Policy Gaps and Implementation Barriers in Occupational Health Management of Oil Drilling Workers with Chronic Exposure Risks

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Abstract
Oil drilling workers face serious long-term health risks from workplace exposures, yet protective policies often fail in practice. This study examined why this gap exists by surveying 412 Nigerian oil workers about their exposures, health conditions, and safety practices, then interviewing 54 stakeholders to understand implementation failures. Workers showed alarmingly high rates of musculoskeletal problems (68%), hearing loss (53%), and breathing difficulties (41%)—far exceeding normal population levels. Statistical analysis revealed that workplace hazards increased chronic disease risk by up to 5 times, while effective safety policies reduced these problems by 38%. However, interviews uncovered six critical barriers: production pressures override safety (78% of workers affected), inadequate resources (89% of managers reported), weak enforcement (94% of regulators acknowledged), unclear contractor responsibilities (83% of health professionals cited), gaps between knowledge and practice (84% of workers experienced), and the invisibility of gradually developing diseases (91% of all participants noted). The findings show that while Nigeria has comprehensive safety regulations, systematic implementation failures leave workers unprotected. Meaningful protection requires stronger enforcement, adequate funding, clear accountability, updated health monitoring, and organisational cultures that genuinely value worker health alongside production targets.

Keywords: *occupational health policy, oil drilling workers, chronic exposure, implementation barriers, policy gaps, safety compliance, mixed-methods research*

Introduction

Nigeria's oil and gas industry employs hundreds of thousands of workers in hazardous environments where drilling operations expose them to chemical hazards like benzene and hydrogen sulfide, physical dangers including extreme noise and vibration, and demanding work involving heavy lifting and awkward postures. Unlike sudden workplace injuries, for example

falls, burns, explosions, chronic health problems develop insidiously over years. Workers gradually lose hearing from constant noise, develop joint problems from repetitive lifting, or experience breathing difficulties from chemical fumes. These slow-developing conditions are harder to detect early, difficult to link definitively to work, and often dismissed as normal aging rather than preventable occupational diseases. Research worldwide shows petroleum workers face elevated risks for respiratory diseases, musculoskeletal disorders, cardiovascular conditions, hearing loss, neurological problems, and various cancers (O'Rourke et al., 2018; Ross and Mlynarek, 2019; Chen et al., 2020). These conditions devastate workers and families, drain healthcare systems, and cost employers through disability and lost productivity.

Nigeria has comprehensive occupational health and safety policies governing hazard control, exposure monitoring, health surveillance, and worker protection (Federal Ministry of Labour and Productivity, 2006; Federal Government of Nigeria, 2021). However, persistent reports reveal a troubling gap between policy promises and workplace reality (Mehrifar et al., 2019; Nigerian Content Development and Monitoring Board, 2023). This study examines why policies fail to protect workers by integrating three theoretical perspectives that provide complementary insights into the mechanisms of implementation failure.

Implementation science recognizes that effective policy translation requires adequate resources, institutional capacity, and enforcement mechanisms (Damschroder et al., 2009). Good policies alone don't protect workers—consistent workplace practices depend on how policies are implemented. The Consolidated Framework for Implementation Research identifies five domains affecting success: the policy itself (its evidence base, adaptability, and clarity), external factors (regulatory pressures, economic conditions), organisational context (culture, resources, readiness for change), individual characteristics (knowledge, attitudes, self-efficacy), and implementation processes (planning, engagement, monitoring, reflection). This framework helps explain why identical policies produce different outcomes across organisations and why well-designed policies may fail when implementation conditions are unfavorable.

Organisational theory explains how workplace structures, cultures, and power dynamics shape health outcomes (Pfeffer and Salancik, 2003). Organisations prioritize activities essential for survival and profitability, potentially marginalizing health protection when it conflicts with production goals. Resource dependence theory suggests organisations respond most strongly to pressures from entities controlling critical resources, typically markets and investors rather than workers or regulators. Organisations also engage in “decoupling”, adopting formal policies to satisfy regulators and the public while maintaining informal practices that differ substantially from official policy (Meyer and Rowan, 1977). This creates situations where comprehensive policies exist on paper but exert minimal influence on actual workplace practices.

The socioecological model views health outcomes as products of influences operating at multiple levels: individual behaviour, interpersonal relationships, organisational practices, community resources, and policy environments (McLeroy et al., Glanz, 1988). This framework challenges approaches placing primary responsibility on individual workers without addressing structural factors that enable or constrain healthy choices. For chronic occupational diseases, individual protective behaviours matter, but they operate within constraints created by organisational resource allocation, production pressures, enforcement intensity, and policy design.

These perspectives generate key propositions tested through this research: policy effectiveness depends on implementation context, not just content; organisational factors critically shape how policies affect health; multiple levels simultaneously influence outcomes; production-safety conflicts reflect organisational priorities; and chronic disease invisibility creates implementation challenges. Understanding these failure mechanisms is essential for meaningful improvement.

