergonomists and safety engineers as part of factory inspection teams (Hermawati et al., 2014; Priyoko et al., 2021). The lack of such expertise in Nigeria's oversight institutions underscores a critical human resource gap that sustains unsafe practices (Osita et al., 2024; Kingsley-Elewa et al., 2024).

3.4. Low Ergonomic Awareness and Inadequate Training

Low ergonomic literacy among workers and employers represents another major determinant of persistent risk. Most block-making artisans lack formal education or exposure to occupational health training (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Aaron et al., 2022). Safety practices are often learned informally or transmitted through apprenticeship systems that prioritize speed and output rather than safety (Ajayeoba *et al,*, 2015). As a result, unsafe behaviours such as lifting heavy blocks alone, using bare hands to mix cement, or operating vibrating moulders without gloves are normalized (Ugbosu et al., 2025; Kingsley-Elewa et al., 2025). This lack of awareness is compounded by misconceptions that PPE reduces productivity or comfort (Hermawati et al., 2014; Rayhan, 2023). Employers, particularly small business owners, often perceive safety investments as unnecessary costs rather than productivity-enhancing measures (Ajayeoba, 2019; Adedoyin et al., 2022). Such attitudes perpetuate poor ergonomic practices and hinder adoption of even low-cost interventions such as tool redesign or rest scheduling (Osita et al., 2024; Kingsley-Elewa et al., 2024).

3.5. Socioeconomic and Cultural Influences

Socioeconomic realities shape the behavioural dimensions of ergonomic risk. Block-making is dominated by low-income workers who depend on daily wages, making them reluctant to report injuries or take rest breaks for fear of income loss (Kingsley-Elewa et al., 2025; Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018). Cultural perceptions of masculinity and endurance further encourage workers to tolerate pain and fatigue, viewing them as indicators of strength and productivity (Sanni et al., 2025; Aaron et al., 2022). These sociocultural norms discourage preventive behaviour and reinforce risk acceptance.

At a macro level, Nigeria's high unemployment rate drives vulnerable populations including youths and migrants into block-making work with little bargaining power or safety protection (Ugbosu et al., 2025; Rayhan, 2023). The absence of social security systems and workers' compensation for informal labour exacerbates the cycle of injury and poverty

(WHO and ILO, 2017; Ojo et al., 2024). Consequently, ergonomic problems persist not only because of poor design or training but also due to deep-rooted social inequities and governance challenges.

4. Contextual and Systemic Factors Intensifying Risks

Ergonomic challenges in Nigeria's block-making industry are deeply embedded within broader systemic, institutional, and socio-environmental contexts. These factors extend beyond the immediate physical conditions of work to include economic instability, policy weaknesses, cultural norms, and infrastructural limitations. The interplay of these systemic influences sustains unsafe work environments and undermines the implementation of ergonomic interventions (Ajayeoba, 2019; Osita et al., 2024; Ugbosu et al., 2025). While the micro-level determinants such as manual work and poor equipment design directly affect the individual worker, the macro-level contextual factors determine whether improvements can be realistically adopted and sustained across the industry (Kingsley-Elewa, Ugbebor, and Awanye, 2025; Kingsley-Elewa et al. 2024).

4.1. Economic Informality and Precarious Employment

The block-making sector operates predominantly in Nigeria's informal economy, which employs over 70% of the national labour force (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Ojo et al., 2024). Informality is characterized by a lack of registration, absence of social protection, and minimal government oversight (WHO and ILO, 2017). In this environment, safety and ergonomics are considered secondary to survival and productivity (Rayhan, 2023; Osita et al., 2024). Employers tend to prioritize profit margins over worker welfare, resulting in underinvestment in safe equipment, personal protective gear, or training programs (Ajayeoba, 2019; Ugbosu et al., 2025).

