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Letter to Editor

The Invisible Toxicity of Work: From an Early Observation to Four Decades of Research on Stress, Health, and Resilience

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Abstract

More than four decades ago, an informal observation among approximately 200 managers and other professionals who had survived a first myocardial infarction profoundly changed the direction of my professional life. During doctoral research at the University of Minnesota, I participated in data collection at the Mayo Clinic and was struck by the fact that more than 90% of those interviewed spontaneously attributed their cardiac event principally to their work. Participants with a previous history of cardiovascular disease had been excluded. Although this observation was neither a controlled epidemiological study nor evidence of causality, it generated a question that has remained central throughout my career: *can work become a form of invisible toxicity capable of damaging both physical and mental health?*

This question led to more than four decades of research on stress, health, work, organizational culture, and resilience, including a research collaboration in Montreal with Hans Selye and multidisciplinary work with André Arsenault (Montreal Institute of Cardiology) and other colleagues. Since then, the scientific evidence linking psychosocial working conditions and cardiovascular disease has expanded substantially. Contemporary estimates indicate that work-related diseases and injuries account for millions of deaths globally, while long working hours alone have been associated with hundreds of thousands of deaths from ischemic heart disease and stroke. At the same time, depression and anxiety impose an enormous global burden on workers and economies.

The central argument of this perspective is that the future of occupational health must move beyond treating stress after it becomes pathological. We need earlier diagnosis of chronic stress, greater attention to organizational sources of toxicity, and systematic redesign of work to enhance resilience and well-being.

Introduction

Occupational stress has become an important area of investigation at the intersection of occupational health, cardiovascular medicine, psychology, and organizational research. The working environment influences not only employees' professional performance but also their physical health, psychological well-being, and capacity to maintain sustainable functioning over time. Work-related factors such as excessive workload, limited decision-making authority, job insecurity, inadequate social support, organizational injustice, and prolonged working hours may contribute to persistent stress and adversely affect health.

Historically, occupational stress has often been examined through the individual's physiological and psychological responses to demanding circumstances. However, understanding chronic work-related stress requires consideration of the organizational conditions that generate and sustain these demands. Leadership practices, organizational culture, employment arrangements, interpersonal relationships, and technological developments can shape employees' experiences of stress and their opportunities for recovery. Consequently, occupational stress should be understood as a phenomenon arising from the interaction between individual characteristics and the psychosocial work environment.

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The relationship between psychosocial working conditions and cardiovascular health has received considerable attention in scientific literature. Previous systematic reviews have examined associations between occupational stress and cardiovascular disease, while research on the Job Demand–Control–Support model has explored how work demands, decision-making authority, and social support relate to psychological well-being [1,2]. Research on long working hours has further highlighted the potential health consequences of prolonged occupational exposure. Nevertheless, the strength and consistency of observed associations vary according to the exposure examined, the population studied, and the methodological characteristics of individual investigations.

The implications of occupational stress extend beyond cardiovascular outcomes. Depression, anxiety, exhaustion, and impaired well-being represent additional concerns for employees and organizations. These outcomes highlight the importance of examining occupational health through an integrated perspective that considers physical health, mental health, organizational conditions, and individual resilience.

The present review examines the development of research on occupational stress, its relationship with cardiovascular and mental health, and the organizational conditions that may contribute to chronic stress. It also considers the role of resilience, preventive occupational health strategies, and emerging transformations in the future of work.

The principal objectives are to: (1) examine the major conceptual approaches used to understand occupational stress; (2) synthesize the literature on psychosocial working conditions and cardiovascular and mental health outcomes; (3) discuss the importance of organizational culture and systemic approaches to stress prevention; and (4) identify research priorities for early risk identification, organizational resilience, and the development of healthier working environments.

By integrating these perspectives, the review seeks to clarify why occupational stress should not be addressed exclusively as an individual coping problem and why the design and management of work environments deserve greater attention in occupational health research.