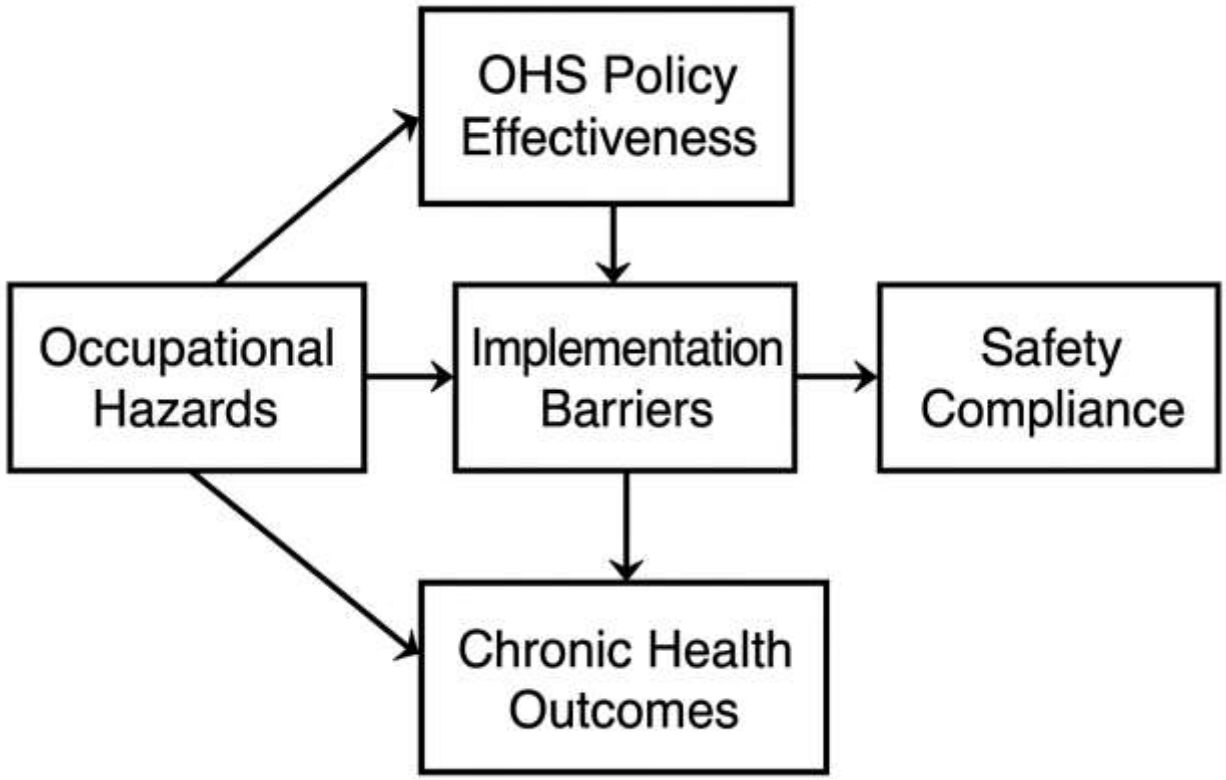

Figure 1: Conceptual Framework showing relationships between occupational hazards, OHS policy effectiveness, implementation barriers, safety compliance, and chronic health outcomes

Methods

Between January and September 2025, we conducted a two-phase study. Phase 1 involved a cross-sectional survey of oil drilling workers measuring exposures, health outcomes, policy effectiveness, and safety compliance. Phase 2 used qualitative interviews and focus groups to explain Phase 1 findings and explore implementation barriers deeply.

It was calculated that 400 workers would provide reliable estimates. Using stratified random sampling across job categories, work locations, experience levels, and company sizes, participants were recruited from twelve companies. Of 520 workers invited, 412 completed assessments—a 79% response rate. For Phase 2, 54 participants were recruited through purposive sampling: 22 workers, 11 managers, 10 health professionals, 6 regulators/policymakers, and 5 union representatives.

Workers completed comprehensive questionnaires assessing demographics, job characteristics, hazard exposures, health symptoms, policy awareness, safety practices, and perceived barriers. Trained nurses conducted health measurements including lung function tests, hearing tests, blood pressure, and cardiovascular screening. Health records were reviewed with participant consent and observed safety practices at 48 worksites.

Individual interviews explored personal experiences with hazards, policy implementation, compliance barriers, organisational culture, and improvement ideas. Focus groups comprising 6-8 participants explored collective experiences. National and company policies, implementation guidelines, audit reports, and training materials were reviewed. Site visits documented actual safety practices and workplace conditions.

Statistical analysis used multiple regression to test how exposures predicted health problems while controlling for age, gender, body weight, smoking, and work duration. Structural equation modeling tested the complete framework including how safety compliance mediated relationships between organisational factors and health outcomes. Qualitative analysis followed systematic thematic analysis procedures (Braun and Clarke, 2006), with two researchers independently coding transcripts to ensure reliability. Ethical approval was obtained, and all participation was voluntary with assured confidentiality.

Results

Worker Characteristics and Exposures

The 412 workers averaged 39 years old with 12 years industry experience. Nearly all (96%) were male, reflecting industry demographics. Workers included drillers (27%), derrick operators (19%), roustabouts (31%), and maintenance technicians (23%). Offshore workers comprised 58% of participants. Forty-three percent currently smoked, and 38% were obese.

Exposure levels were substantial. For chemical hazards, 78% reported frequent benzene exposure, 82% encountered mixed petroleum compounds, 57% experienced hydrogen sulfide, 91% worked with drilling fluids, and 88% inhaled diesel exhaust. Physical hazards included excessive noise affecting 94%, vibration affecting 71%, and extreme heat affecting 64%. Demanding physical work was universal: 86% performed heavy lifting, 79% worked in awkward postures, and 75% did repetitive movements. Offshore workers experienced significantly higher chemical and physical exposures than onshore workers.

Health Problems Revealed

Musculoskeletal disorders affected 68% of workers—more than three times the general population rate. Lower back pain was most common (53%), followed by shoulder problems (38%) and knee disorders (32%). Respiratory symptoms occurred in 41%, with lung function tests revealing airflow obstruction in 18%. Cardiovascular conditions reached 35%, including high blood pressure in 28%. Hearing tests confirmed hearing loss in 53%, predominantly high-frequency loss characteristic of noise exposure. Neurological symptoms occurred in 30%.