Workers in this sector are typically employed on daily or piece-rate contracts, leading to income insecurity and encouraging excessive physical exertion to meet output targets (Aaron, Madume, and Ijah, 2022; Kingsley-Elewa et al., 2025). Such conditions create psychosocial stress, which amplifies physical fatigue and the likelihood of accidents (Kingsley-Elewa et al., 2024; Howe et al., 2024). Furthermore, informal employment relationships mean that injuries are rarely reported, and compensation mechanisms are virtually nonexistent (Lamai, 2021; WHO and ILO, 2017). This economic precarity perpetuates a cycle of ergonomic neglect where workers trade their health for daily sustenance (Osita et al., 2024; Ajayeoba, 2019).

4.2. Weak Policy Implementation and Institutional Gaps

A recurring systemic issue in Nigeria's industrial landscape is the gap between policy formulation and enforcement. Although the *National Policy on Occupational Safety and Health (2016)* outlines standards for workplace safety, its practical application in informal sectors like block-making remains limited (Lamai, 2021; Ugbosu et al., 2025). Regulatory bodies such as the Standards Organisation of Nigeria (SON), the National Environmental Standards and Regulations Enforcement Agency (NESREA), and local environmental health units lack the resources and manpower to inspect informal enterprises scattered across urban and peri-urban areas (Osita et al., 2024; Rayhan, 2023).

Compounding this is the absence of ergonomic specialists within inspection and policy teams. Most occupational health initiatives focus on chemical exposure, noise, and environmental pollution, with little attention paid to postural ergonomics and human–machine interaction (Ajayeoba, 2019; Kingsley-Elewa et al., 2024). The lack of institutional collaboration between regulatory agencies, universities, and local government councils further fragments policy efforts (Adedoyin et al., 2022; Ugbosu et al., 2025). As a result, ergonomic risk factors remain invisible within the national discourse on industrial safety, leaving block-making workers largely unprotected (Osita et al., 2024; WHO and ILO, 2017).

4.3. Environmental and Infrastructural Limitations

Environmental conditions in Nigeria exacerbate ergonomic stress in the block-making industry. The tropical climate exposes workers to high temperatures, humidity, and seasonal rainfall, creating both thermal and physical discomfort (Aaron et al., 2022; Nari et al., 2020). Many block-making yards are situated in open spaces without roofing, adequate ventilation, or leveled surfaces (Ajayeoba, 2019; Ugbosu et al., 2025). Workers therefore perform strenuous tasks under intense sunlight, which elevates body temperature, accelerates dehydration, and increases cardiovascular strain (Jibiri et al., 2024; Ahmad et al., 2021). In addition, poor infrastructure limits access to mechanization and safe work environments. Most block-making enterprises operate in unplanned settlements with irregular electricity supply, forcing operators to depend on diesel generators that produce noise and vibration beyond permissible exposure limits (Rayhan, 2023; Osita et al., 2024). Uneven and muddy surfaces during the rainy season also create unsafe footing,

increasing slip and fall incidents (Muraina et al., 2024; Adedoyin et al., 2022). The combination of extreme weather, infrastructural decay, and unregulated workspace layouts amplifies ergonomic and safety risks across the industry (Kingsley-Elewa et al., 2025; Ugbosu et al., 2025).

4.4. Cultural and Behavioural Dimensions of Risk

Culture plays a crucial role in shaping how workers perceive and respond to ergonomic hazards. In many Nigerian communities, physical endurance and resilience are culturally valorized, particularly among male-dominated occupations such as block making (Sanni et al., 2025; Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018). Workers often interpret fatigue or pain as proof of strength, discouraging them from adopting protective measures or taking rest breaks (Aaron et al., 2022; Kingsley-Elewa et al., 2024). This mindset fosters a normalization of discomfort, where pain becomes an accepted aspect of daily labour rather than a signal of potential injury (Ajayeoba, 2019; Adebiyi et al., 2018).

