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Technostress in Midlife: A Brain-Heart-Breath Framework for Mind-Body Medicine

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ABSTRACT

Technostress has emerged from increasing dependence on digital technologies and is characterized by information overload, multitasking, continuous connectivity, frequent interruptions, and rapid technological adaptation. Although technostress research has predominantly emphasized psychological, behavioral, and occupational outcomes, the physiological pathways linking persistent digital demands with cognitive and physiological regulation remain insufficiently characterized. This perspective proposes a Brain-Heart-Breath Framework that integrates cognitive load, autonomic and cardiovascular regulation, respiratory and CO2 physiology, cerebral hemodynamics, and Conservation of Resources theory. Within this framework, sustained digital demands are hypothesized to increase cognitive and physiological load and, when recovery is insufficient, contribute to dysregulation across interconnected brain, cardiovascular, and respiratory systems. Mind-body practices, including meditation, breathing practices, yoga-based movement, relaxation, and related behavioral strategies, are proposed as potential resource-restorative approaches that may influence these interconnected pathways. The framework distinguishes established physiological mechanisms from pathways that remain to be tested specifically in technostress. We propose a multimodal research agenda integrating cognitive assessment with heart rate variability, blood pressure, respiratory measures, end-tidal CO2, cerebral blood-flow measures, and cortical oxygenation. This framework provides a testable systems-level basis for investigating the physiological correlates of technostress and examining whether mind-body practices may support cognitive resilience and physiological adaptation in increasingly connected environments.

Keywords: Technostress; Cognitive Resilience; Brain-Heart-Breath; Sustained Attention; Mind-Body Practices

Abbreviations: ICTs: Information and Communication Technologies; HPA: Hypothalamic-Pituitary-Adrenal; COR: Conservation of Resources; ANS: Autonomic Nervous System; HRV: Heart Rate Variability; CBF: Cerebral Blood Flow; FNIRS: Functional Near-Infrared Spectroscopy; TCD: Transcranial Doppler Ultrasonography; SART: Sustained Attention to Response Task; EEG: Electroencephalography

Introduction

The rapid expansion of digital technologies has fundamentally transformed how individuals work, communicate, learn, and interact. Information and communication technologies (ICTs) have become indispensable for professional productivity, social connectivity, and access to information. However, increasing dependence on digital technologies has also introduced persistent demands associated with continuous connectivity, information overload, multitasking, rapid communication, and the need to adapt to evolving technological environments. These demands have contributed to the growing phenomenon of technostress, which is increasingly recognized as an important occupational and public health concern in the digital era. Technostress was initially conceptualized by Brod (1984) as a difficulty in adapting to new technologies and has subsequently evolved into a multidimensional construct encompassing the psychological and behavioral strain associated with technology use [1]. Contemporary models describe several technology-related stressors, including techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty [2]. The widespread use of smartphones, cloud-based platforms, artificial intelligence, social media, and digital communication systems has further blurred the boundaries between work and personal life.

Constant availability, frequent interruptions, and the simultaneous management of multiple digital platforms may increase cognitive and emotional burden while reducing opportunities for recovery [3]. A central cognitive demand of persistent digital engagement is the need to sustain goal-directed attention while continuously filtering competing information and switching between multiple streams of digital input. Notifications, interruptions, parallel information streams, and rapid task switching may repeatedly challenge attentional control and increase cognitive load [4]. Sustained attention is essential for maintaining goal-directed behavior over time, particularly when tasks require continuous monitoring and resistance to distraction. Prolonged exposure to such demands may increase cognitive effort, reduce opportunities for attentional recovery, and potentially contribute to attentional fragmentation and mental fatigue. Although digital technologies may enhance information access and productivity, persistent attentional demands may therefore represent an important pathway linking digital engagement with subjective technostress and reduced cognitive resilience.