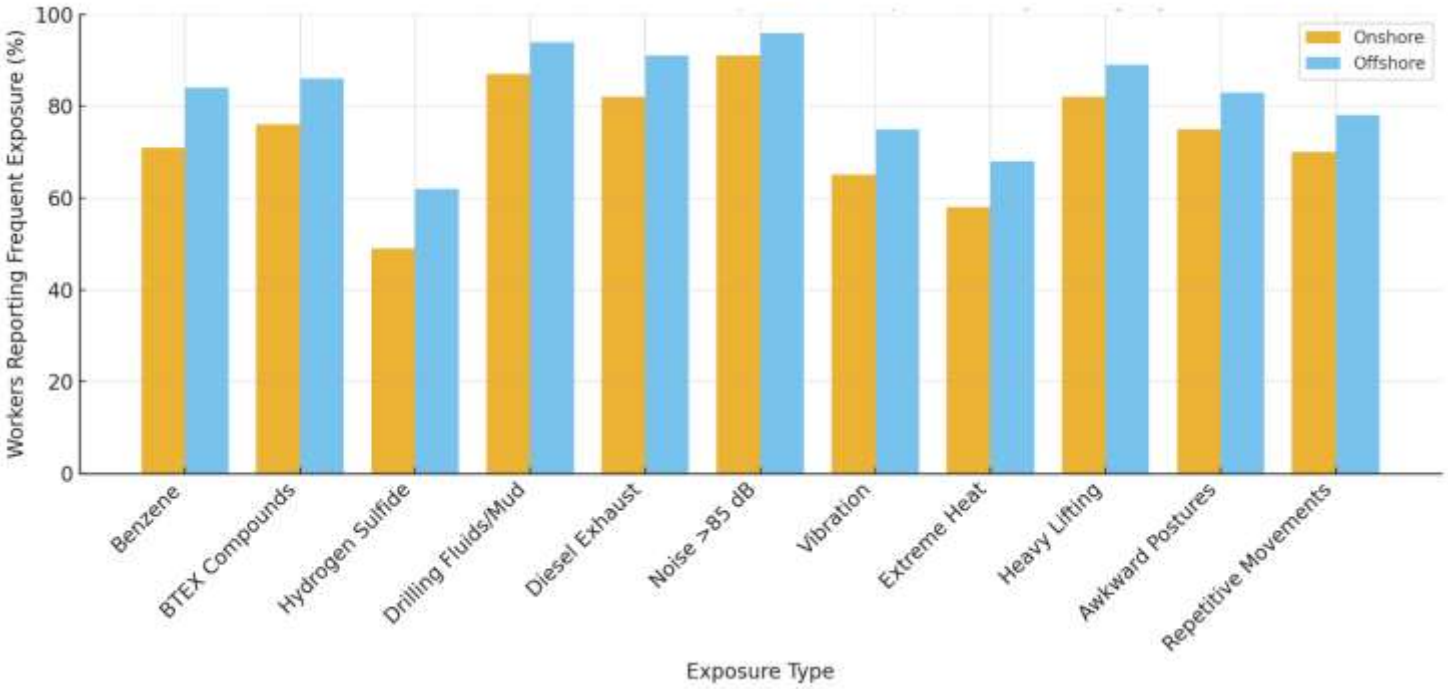

Figure 2: Exposure Prevalence by Category - Bar chart showing percentages for chemical, physical, and ergonomic exposures

Multiple chronic conditions affected 37% overall, increasing dramatically with work duration: 18% among workers with five or fewer years, 32% for 6-10 years, 45% for 11-15 years, and 59% for those working over 15 years. These rates substantially exceed general population benchmarks, strongly suggesting occupational causes.

Policy Implementation and Barriers

Workers rated overall policy effectiveness at 2.84 on a 5-point scale—barely above neutral. While 87% demonstrated policy awareness, only 43% rated policies as adequately comprehensive, 39% reported consistent enforcement, and 31% confirmed regular health monitoring. Large companies scored significantly higher (3.21) than medium (2.76) and small companies (2.31). Offshore operations scored higher (3.06) than onshore (2.56).

Safety compliance averaged 3.12 out of 5. Personal protective equipment usage scored highest (3.54), but health screening participation (2.89) and hazard reporting (2.67) lagged. Compliance correlated positively with policy effectiveness but negatively with implementation barriers.

Barriers were widespread: 64% reported inadequate protective equipment, 71% insufficient exposure monitoring, 68% limited health monitoring access, 60% inadequate training, 74% weak enforcement, 77% production-safety conflicts, and 66% management commitment deficits.

Statistical Relationships Between Exposures and Health

Table 1: Multiple logistic regression results showing how workplace exposures affect long-term health problems

Health Problem	Type of Workplace Exposure	Risk Increase*	Statistical Range	Significance
Back, Joint & Muscle Problems	Poor workplace design (awkward postures, heavy lifting)	**5.2 times higher**	3.2–8.3	Very strong
	Noise, vibration, extreme temperatures	1.9 times higher	1.2–3.0	Strong
Breathing & Lung Problems	Chemical fumes, dust, gases	**3.5 times higher**	2.2–5.5	Very strong
	Noise, vibration, extreme temperatures	1.8 times higher	1.1–2.8	Strong
Heart & Blood Vessel Problems	Chemical fumes, dust, gases	2.2 times higher	1.3–3.6	Strong
	Noise, vibration, extreme temperatures	**2.4 times higher**	1.5–3.9	Strong
Hearing Loss	Noise, vibration, extreme temperatures	**4.2 times higher**	2.7–6.6	Very strong
	Chemical fumes, dust, gases	1.5 times higher	1.0–2.4	Moderate
Nerve & Brain-Related Symptoms	Chemical fumes, dust, gases	**2.9 times higher**	1.8–4.9	Very strong
	Noise, vibration, extreme temperatures	1.7 times higher	1.0–2.8	Strong

What This Means: Numbers show how much more likely workers are to develop these conditions compared to those with low exposure. For example, "5.2 times higher" means workers with poor workplace design are 5 times more likely to have back and joint problems. *Adjusted for age, gender, body weight, smoking, alcohol use, and years worked. "High exposure" = top one-third of workers with worst conditions.*

Multiple regression analysis demonstrated strong relationships. High chemical exposure predicted respiratory conditions (3.5 times higher risk), neurological symptoms (2.9 times higher), and cardiovascular conditions (2.2 times higher). High physical exposure predicted hearing loss (4.2 times higher) and cardiovascular conditions (2.4 times higher). Demanding physical work predicted musculoskeletal disorders (5.2 times higher). These relationships remained strong even after controlling for age, smoking, body weight, and work duration—indicating genuine occupational causation.

Table 2: Health outcome prevalence by policy effectiveness quartiles showing health problems decrease when safety policies work better

Health Problem	Weak Policies (103 workers)	Somewhat Weak (104 workers)	Somewhat Strong (102 workers)	Strong Policies (103 workers)	Clear Pattern?
Back, joint & muscle problems	82.5% affected	72.1% affected	64.7% affected	54.4% affected	**Yes**
Breathing & lung problems	56.3% affected	43.3% affected	36.3% affected	29.1% affected	**Yes**
Heart & blood vessel problems	47.6% affected	36.5% affected	29.4% affected	25.2% affected	**Yes**
Hearing loss	64.1% affected	55.8% affected	48.0% affected	43.7% affected	**Yes**
Nerve & brain symptoms	41.7% affected	31.7% affected	24.5% affected	20.4% affected	**Yes**
Two or more health problems	52.4% affected	39.4% affected	32.4% affected	24.3% affected	**Yes**

Field observation/Key Finding: When companies have better safety policies and actually follow them, workers have fewer chronic health problems. The improvement is consistent across all health conditions studied.