Low literacy levels and lack of ergonomic education reinforce these behavioural risks. Safety instructions, when provided, are rarely understood or implemented (Ugbosu et al., 2025; Kingsley-Elewa et al., 2025). Moreover, informal workgroups often lack leadership structures capable of enforcing safety practices, relying instead on peer observation and informal norms (Osita et al., 2024; Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018). In this context, cultural values, economic necessity, and ignorance interact to perpetuate unsafe work patterns and resistance to behavioural change (Hermawati et al., 2014; Priyoko et al., 2021).

4.5. Educational and Research Deficiencies

A systemic factor that underpins the persistence of ergonomic risks is the inadequate integration of ergonomics into Nigeria's educational and research systems. Few polytechnics, technical colleges, or universities offer practical ergonomics modules within engineering or construction curricula (Lamai, 2021; Ugbosu et al., 2025). As a result, graduates who enter the manufacturing or construction industries often lack foundational knowledge of workplace design principles (Ajayeoba, 2019; Osita et al., 2024).

Furthermore, research funding for ergonomics and occupational health remains limited. Most existing studies are localized, small-scale surveys conducted without the technological tools (e.g., EMG sensors, motion capture, or biomechanical modeling) that characterize global ergonomic research (Hermawati et al., 2014; Howe et al., 2024). The absence of national-level ergonomic data hinders evidence-based policymaking and prevents industry-wide benchmarking (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Kingsley-Elewa et al., 2024). Thus, Nigeria's block-making industry operates within a knowledge vacuum where empirical evidence of risk exists but remains underutilized.

In summary, these systemic factors, economic informality, weak policy enforcement, environmental adversity, cultural acceptance of risk, and educational neglect collectively sustain the ergonomic challenges identified earlier. The absence of institutional coordination and cultural adaptation makes it difficult to implement even simple ergonomic interventions. A comprehensive understanding of these contextual realities is essential for designing sustainable, culturally appropriate solutions in the next stage of this review.

5. Pathways Toward Ergonomic Improvement and Sustainable Practice

Transforming Nigeria's block-making industry from a labour-intensive, high-risk occupation into a safe and productive enterprise requires a multidimensional ergonomic strategy as shown in Figure 2. Such transformation must integrate engineering innovation, behavioural modification, policy enforcement, and cultural reorientation. Ergonomics, when properly applied, can reduce work-related injuries, enhance worker wellbeing, and improve industrial efficiency (Adebiyi et al., 2018; Ajayeoba, 2019; Priyoko et al., 2021). However, effective implementation demands contextualized approaches tailored to the realities of small and medium-scale enterprises operating within the informal economy (Ugbosu et al., 2025; Kingsley-Elewa et al., 2025).

Figure 2 Pathways Toward Ergonomic Improvement and Sustainability Practice

5.1. Engineering and Technological Interventions

Engineering design improvements form the foundation of ergonomic advancement. The introduction of mechanized or semi-automated equipment can significantly reduce physical strain, lifting frequency, and vibration exposure among block-making workers (Nari et al., 2020; Jibiri et al., 2024). Machines equipped with adjustable handles, vibration-damping mounts, and height-regulated moulds can minimize awkward postures and musculoskeletal stress (Ajayeoba, 2019; Adebiyi et al., 2018).

Locally engineered innovations have shown potential for addressing these challenges. For example, the National Agency for Science and Engineering Infrastructure (NASENI) has developed semi-automated block moulding machines with ergonomic features adapted to Nigerian anthropometric data (Osita et al., 2024; Ugbosu et al., 2025). Similarly, collaborative projects between LAUTECH researchers and small-scale entrepreneurs have yielded prototypes of lever-assisted lifting devices and mixing platforms designed to reduce spinal compression loads (Ajayeoba, 2019; Adedoyin et al., 2022). The adoption of such locally appropriate technologies can help balance cost efficiency with ergonomic safety.

Incorporating anthropometric data of Nigerian workers into the design of tools and workstations is also essential. Studies show that imported machines are often designed for body dimensions that do not correspond to local populations, resulting in poor posture and excessive reach distances (Kingsley-Elewa et al., 2024; Muraina et al., 2024). Ergonomic calibration of workstation heights and handle spacing using national body dimension databases can improve comfort and reduce fatigue (Hermawati et al., 2014; Howe et al., 2024). Investment in localized industrial design research is, therefore, a cost-effective means of preventing injuries while enhancing productivity.