Review approach and scope

This article is a narrative perspective informed by published research on psychosocial working conditions, cardiovascular health, mental health, occupational stress, and resilience. Its purpose is to connect the author's retrospective observation with established research and to discuss implications for occupational health practice and organizational prevention. It does not seek to calculate a new pooled estimate of risk or to present a systematic review.

The discussion considers research on psychosocial stressors at work, models of job demands and workplace support, studies of cardiovascular outcomes, research on the health implications of prolonged working hours, and publications from international public-health and occupational-health organizations. It also considers individual and organizational resilience, particularly their implications for workplace prevention and employee well-being.

The evidence is discussed thematically in relation to the article's principal arguments rather than as a set of directly comparable findings. Particular attention is given to the distinction between observed associations and demonstrated causation, the difference between individual coping and organizational prevention, and the limitations of applying population-level estimates to individual experiences. The author's historical observation is treated as contextual reflection rather than as an independent research dataset.

This article was prepared as a narrative perspective rather than through a documented systematic search with predefined inclusion and exclusion criteria. Accordingly, it should not be interpreted as an exhaustive or systematic assessment of the literature. Relevant studies may not have been identified or included, and the conclusions are limited to the evidence and perspectives discussed here.

The observation that changed my life

In the mid-1970s, while I was a doctoral student at the University of Minnesota, I participated in research in which data were collected informally at the Mayo Clinic. We interviewed almost 200 managers and other professionals who had survived their first heart attack.

One finding astonished me. More than 90% of those interviewed attributed the principal cause of their cardiac event to their work.

The participants ranged in age from approximately 27 to 77 years. Importantly, people with a previous history of cardiovascular problems had been excluded from the group. Many therefore considered themselves to have been in relatively good health before their cardiac event.

I understood that this was not, in itself, scientific evidence that work had caused their heart attacks. There was no experimental design, no matched control group, no validated stress scale, and no longitudinal causal analysis. It was an informal observation based on the subjective accounts of people who had experienced a major cardiovascular event.

But scientifically interesting questions do not always begin with definitive evidence. Sometimes they begin with an observation that refuses to go away. For me, the question was: *Could work itself become a form of toxicity?* Not a toxicity with a color, a smell, or a chemical signature, but an invisible toxicity capable of progressively affecting the human organism.

That question became a paradigm-changing moment in my life.

From "stress" to an invisible occupational toxicity

At the time, the concept of stress was already established, particularly through the pioneering work of Hans Selye. Yet much of the discussion of stress remained focused on physiological responses and on the individual's ability to cope with demanding circumstances.

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My early observation encouraged me to look in another direction. Perhaps we needed to understand not only how individuals respond to stress, but also how organizations create the conditions under which chronic stress develops.

That distinction has remained central to my work.

An employee does not experience workload, uncertainty, lack of control, interpersonal conflict, organizational injustice, job insecurity, or conflicting expectations in isolation. These experiences are embedded in organizational structures, leadership systems, cultures, relationships, and increasingly complex technological environments.

Stress can therefore become systemic.

The scientific literature has subsequently provided substantial support for the importance of psychosocial working conditions in cardiovascular health. Systematic reviews have reported associations between occupational psychosocial stress and cardiovascular morbidity and mortality, although the magnitude and consistency of associations vary across exposures, populations, and research designs [1,2].

The field has also demonstrated that the relationship is not reducible to a single dimension of work. Different research traditions have examined job demands and control, effort and reward, social support, insecurity, working time, and other psychosocial exposures.

I have never regarded one model as capable of explaining the entire phenomenon.

Nevertheless, over my years of collaboration with Hans Selye, André Arsenault, and colleagues, we developed an integrative approach that connected stress, self-perception, health, and work. This intellectual lineage subsequently evolved through research, doctoral dissertations, books, clinical and organizational applications, and diagnostic tools. It is one contribution among several important approaches to understanding occupational stress, but it has provided the conceptual foundation for much of my subsequent work.

Four decades later: The scale of the problem

The question that initially emerged from a small and informal observation now has a global context.