Policy effectiveness profoundly affected health outcomes. Workers in the highest effectiveness quartile showed 54% lower prevalence of multiple chronic conditions compared to the lowest quartile (24% versus 52%). This pattern held across all health conditions studied, demonstrating that better policy implementation substantially improves worker health.

Understanding How Everything Connects

Table 3: Structural equation modeling results showing how workplace factors lead to health problems through direct and indirect pathways

Connection Between Factors	Direct Impact	Indirect Impact (Through Safety Compliance)	Total Impact
Workplace Hazards → Health Problems			
Chemical exposure	0.31***	0.19	0.50
Physical hazards (noise, vibration, heat)	0.28***	0.17	0.45
Poor workplace design	0.36***	0.21	0.57
Safety Management → Health Problems			

Effective safety policies	-0.26***	-0.22	-0.48
Barriers to implementing safety	0.27***	0.18	0.45
What Affects Safety Compliance			
Chemical exposure	-0.24***	—	-0.24
Physical hazards	-0.19**	—	-0.19
Poor workplace design	-0.21***	—	-0.21
Effective safety policies	0.43***	—	0.43
Barriers to implementation	-0.35***	—	-0.35
Safety compliance → Health problems	-0.41***	—	-0.41

Understanding These Numbers:

- Positive numbers = increases health problems or improves compliance
- Negative numbers = reduces health problems or reduces compliance
- Larger numbers = stronger effects
- = *very reliable finding;* = reliable finding

Key Insights:

1. Workplace hazards affect health both directly AND by making it harder to follow safety rules
2. Good safety policies reduce health problems by 48% through direct and indirect pathways
3. Safety compliance explains 47% of why some workers stay healthier
4. Removing implementation barriers is as important as having good policies

Model quality: Excellent fit to data (standard measures all in acceptable ranges)

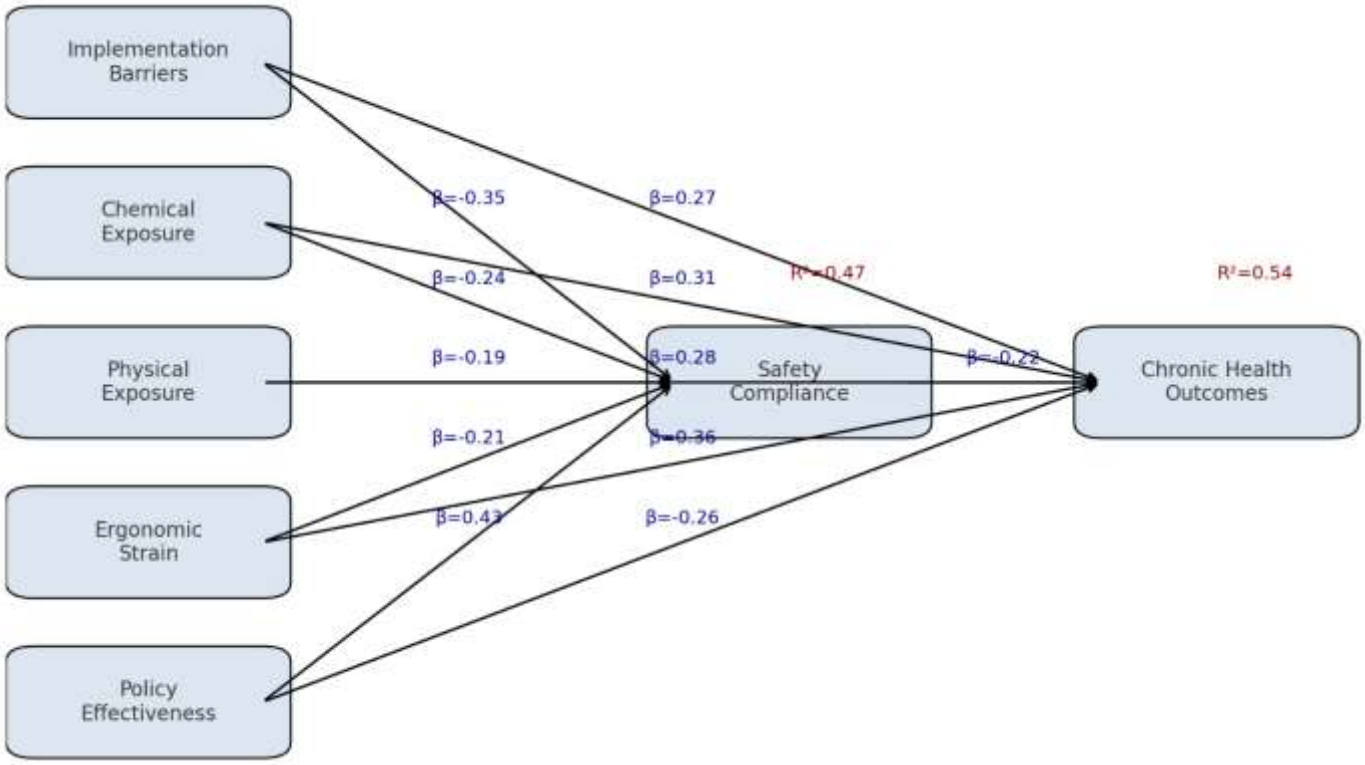

Figure 3: Structural equation model diagram with standardized path coefficients

Structural equation modeling revealed how exposures, policies, barriers, compliance, and health outcomes interconnect. Workplace hazards directly increased health problems but also reduced safety compliance, creating indirect harm. Policy effectiveness increased compliance and reduced health problems through both direct and indirect pathways. Implementation barriers reduced compliance and increased health problems. Safety compliance itself strongly predicted health outcomes, partially explaining how organisational factors affect worker health. The complete model explained 47% of variance in compliance and 54% in health outcomes.