5.2. Training, Education, and Behavioural Change

Beyond technology, human capacity development is critical. Training programs focusing on safe material handling, posture correction, and fatigue management can substantially lower ergonomic risks (Kingsley-Elewa et al., 2024; Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018). Evidence from similar industries in India and Ghana indicates that participatory ergonomic training where workers identify hazards and propose solutions leads to sustained behavioural change (Priyoko et al., 2021; Acquah et al., 2021).

Nigeria's polytechnics and vocational training centers should incorporate applied ergonomics modules into construction and engineering curricula (Lamai, 2021; Ugbosu et al., 2025). By equipping future artisans and technicians with ergonomic literacy, the country can gradually shift from reactive to preventive occupational safety practices. Regular workshops and on-site demonstrations for block-makers can also bridge the knowledge gap among existing workers (Ajayeoba, 2019; Osita et al., 2024).

Behavioural change strategies must address deep-seated attitudes toward risk and pain tolerance. Awareness campaigns emphasizing the link between ergonomics and long-term health can help reshape perceptions of "strength" and "endurance" within male-dominated trades (Sanni et al., 2025; Aaron et al., 2022). Demonstrating how proper posture, hydration, and rest intervals enhance performance rather than hinder it can improve compliance with safety practices (Okoye and Department of Building, Nnamdi Azikiwe University, Nigeria, 2018; Kingsley-Elewa et al., 2025).

Community-based engagement, using peer mentors and local champions, has proven effective in reinforcing these behavioural changes in other informal sectors (Rayhan, 2023; WHO and ILO, 2017).

5.3. Policy Integration and Institutional Strengthening

Institutional support remains pivotal for scaling ergonomic improvements. Enforcement of Nigeria's *National Policy on Occupational Safety and Health (2016)* should explicitly include informal industries such as block-making (Lamai, 2021; Osita et al., 2024). Regulatory agencies like the Standards Organisation of Nigeria (SON) and NESREA must collaborate with local governments to monitor compliance and provide technical guidance on safe workspace design (Ugbosu et al., 2025; Rayhan, 2023). Introducing incentive-based safety programs can motivate compliance. For example, providing tax relief or microcredit access for enterprises that adopt certified ergonomic practices can stimulate gradual transformation (Ojo et al., 2024; Kingsley-Elewa et al., 2025). Partnerships with NGOs and professional associations such as the Nigerian Society of Engineers and the Ergonomics Society of Nigeria can facilitate awareness drives and periodic risk assessments (Ajayeoba, 2019; Kingsley-Elewa et al., 2024).

Furthermore, data-driven policymaking should be promoted through national occupational health surveillance. Developing a centralized ergonomic injury database would enable evidence-based planning, allowing regulators to prioritize high-risk sectors and allocate resources more effectively (Howe et al., 2024; Priyoko et al., 2021). Without reliable data, policymaking will remain reactive rather than preventive a limitation that currently undermines Nigeria's occupational health system (WHO and ILO, 2017; Osita et al., 2024).

5.4. Socio-Cultural and Community-Based Approaches

Cultural and community-level interventions are essential to address the behavioural dimension of ergonomic risk. Engaging trade associations, cooperative societies, and community leaders in ergonomic advocacy can enhance the legitimacy of safety messages (Sanni et al., 2025; Aaron et al., 2022). Since many block-makers operate within informal community clusters, interventions that build trust and local ownership are more likely to succeed than top-down regulatory mandates (Ajayeoba, 2019; Ugbosu et al., 2025). Gender-sensitive approaches should also be incorporated. Although block-making is predominantly male-dominated, female workers involved in material preparation or quality control face unique ergonomic challenges due to physiological differences and social constraints (Kingsley-Elewa et al., 2024; Adedoyin et al., 2022). Ergonomic interventions must therefore consider inclusivity and adaptation to different body types and roles. Additionally, promoting cooperative models where block-making groups pool resources to acquire semi-mechanized tools can help overcome financial barriers to safety upgrades (Ojo et al., 2024; Kingsley-Elewa et al., 2025). When workers collectively invest in technology, peer accountability also increases, encouraging better maintenance and safer operational practices (Osita et al., 2024; Ugbosu et al., 2025).