Although digital technologies enhance productivity and connectivity, increased technology-related demands have been associated with burnout, work-family conflict, psychological distress, and technology-related health complaints [3,5,6]. Despite growing recognition of these consequences, research on technostress remains predominantly focused on psychological, behavioral, and organizational outcomes. Comparatively limited attention has been directed toward the biological mechanisms through which persistent digital demands may influence brain function, cardiovascular regulation, and respiratory physiology. This gap is important because chronic stress is not solely a psychological phenomenon. Persistent exposure to environmental demands can influence interconnected neural, autonomic, neuroendocrine, vascular, and respiratory systems. Evidence from stress neuroscience suggests that prolonged stress may alter cognitive control, autonomic regulation, hypothalamic-pituitary-adrenal (HPA) axis activity, cerebral blood flow, neurovascular function, and cardiovascular health [7,8]. Whether and how these interconnected pathways contribute specifically to technostress remains insufficiently understood.

Importantly, the physiological characterization of technostress remains substantially less developed than its psychological and organizational characterization. A recent systematic review of biomarkers in technostress identified physiological measures including cortisol, salivary α-amylase, heart rate variability, skin conductance, heart rate, and blood pressure, but also highlighted the relatively limited number of studies using biological measures to characterize technostress. This gap provides a rationale for moving toward multimodal assessment that can simultaneously characterize psychological experience and physiological regulation. Midlife is considered here as a theoretically relevant context rather than a uniquely vulnerable population. During this life stage, occupational responsibilities, family roles, caregiving demands, and other major life transitions may converge with changes in physical and psychological health and opportunities for recovery. Accordingly, midlife may provide an informative context in which cumulative digital demands and resource-recovery processes can be investigated [9]. The Conservation of Resources (COR) Theory provides a useful framework for understanding these converging demands. According to COR Theory, individuals strive to acquire, maintain, and protect resources such as time, energy, health, skills, and social support, while stress occurs when these resources are threatened, depleted, or insufficient to meet environmental demands [10].

In the context of midlife, continuous connectivity, information overload, multitasking, and rapid technological change may require sustained expenditure of cognitive, emotional, and physiological resources. When such demands persist without adequate opportunities for restoration, progressive resource depletion may increase vulnerability to stress-related outcomes and contribute to resource loss spirals [11]. COR theory provides a useful bridge between the psychosocial and physiological components of the proposed framework. Digital demands may consume resources such as attentional capacity, time, energy, sleep opportunity, and perceived control. When resource expenditure repeatedly exceeds opportunities for recovery or resource gain, a resource-loss cycle may develop. Understanding the neurophysiological consequences of this process is important for identifying objective markers of technostress and developing effective interventions. Within this resource-based framework, Mind-body practices may represent a potential resource-restorative approach because they integrate movement, breathing regulation, meditation, relaxation, and lifestyle practices.

Its potential to influence interconnected cognitive, autonomic, cardiovascular, and respiratory processes provides a rationale for considering mind-body practices within the proposed Brain-Heart-Breath framework. Emerging evidence suggests that yoga can support autonomic regulation, heart rate variability, stress reduction, cerebral circulation, and psychological well-being [12-15]. These multidimensional effects suggest that yoga may offer a resource-restorative approach to addressing the broader physiological consequences of persistent digital stress. In this perspective, we conceptualize technostress not merely as a psychological or occupational phenomenon but as a multidimensional process involving dynamic interactions among neural, cardiovascular, and respiratory systems. Drawing upon COR Theory, contemporary evidence from stress neuroscience and physiology, and insights from mind-body practices, a Brain-Heart-Breath Model of Technostress is proposed. The framework positions sustained attention as an important cognitive interface through which persistent digital demands may interact with neural, cardiovascular, and respiratory regulation. This framework provides a systems-level perspective on how persistent digital demands may contribute to cognitive and physiological dysregulation and identifies potential pathways through which mind-body practices may support recovery and resilience.