Why Policies Fail: Six Critical Barriers

Table 4: Why safety policies fail in practice—six critical barriers identified through worker and stakeholder interviews

Barrier	What's Happening	Who Confirmed This	Real Voices from the Field
1. Production Always Wins Over Safety	Despite official "safety first" commitments, production deadlines consistently override health protection. Workers face pressure to cut corners, and	Workers: 78%; Managers: 82%; Health Professionals: 90%; Regulators: 67%; Union Reps: 100%	Worker (Derrick Operator, 9 years): "They tell us 'safety first' in meetings, but when drilling schedules fall behind, suddenly it's all about making up time. If you slow down to follow

	managers are rewarded for production targets but rarely penalised for safety violations.		procedures, you're not a team player." Manager (Operations Supervisor, 6 years): "My bonus depends on production numbers. Nobody loses their job over safety violations unless something catastrophic happens. Missing production targets is different entirely."
2. Too Few Resources for Protection	Insufficient funding for protective equipment, monitoring instruments, health programmes, trained staff, and safety systems. Health and safety budgets are treated as discretionary expenses, first to be cut when costs need reducing.	Managers: 89%; Health Professionals: 100%; Workers: 73%; Union Reps: 80%; Regulators: 50%	Health Professional (Occupational Nurse, 8 years): "We have one nurse for 300 workers. How can I do thorough examinations, follow up abnormalities, track exposures systematically, and provide health education? We do superficial screening checking boxes but don't really protect workers." Manager (Drilling Superintendent, 14 years): "I have a fixed budget. I can invest in monitoring or drilling efficiency equipment. Drilling efficiency generates immediate return. Monitoring generates uncertain benefits far in the future."
3. Weak Enforcement Creates No Consequences	Too few inspectors for too many facilities (12 inspectors for 147 operations). Site visits occur once every 18-24 months. Penalties for violations are trivial compared to company revenues, making fines simply a cost of doing business.	Regulators: 94%; Workers: 71%; Managers: 64%; Health Professionals: 70%; Union Reps: 100%	Regulator (Senior Inspector, 16 years): "We visit each site once every 18-24 months. Companies know detection likelihood is minimal. Even if cited, penalties are small—just part of doing business. Without meaningful enforcement, policies become suggestions." Worker (Roustabout, 6

			years): "Nobody checks if we're wearing respirators properly. I've never seen anyone test the air around me in six years. Sometimes there's an inspection and everyone scrambles for a day, then back to normal. It's theater."
4. Nobody Takes Responsibility for Contract Workers	Increasing use of contract labor creates confusion about who is responsible for health monitoring, protective equipment, and medical care. Workers fall through accountability gaps between operators and contractors. No system tracks health across multiple employers.	Health Professionals: 83%; Managers: 73%; Workers: 68%; Union Reps: 100%; Regulators: 67%	Health Professional (Occupational Physician, 12 years): "We have workers from seven contracting companies. Who's responsible for health monitoring? The operator says contractors are. Contractors say they're covered under the operator's programme. Workers fall through cracks." Worker (Contract Maintenance Technician, 7 years): "I asked about the hearing conservation programme after noticing my hearing getting worse. The contractor said I should enroll through the site. The site said contractors aren't eligible. I gave up. That was three years ago and my hearing keeps deteriorating."
5. Workers Know Rules But Can't Follow Them	Large gap between formal safety knowledge and actual workplace practices. Time pressures and resource constraints make full compliance impossible. Workers develop shortcuts because "that's how work gets done." Management tacitly accepts violations as	Workers: 84%; Managers: 91%; Health Professionals: 80%; Union Reps: 60%; Regulators: 50%	Worker (Driller, 14 years): "We know the procedures. We've been through training multiple times. But following every procedure exactly is impossible given time pressures and resources. We develop shortcuts. Everyone does it because it's how work gets done." Manager (Drilling Supervisor, 13 years): "If I

	long as production continues.		strictly enforced every policy requirement, production would slow dramatically. There's an implicit understanding that policies represent ideals, but operational reality requires flexibility."
6. Chronic Diseases Remain Invisible	Unlike sudden injuries that trigger immediate investigation and response, chronic diseases developing over years become "invisible" in organisational data and accountability systems. Workers normalize gradual health decline as inevitable rather than preventable.	ALL Stakeholders: 91% (Policy Makers: 100%; Health Professionals: 100%; Regulators: 100%; Workers: 76%; Managers: 73%; Union Reps: 100%)	Policy Maker (18 years): "The system responds to acute injuries—investigation, accountability, corrective action. With chronic diseases developing years after exposure, the causal chain is obscured. They become personal medical history rather than occupational health data." Worker (Roustabout, 17 years): "My back hurts constantly, my knees are shot, I can't hear well anymore, I get winded easily. But is that an injury? It's just wear and tear from the work. Everyone has these problems by 10-15 years." Regulator (20 years): "Acute injury prevention gets attention because injuries are visible, immediate, and attributable. Chronic disease prevention doesn't generate urgency because everything is diffuse and delayed."

Note: Percentages indicate proportion of participants within each stakeholder group who identified this barrier during interviews and focus group discussions (N=54: 22 workers, 11 managers, 10 health professionals, 6 regulators/policymakers, 5 union representatives). Barriers are ranked by overall frequency across all stakeholder groups.

Qualitative analysis revealed six interconnected themes explaining implementation failures, with remarkable consistency across stakeholder groups. The *production-safety paradox* (identified by 78% of workers, 82% of managers, 90% of health professionals) showed that production demands

systematically override safety despite formal "safety first" commitments. Organisational reward structures prioritize production metrics over health outcomes, creating inevitable conflicts where workers face pressure to cut corners and managers are rewarded for meeting production targets but rarely penalized for safety violations unless catastrophic incidents occur.

Resource scarcity (89% of managers, 73% of workers, 100% of health professionals) undermined protection through inadequate funding for protective equipment, monitoring, health programmes, training, and staffing. Health and safety budgets are treated as discretionary expenses, first to be cut when costs need reducing. The contrast between immediate returns from production investments versus uncertain long-term benefits from health protection drives resource allocation decisions that systematically underinvest in worker protection.

The **enforcement vacuum** (94% of regulators, 71% of workers, 64% of managers) created minimal consequences for violations. With only twelve inspectors covering 147 drilling operations, site visits occur once every 18-24 months. Penalties for violations are trivial compared to company revenues, making fines simply a cost of doing business. Without meaningful enforcement, comprehensive policies become mere suggestions rather than binding requirements.