Cardiovascular disease remains the world's leading cause of death. According to the World Health Organization, ischemic heart disease remained the leading global cause of death in 2023, accounting for approximately 9.5 million deaths, or about 16% of all deaths worldwide (World Health Organization [3].

The occupational contribution is particularly striking.

WHO and the International Labour Organization estimated that in 2016 approximately 745,000 deaths from ischemic heart disease and stroke were attributable to exposure to long working hours-defined as working at least 55 hours per week. Their analysis estimated that approximately 479 million people, or about 9% of the global population, were working such hours in 2016. Compared with a 35–40-hour working week, exposure to 55 or more hours was associated with an estimated 17% higher risk of ischemic heart disease and a 35% higher risk of stroke [4].

These numbers are not simply statistics about working time. They are an indication that the organization of work can become a public-health issue.

More recent WHO/ILO work-related burden estimates place the overall global burden even more starkly. A global analysis of 2019 data estimated approximately 2.9 million deaths attributable to work, including about 2.58 million deaths from work-related diseases and 0.32 million from occupational injuries [5]. These estimates encompass multiple occupational hazards and should not be interpreted as deaths caused exclusively by psychosocial stress.

The mental-health burden is equally important.

WHO currently estimates that approximately 16% of working-age adults had a mental disorder in 2023. Depression and anxiety alone are estimated to result in approximately 12 billion lost working days every year, with an estimated global productivity cost of approximately US$1 trillion annually [6,7].

These numbers represent different phenomena and should not be added together. Nevertheless, taken together, they illustrate the extraordinary intersection between work, physical health, mental health, and economic performance.

The invisible toxicity of work is no longer merely a provocative metaphor. It has become a legitimate subject of public-health research.

From individual stress to organizational diagnosis

One of the most important lessons of my research journey is that stress should not automatically be understood as an individual weakness.

When an organization repeatedly generates excessive demands, insufficient recovery, low autonomy, poor recognition, interpersonal conflict, uncertainty, or a persistent mismatch between individual values and organizational practices, telling the individual simply to "manage stress" may be insufficient.

The question should also be: *What is happening in the system that is producing the stress?*

This is particularly important because people differ considerably in their responses to the same environment.

Two employees may face the same workload and react very differently. One may experience stimulation and growth; another may experience chronic threat and exhaustion. Individual resources, personality, previous experiences, social support, values, health, and perceived control all influence the response.

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Consequently, the appropriate unit of analysis is neither exclusively the individual nor exclusively the organization.

It is the interaction between the person and the context; this interaction has been a recurring theme throughout my research.

From stress management to resilience engineering

During the later stages of my career, the focus of my work increasingly shifted from understanding stress to developing ways of detecting chronic stress earlier and converting vulnerability into resilience.

This represents an important conceptual change. Traditional stress management often asks: *How can the individual cope better?* A more systemic approach asks: *What can the individual, the leader, and the organization change so that chronic stress is less likely to develop in the first place?*

The distinction is consequential. If an organization continually generates unhealthy conditions, teaching employees breathing exercises, mindfulness, time management, or relaxation techniques may help, but it does not remove the source of the problem.

Resilience should therefore not become another way of placing responsibility for organizational problems on individuals. Resilient people need resilient systems.

This principle has guided the development of diagnostic approaches and practical tools intended to identify sources of chronic stress and develop individualized and organizational responses. The current Stress2Resilience initiative (www.stress2resilience.com), for example, reflects an effort to translate decades of research into accessible diagnostic and action-oriented processes.

The objective is not to eliminate stress. Stress is part of life, and a certain amount of challenge can be motivating and adaptive. The objective is to recognize when challenge becomes chronic overload, when adaptation becomes exhaustion, and when an environment begins to undermine rather than support human functioning.

The future of work: A new layer of complexity

The problem is becoming more urgent because the nature of work is changing rapidly. Digitalization, artificial intelligence, remote and hybrid work, permanent connectivity, algorithmic management, geopolitical uncertainty, economic insecurity, demographic change, and the erosion of boundaries between work and private life are creating new configurations of psychosocial risk.