Neurophysiological Pathways of Technostress

Technostress extends beyond a psychological response to excessive technology use. Persistent digital demands, including continuous connectivity, frequent interruptions, multitasking, information overload, and rapid technological adaptation, may engage multiple physiological systems involved in stress regulation. Although direct neurophysiological evidence specific to technostress remains limited, findings from broader stress research provide a framework for understanding how prolonged digital demands may influence neural, autonomic, neuroendocrine, and inflammatory processes. The proposed neurophysiological pathways should therefore be interpreted at three levels:

1. Physiological mechanisms established in the broader stress literature;
2. Empirical observations reported in studies of technology-related stress; and
3. Mechanistic hypotheses that remain to be tested specifically in technostress.

This distinction is important because evidence for general stress physiology cannot automatically be interpreted as evidence for technostress-specific pathophysiology. A central pathway involves the autonomic nervous system (ANS). Digital environments frequently require sustained vigilance, rapid responses, and prolonged cognitive engagement, which may repeatedly activate sympathetic stress responses. While acute sympathetic activation is adaptive, persistent activation without adequate recovery may contribute to autonomic imbalance and reduced physiological flexibility. Technology-related stress has been associated with alterations in heart rate variability (HRV), suggesting that autonomic dysregulation may represent an important physiological correlate of persistent digital stress [16]. The hypothalamic-pituitary-adrenal (HPA) axis represents another important stress-responsive pathway. Technology-related overload and perceived time pressure may engage stress-responsive systems, including the hypothalamic-pituitary-adrenal axis. However, direct evidence demonstrating sustained HPA-axis dysregulation specifically attributable to technostress remains limited. Cortisol may therefore be considered a candidate physiological marker for future mechanistic studies rather than an established biomarker of technostress. Although short-term HPA-axis activation supports adaptation, prolonged activation may increase allostatic load and influence cognitive function, emotional regulation, sleep, and cardiovascular regulation [17].

The HPA axis interacts closely with autonomic mechanisms and may therefore contribute to sustained physiological arousal under persistent stress. Persistent digital engagement may also impose substantial demands on neural systems supporting sustained attention, working memory, and executive control. Continuous information streams, frequent interruptions, and repeated task switching may increase cognitive load and require sustained engagement of cognitive control networks. Prolonged cognitive effort may contribute to mental fatigue, attentional lapses, and reduced cognitive efficiency [18]. These effects are particularly relevant to sustained attention, which requires maintaining goal-directed processing while resisting competing information over time. However, direct evidence linking specific neural alterations to technostress remains limited and warrants further investigation. Beyond neural and neuroendocrine responses, persistent stress exposure is associated with inflammatory and oxidative processes that may influence brain and cardiovascular function. Persistent activation of stress-responsive systems may contribute to altered inflammatory signaling and neuroplasticity [19,20].

Although the direct contribution of these mechanisms to technostress remains insufficiently established, they represent plausible pathways through which persistent digital stress may influence broader physiological functioning. These pathways suggest that technostress may involve dynamic interactions among cognitive, autonomic, neuroendocrine, and inflammatory processes rather than an isolated psychological response. Persistent digital demands and inadequate recovery may progressively challenge the body's capacity to maintain adaptive regulation. These interacting mechanisms provide the neurophysiological foundation for examining how technostress may extend to cerebral hemodynamics, respiratory regulation, and cardiovascular function.

Cerebral Hemodynamics, Respiration, and Brain Health

The brain depends on tightly regulated cerebral blood flow (CBF) to ensure the continuous delivery of oxygen and nutrients required for cognitive and emotional functioning. This regulation involves dynamic interactions among neural activity, vascular responses, metabolic demands, and respiratory physiology. Evidence from chronic stress research suggests that persistent stress exposure may influence these processes, potentially affecting cerebral perfusion, cortical oxygenation, and neurovascular function. These pathways may be particularly relevant to technostress, given the sustained attention, information processing, and cognitive demands associated with persistent digital engagement. A central mechanism underlying cerebral function is neurovascular coupling, through which regional blood flow is adjusted to meet changes in neuronal activity. Increased neuronal activity triggers local vascular responses that support the delivery of oxygen and glucose to metabolically active brain regions [21]. Efficient neurovascular regulation is therefore essential for sustained attention, executive functioning, and cognitive flexibility. Chronic stress may influence vascular responsiveness and endothelial function, potentially affecting the capacity to maintain cerebral perfusion during prolonged cognitive demands [22].