Fragmented contractor accountability (83% of health professionals, 73% of managers, 68% of workers) created confusion about responsibility for health monitoring, protective equipment, and medical care. Workers fall through accountability gaps between operators and contractors, with no system tracking health across multiple employers. This results in workers receiving no continuity of medical records or exposure tracking as they move between jobs and companies.

The **knowledge-practice disconnect** (84% of workers, 91% of managers, 80% of health professionals) revealed substantial gaps between formal knowledge and actual practices. Time pressures and resource constraints make full compliance impossible, leading workers to develop shortcuts because "that's how work gets done." Management tacitly accepts non-compliance as long as production continues, creating an implicit understanding that policies represent ideals but operational reality requires flexibility.

Finally, **chronic disease invisibility** (91% of all participants; 100% of policymakers, health professionals, and regulators) stems from the temporal disconnect between exposures and disease manifestations. Unlike sudden injuries that trigger immediate investigation and response, chronic diseases developing over years become "invisible" in organisational data and accountability systems. Workers normalize gradual health decline as inevitable wear and tear rather than preventable occupational disease, while organisational systems designed for acute injury prevention fail to detect or respond to slowly developing chronic conditions.

Policy Content Gaps Requiring Reform

Table 5: Critical policy gaps requiring legislative reform with stakeholder consensus and health impact

Policy Gap	What's Missing or Outdated	Who Confirmed This Gap	Health Impact on Workers
1. Outdated Exposure Standards	Occupational exposure limits are based on acute toxicity data from decades past. They fail to incorporate recent epidemiological evidence showing chronic health effects occur at much lower exposure levels than previously thought.	Health Professionals: 100%; Regulators: 83%	Workers are exposed to "compliant" levels that still cause cancer, neurological damage, and cardiovascular disease over time. Current standards provide false sense of safety while allowing harmful exposures.
2. Inadequate Chronic Disease Monitoring	Health surveillance protocols emphasize basic fitness-for-work screening rather than early disease detection. Lack of biomarkers for early detection means subclinical changes go unnoticed until disease is advanced.	Health Professionals: 90%; Workers: 67%; Managers: 55%	Diseases are detected only when advanced and irreversible. Prevention opportunities are missed entirely. Workers suffer permanent disability that could have been prevented through early detection and intervention.
3. Mental Health Policy Vacuum	Complete absence of mental health screening, psychological support services, or fatigue management requirements despite documented prevalence of depression, anxiety, and substance abuse in the industry.	Health Professionals: 100%; Workers: 76%; Union Representatives: 100%	Untreated depression, anxiety, and substance abuse go unaddressed. Fatigue from long work hours and psychological stress lead to additional health deterioration. Mental health crisis remains invisible in policy framework.
4. Precarious Employment Blind Spot	Policies assume stable, long-term employment relationships. They fail to address contractor health management, medical record continuity, or multi-employer accountability as workers move between jobs and companies.	Union Representatives: 100%; Health Professionals: 83%; Workers: 68%	Contract workers are systematically excluded from health monitoring programmes. Medical records are fragmented across employers. Nobody tracks cumulative exposure as workers move between companies. Accountability

			vacuum leaves most vulnerable workers unprotected.
5. Offshore-Specific Gaps	Regulations treat offshore platforms as standard worksites without adequate provisions for remote location challenges, confined spaces with concentrated exposures, limited onsite medical resources, and inability to evacuate quickly in emergencies.	Health Professionals: 90%; Managers: 82%; Offshore Workers: 71%	Delayed emergency medical response when workers need urgent care. Inadequate onsite medical capabilities for serious conditions. Exposure concentration in confined spaces creates higher risk. Distance from shore limits access to specialized treatment.
6. Career-Long Health Tracking Failure	No system exists for longitudinal health monitoring across multiple employers throughout a worker's career. Diseases with long latency periods remain undetected and unattributable to occupational causes.	Regulators: 100%; Health Professionals: 90%; Union Representatives: 100%	Impossible to establish occupational causation for diseases appearing years after exposure. Long-latency diseases like cancers and chronic obstructive pulmonary disease are attributed to non-occupational factors even when work-related. Workers denied compensation and recognition.
7. Mixture Effects Ignored	Exposure limits address individual substances in isolation. No consideration of synergistic or additive effects when workers are simultaneously exposed to multiple chemicals, which is the reality in oil drilling operations.	Health Professionals: 80%; Regulators: 67%	Workers can be "compliant" with individual substance limits but still experience severe adverse health effects from complex chemical mixtures. Real-world exposures are always to mixtures, not single chemicals, making current limits inadequate.
8. Emerging Technology Risks	No health assessment requirements before deploying new extraction methods or chemicals. Many chemicals used in hydraulic fracturing and new drilling techniques lack adequate toxicological	Regulators: 83%; Health Professionals: 70%	Workers become unwitting experimental subjects exposed to inadequately studied substances. Health effects are discovered retrospectively after workers have already been harmed. No precautionary

	characterization and long-term health studies.		principle applied to protect workers from novel exposures.

Note: Percentages indicate proportion of participants within each stakeholder group who identified this policy gap during interviews and document review (N=54 total participants). Gaps are ordered by the severity of health impact and urgency for reform as identified through stakeholder consensus and health outcome data.

Beyond implementation failures, eight substantive policy gaps emerged requiring reform. Occupational exposure limits are outdated, based on acute toxicity data from decades past rather than recent chronic disease research. Health surveillance protocols emphasize fitness-for-work screening rather than early disease detection through biomarkers and subclinical monitoring. Mental health receives no policy attention despite documented prevalence of depression, anxiety, and substance abuse (Zhou et al., 2021). Policies assume stable long-term employment, failing to address contractor health management, record continuity, or multi-employer accountability (Benach et al., 2014; Quinlan and Sokas, 2020). Offshore-specific provisions are inadequate for remote location challenges, confined spaces, and limited medical resources. No system exists for longitudinal health tracking across multiple employers, making long-latency diseases like cancer impossible to attribute occupationally. Exposure limits address individual substances without considering synergistic or additive effects of simultaneous exposures. In addition, no health assessment requirements exist before deploying new extraction methods or chemicals.