5.5. Sustainability and Future Research Directions

To sustain ergonomic improvements, interventions must be integrated within broader sustainable development goals (SDGs), particularly SDG 3 (Good Health and Well-being) and SDG 8 (Decent Work and Economic Growth) (WHO and ILO, 2017; Lamai, 2021). Establishing research–industry partnerships between universities and small-scale block producers can accelerate innovation in ergonomic design and safety practices (Ajayeoba, 2019; Ugbosu et al., 2025).

Future research should employ quantitative ergonomic assessment **tools** such as Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA), and biomechanical simulation models to generate precise data on postural loads and task risk levels (Hermawati et al., 2014; Jibiri et al., 2024). These methods can help identify high-risk tasks and evaluate the impact of interventions objectively. Furthermore, longitudinal studies tracking worker health outcomes before and after ergonomic modifications would provide valuable insights into long-term benefits and cost-effectiveness (Kingsley-Elewa et al., 2024; Adebiyi et al., 2018).

By embedding ergonomic research within Nigeria's industrial development agenda, the country can gradually reduce its dependence on physically intensive labour systems and transition toward sustainable, human-centered production. Such transformation would not only improve worker wellbeing but also enhance the efficiency and competitiveness of the construction sector.

6. Conclusion

The block-making industry remains a cornerstone of Nigeria's construction and housing sector, yet it continues to operate under difficult and unsafe working conditions. Workers in this field endure heavy physical strain, poor postures, and exposure to dust, noise, and vibration on a daily basis. These challenges reflect a wider issue of neglect toward

ergonomics and occupational health within the informal economy. The physical toll on workers not only threatens their health and wellbeing but also reduces overall productivity, efficiency, and sustainability within the construction supply chain. The review shows that the risks faced by block-makers are largely preventable. The persistence of these hazards stems from a combination of factors low mechanization, limited ergonomic awareness, weak regulatory enforcement, and cultural attitudes that normalize discomfort as part of hard work. Without deliberate intervention, these structural and behavioural patterns will continue to undermine worker safety and industrial progress.

However, meaningful improvement is achievable through a multi-level approach. Engineering solutions such as semi-mechanized moulding equipment, adjustable workstations, and vibration-reducing tools can significantly lower physical stress. Training and education are equally vital, empowering workers to adopt safer work habits and improving supervisors' understanding of ergonomic principles. Embedding ergonomics into vocational and technical education will help shift workplace culture from reactive to preventive safety practices. Policy reform is another crucial step. National occupational safety standards must be extended to cover informal industries like block-making, supported by enforcement mechanisms and incentives that encourage compliance. Partnerships between research institutions, government agencies, and industry stakeholders can promote innovation and ensure that ergonomic principles are integrated into equipment design, workspace layout, and worker training programs.

Cultural reorientation is also essential. Promoting awareness that health and safety contribute directly to productivity can help dismantle harmful perceptions that equate endurance with efficiency. By encouraging rest, hydration, and the proper use of protective gear, communities can begin to value the long-term wellbeing of their workforce.

Ultimately, the path toward a safer and more sustainable block-making industry lies in combining technological innovation, education, and policy with empathy for the workers who form its backbone. Investing in ergonomics is not just a matter of compliance or welfare it is a strategic choice that enhances productivity, preserves human dignity, and contributes to national development. The true measure of progress in this vital industry will be seen not only in the number of blocks produced, but in the improved health, comfort, and safety of those who produce them.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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