Some of these developments may improve well-being. Others may intensify pressure. The central challenge is therefore not to declare that technology is "good" or "bad," nor that modern work is inherently more stressful than work in the past. The challenge is to develop systems capable of detecting emerging risks before they become health crises.

This is why I created the Global Future of Work Foundation: to examine emerging transformations in work and society and to encourage intervention before new risks become deeply embedded.

The future of occupational health cannot be separated from the future of work.

Limitations of the article

This article has several limitations that should be considered when interpreting its arguments. First, the author's initial observation concerning individuals who experienced a first myocardial infarction is presented as a retrospective account. The available description does not establish a controlled sampling process, standardized data collection, or an appropriate comparison group. Consequently, the reported proportion of individuals attributing their cardiac events to work should not be interpreted as a population estimate or as evidence that occupational stress caused those events.

Second, the article brings together research and conceptual perspectives covering different exposures, outcomes, and populations. Findings from individual studies and international burden estimates may rely on different definitions, methods, and assumptions. They should therefore be interpreted within their original contexts rather than treated as directly comparable measures. The discussion does not itself establish a new pooled estimate or demonstrate a causal effect.

Third, the scope of the conclusions depends on the literature-selection process used to prepare the article. As this manuscript is a narrative perspective rather than a documented systematic review, relevant studies may not have been identified or evaluated comprehensively. The possibility of selection bias should therefore be acknowledged.

Finally, the article addresses a broad and evolving topic. Workplace practices, technologies, employment arrangements, and occupational-health evidence continue to change. The discussion should be understood as a synthesis and interpretation of the material within the stated scope, rather than an exhaustive assessment of every occupational stressor, health outcome, or preventive intervention.

Conclusion: From invisible toxicity to healthy systems

Looking back more than four decades, I now see my original observation differently. The most important outcome of that informal study was not the percentage of people who attributed their heart attack to work. That observation was never designed to establish causality and should not be interpreted as such.

Its importance was that it forced me to ask a question: *What if the organization of work can become a determinant of health?*

Since then, scientific evidence has become far more sophisticated. We now have epidemiological studies, systematic reviews, global burden estimates, physiological research, and increasingly sophisticated models of psychosocial risk. We also know that long working hours, certain psychosocial exposures,

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and poor working environments are associated with important cardiovascular and mental-health consequences.

Yet I believe we are still approaching the problem too late. Medicine has become extraordinarily good at diagnosing disease once it appears. Occupational health has become increasingly capable of identifying hazards once they are recognized. But the next frontier should be anticipatory health: identifying the conditions that are likely to generate chronic stress before they produce disease.

This requires a change in mindset. We should move:

- from treatment to prevention;
- from individual coping to system redesign;
- from measuring burnout to identifying its precursors;
- from reacting to illness to diagnosing risk;
- from resilience as an individual attribute to resilience as an organizational capability.

The ultimate objective is not a workforce that becomes exceptionally good at tolerating unhealthy environments. It is a workforce operating within environments that are designed to support sustainable human functioning.

This is particularly relevant to cardiovascular medicine. The heart is not an isolated biological organ disconnected from the social world. Human physiology is continuously influenced by the environments in which people live, work, sleep, relate, and recover. The boundaries between cardiovascular health, mental health, and organizational health are therefore considerably less rigid than our professional disciplines sometimes suggest.

After more than 45 years studying stress, I have come to a simple conclusion: We should not merely teach people how to survive toxic work. We should learn how to recognize and redesign the conditions that make work toxic.

The invisible toxicity of work may never have a color or an odor. But if it contributes to disease, it deserves to be detected, measured, prevented, and treated with the same seriousness that we apply to more visible health hazards.

The next generation of occupational and cardiovascular health research should therefore ask not only "What does work do to the heart?" but also:

"What kind of work allows the heart, and the whole person, to flourish?"

That, in my view, is the deeper challenge of the future of work.

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