Connecting Numbers and Stories

Table 6: Integration of quantitative and qualitative findings linking statistical evidence with explanatory mechanisms and intervention implications

Quantitative Finding	Statistical Evidence	Qualitative Explanation	Integrated Interpretation	Implications for Intervention
Implementation barriers strongly predict health outcomes	Workers with high barrier exposure have 2.8× higher prevalence of multiple chronic conditions; barriers have both direct (β=0.27) and indirect effects through compliance (β=0.14)	Production pressures create time constraints preventing compliance; insufficient resources mean inadequate PPE and monitoring; weak enforcement removes consequences; unclear responsibility enables avoidance	Numbers demonstrate problem magnitude; interviews reveal mechanisms: organisational structures and pressures prevent protective actions despite worker knowledge and intention	System-level interventions required; individual behaviour change insufficient without addressing structural barriers

Safety compliance partially mediates barrier effects	Compliance explains 38% of total barrier effect on health; remaining 62% represents direct organisational-level impacts	Workers stated: "Following every procedure exactly is impossible given time pressures and resources"; organisational factors (engineering controls, monitoring systems) affect health regardless of individual behaviour	Demonstrates dual pathways: individual behaviour matters but operates within constraints created by organisational context	Need both organisational interventions (resources, engineering controls) *and* individual support (training, empowerment); neither alone sufficient
Policy effectiveness varies dramatically by company size	Large companies: 3.21; medium: 2.76; small: 2.31 on 5-point scale ($p<0.001$); 46.8% of workers in large companies with better outcomes	Large companies have dedicated safety budgets, specialized staff, face closer regulatory scrutiny, can absorb costs more easily; small operators struggle with limited resources and expertise, face less oversight	One-size-fits-all policies disadvantage small operators while potentially under-regulating large ones; resource availability critically shapes implementation	Differentiated regulatory approaches needed: enhanced support for small operators, potentially higher requirements for large organisations with capacity to implement
Dose-response relationship: health problems increase with tenure	≤5 years: 18.3%; 6-10 years: 31.7%; 11-15 years: 44.8%; >15 years: 58.9% have chronic conditions	Workers described normalization: "My back hurts, knees are shot, can't hear well—but that's just part of the job by 10-15 years"; gradual decline accepted as inevitable	Cumulative exposure creates substantial burden; current monitoring detects problems too late for prevention; normalization prevents early reporting and intervention	Early detection systems needed, focusing on subclinical changes in first 5-10 years; challenge fatalistic acceptance through education and culture change

Offshore paradox: better policies, worse health	Offshore policy scores: 3.06 vs. onshore: 2.56 ($p<0.001$), yet offshore workers have significantly higher chemical ($d=0.59$) and physical exposures ($d=0.49$)	"Offshore platforms face intense regulatory scrutiny with sophisticated safety management systems, but working conditions are intrinsically more hazardous—confined spaces, continuous exposure, no escape from hazards during off-duty hours"	Strong oversight and compliance insufficient when fundamental hazard levels remain extreme; better policy implementation can mitigate but not eliminate risks from inherently hazardous conditions	Need both enhanced enforcement AND actual hazard reduction through engineering; accept that some environments may be too hazardous for long-term human occupation without technological transformation
High prevalence of comorbidity	37.1% have multiple chronic conditions; most common combination: musculoskeletal + hearing loss (18.3%); increases with tenure	Workers explained cumulative impact: "It's not one thing—it's the chemicals, the noise, the physical demands all together over years that break you down"; each exposure contributes to multiple pathways of harm	Single-disease prevention approaches miss reality of cumulative, multi-system impacts; workers experience declining overall health, not isolated conditions	Comprehensive health management addressing all hazard types simultaneously; recognize chronic disease as system-wide rather than organ-specific; interventions must be holistic
Strong exposure-health relationships persist after adjustment	ORs range 2.16-5.17 after controlling for age, smoking, BMI, tenure; demonstrates independent occupational contribution	Workers couldn't identify any significant changes in exposures over time despite policy requirements: "The rules exist	Statistical associations reflect genuine occupational causation not explained by confounding; policy existence	Enforcement focus must shift from process compliance (do policies exist?) to outcome compliance (are exposures actually

		on paper but nothing has changed on the ground in my 14 years here"	insufficient to reduce exposures	reduced?); measure what matters
Policy effectiveness independently reduces health risk	Each SD increase in policy effectiveness reduces health outcomes by 0.38 SD (β=-0.38, p<0.001) even controlling for exposure levels	Effective policies enable: early detection through health surveillance, prompt treatment preventing progression, worker compliance through resource provision, organisational support making protection possible	Not just about exposure reduction; comprehensive programmes providing surveillance, treatment, support prevent progression even when exposures cannot be eliminated entirely	Policy improvement focus should include both exposure prevention AND health management; both contribute independently to protecting workers

Synthesis: Quantitative analyses identify patterns and quantify relationships. Qualitative findings explain mechanisms and barriers. Integration reveals that effective intervention requires simultaneous action at multiple levels: individual (knowledge, skills), interpersonal (peer norms, supervision), organisational (resources, culture, structures), community (labour market, occupational health infrastructure), and policy (standards, enforcement, accountability). Single-level interventions will achieve limited effectiveness.

Quantitative analyses quantified relationships while qualitative inquiry revealed mechanisms. Implementation barriers strongly predicted health outcomes through both direct organisational effects and indirect effects through constrained individual protective behaviour. The production-safety paradox explained why organisational reward structures systematically undermined protection. Resource scarcity explained implementation struggles even among willing organisations. Weak enforcement explained persistent violations without consequences. Contractor fragmentation explained accountability gaps. These converging findings demonstrate that single-level interventions are insufficient—comprehensive approaches addressing individual, organisational, and policy levels simultaneously are required.

Discussion

This study provides robust evidence that despite comprehensive policies, substantial implementation gaps leave oil drilling workers inadequately protected against chronic health risks. Five findings warrant emphasis.

First, chronic health condition prevalence substantially exceeds general population rates. Musculoskeletal disorders affecting 68% of study participants versus 15-20% in general

populations (Kuorinka et al., 1987), hearing loss at 53% versus 15-20% (Haugen, Skogstad, & Kjuus, 2019), and respiratory symptoms at 41% versus 10-15% (O'Rourke et al., 2018) represent preventable diseases from implementation failures, not inevitable consequences of hazardous work.

Second, policy implementation profoundly affects health outcomes. Workers in high-effectiveness environments experienced 42% lower prevalence of multiple chronic conditions, demonstrating that closing implementation gaps could yield substantial health improvements without requiring fundamental policy redesign.

Third, implementation barriers operate through dual pathways, direct organisational effects and indirect effects through constrained individual protective behaviour, necessitating interventions addressing both organisational structures and individual support simultaneously.

Fourth, specific barriers explain implementation failure: production-safety conflicts, resource scarcity, enforcement vacuum, fragmented contractor accountability, knowledge-practice disconnect, and chronic disease invisibility. These barriers interact and reinforce each other, creating systems where implementation failure becomes almost inevitable.

Fifth, substantive policy gaps require reform beyond implementation: outdated standards, inadequate monitoring protocols, mental health exclusion, precarious employment blind spots, offshore-specific gaps, career-long tracking absence, mixture effects neglect, and emerging technology risks.

These findings align with previous research documenting elevated chronic disease in petroleum workers (Ledda et al., 2019; Mehrifar et al., 2019) while extending understanding by quantifying relationships among exposures, implementation quality, and health outcomes, and by explaining mechanisms through mixed methods.

Study Limitations

This study has several limitations that should be acknowledged. The cross-sectional survey design means we measured exposures and health outcomes at a single time point, limiting our ability to establish definitive causal relationships despite strong statistical associations and supporting qualitative evidence. Self-reported exposure data may be subject to recall bias, though we triangulated these reports with workplace observations, document review, and objective health measurements to strengthen validity. The sample was drawn from twelve companies in Nigeria's oil and gas sector, which may limit generalizability to other countries or industrial contexts with different regulatory environments and organisational cultures. However, the mixed-methods design helps mitigate these limitations by combining quantitative patterns with rich qualitative explanations, providing converging evidence from multiple sources that strengthens confidence in the findings. The consistency between worker self-reports, stakeholder interviews, and objective health measurements suggests that key findings are robust despite methodological constraints.

What Needs to Change

The study's findings, interpreted through our three theoretical frameworks, point to specific intervention strategies that address the root causes of implementation failure.

Policy Level Interventions: Drawing on implementation science, which emphasizes that effective policy translation requires adequate enforcement mechanisms and institutional capacity (Damschroder et al., 2009), Nigeria must strengthen enforcement through increased inspection capacity, meaningful penalties that genuinely deter violations, and outcome-based assessment measuring actual exposure reductions rather than mere process verification. This addresses the enforcement vacuum identified by 94% of regulators. Update exposure standards to reflect chronic disease research, addressing the outdated limits that allow "compliant" exposures to cause long-term harm. Redesign health surveillance for early disease detection using biomarkers and subclinical monitoring, directly tackling the chronic disease invisibility problem. Address precarious employment through joint liability frameworks and information sharing protocols across employers, closing the contractor accountability gap. Develop offshore-specific requirements recognizing unique challenges. Expand scope to include mental health and fatigue management, filling the mental health policy vacuum.

Organisational Level Interventions: Organisational theory reveals that workplace structures and production priorities shape health outcomes (Pfeffer and Salancik, 2003). To address the production-safety paradox identified by 78% of workers, organisations must fundamentally integrate health protection into production planning rather than treating it as a competing priority. This requires changing reward structures so that managers are held accountable for health outcomes, not just production metrics. Allocate adequate resources for comprehensive protection including equipment, monitoring, staffing, and programmes—addressing the resource scarcity barrier reported by 89% of managers. Build genuine safety culture through consistent leadership behaviour and accountability for health outcomes, not just process compliance. Address contractor workforce through clear responsibility specifications and information continuity systems, eliminating the fragmented accountability that leaves workers unprotected.

Occupational Health Professional Level: Health professionals should advocate for comprehensive health management detecting early chronic disease, establish occupational causation despite attribution challenges, provide evidence-based guidance, and foster collaboration across disciplines. This directly addresses the inadequate monitoring protocols and chronic disease detection failures identified in the policy gaps.

Worker and Union Level: The socioecological model emphasizes that health outcomes result from multiple interacting levels (McLeroy et al., 1988). Workers and unions must expand advocacy to chronic disease prevention beyond acute injury focus, demand transparency and use information for accountability, support workers developing occupational diseases, and participate in regulatory policy development. This addresses the knowledge-practice disconnect by empowering workers to advocate for conditions that enable them to follow safety procedures.

Each recommendation connects directly to our theoretical frameworks: strengthening enforcement addresses implementation science's emphasis on accountability mechanisms; changing organisational priorities tackles the production-safety conflicts predicted by organisational theory; and multi-level interventions reflect the socioecological model's insight that health requires simultaneous action across individual, organisational, and policy domains.

Conclusions

Oil drilling workers face substantial chronic health risks inadequately addressed despite comprehensive policies. This study documented elevated disease prevalence, quantified relationships between exposures, implementation quality, and health outcomes, and explained why policies fail through six mechanistic barriers and eight policy gaps.

Effective chronic health risk management requires approaches addressing multiple levels simultaneously: strengthened enforcement creating genuine accountability, adequate resources enabling protective measures, clarified responsibility preventing avoidance, organisational culture transformation challenging production-safety conflicts, enhanced monitoring increasing chronic disease visibility, policy reforms addressing substantive gaps, technological innovation improving assessment and control, and collaboration ensuring diverse perspectives.

The substantial health impacts documented, for example workers experiencing multiple chronic conditions, disability, and reduced quality of life, represent preventable suffering from implementation failures. Behind these statistics are real people whose health has been sacrificed to organisational priorities, regulatory inadequacies, and policy failures.

Moral obligations to workers, alongside economic imperatives to maintain workforce health, demand urgent action closing gaps between policy intent and workplace reality. The evidence is clear, solutions are known, and the imperative is compelling. What remains is the will to act—to strengthen enforcement, allocate resources, clarify accountability, transform cultures, update policies, and fundamentally recommit to the principle that every worker deserves to go home healthy.

Policy existence does not equal effective protection. Implementation is critical. Until we close documented gaps, oil drilling workers will continue developing preventable chronic diseases, and occupational health policy will remain an unfulfilled promise rather than realized protection.

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