Persistent digital engagement may impose substantial demands on neural systems involved in attention, working memory, and

executive control. Information overload, multitasking, sustained concentration, and rapid decision-making may increase cognitive demands and contribute to mental fatigue. Studies of cognitive workload have demonstrated increased prefrontal activation during demanding tasks, with prolonged engagement potentially contributing to reduced cognitive efficiency [23]. Although direct evidence linking technostress to altered neurovascular coupling remains limited, the relationship between sustained cognitive demands and cerebral hemodynamics warrants further investigation. Respiratory physiology represents another important regulator of cerebral circulation. Carbon dioxide (CO_2) strongly influences cerebrovascular tone: reductions in arterial CO_2 promote cerebral vasoconstriction and may decrease cerebral blood flow, whereas increased CO_2 promotes vasodilation [24]. Persistent stress may be associated with altered breathing patterns, including rapid or shallow breathing, which could influence CO_2 regulation and cerebral perfusion. However, whether such respiratory alterations occur consistently during technostress remains unclear.

This mechanism may be particularly relevant to prolonged digital engagement because sustained concentration, sedentary behavior, and screen-based work may alter breathing behavior and opportunities for physiological recovery. However, evidence directly linking digital engagement or technostress with clinically meaningful changes in breathing patterns, CO_2 levels, or cerebral perfusion remains limited. Investigating respiratory patterns alongside cerebral hemodynamics may therefore help determine whether altered respiratory regulation represents a measurable pathway linking technostress with cognitive functioning. Cerebral autoregulation provides an additional mechanism for maintaining relatively stable cerebral blood flow despite fluctuations in systemic blood pressure. Stress-related autonomic dysregulation and vascular alterations may influence this regulatory capacity, potentially altering the brain's ability to adapt to changing cognitive and physiological demands [24]. Neurovascular coupling, cerebral autoregulation, and respiratory regulation may represent important but underexplored pathways linking persistent digital stress with brain health. Advances in non-invasive neurophysiological techniques provide opportunities to investigate these mechanisms objectively.

Functional near-infrared spectroscopy (fNIRS) can assess cortical oxygenation and hemodynamic responses, whereas transcranial Doppler ultrasonography (TCD) provides measures of cerebral blood flow velocity and cerebrovascular reactivity [25,26]. Integrating these approaches with respiratory and autonomic measurements may help identify physiological signatures of technostress and clarify the relationship between persistent digital demands, cerebral circulation, and cognitive function. Cerebral hemodynamics and respiratory physiology provide a potential mechanistic bridge between persistent digital stress and brain function. These pathways also connect neural processes with systemic cardiovascular regulation, forming an important component of the proposed Brain-Heart-Breath framework.

Cardiovascular Consequences and Brain-Heart Interactions

The cardiovascular system is highly responsive to persistent stress and represents an important pathway through which sustained digital demands may influence physiological regulation. Repeated exposure to information overload, continuous connectivity, and technology-related time pressure may contribute to sustained physiological arousal. Although acute cardiovascular responses facilitate adaptation to immediate demands, persistent activation without adequate recovery may contribute to autonomic imbalance, altered vascular regulation, and reduced cardiovascular flexibility. The HRV provides a useful non-invasive marker of autonomic regulation and physiological adaptability. Reduced HRV is generally associated with diminished parasympathetic modulation and reduced capacity to adapt to changing demands [27]. Evidence from occupational and technology-related stress suggests that persistent stress exposure may be associated with lower HRV and reduced physiological recovery [28]. HRV may therefore represent a useful objective marker for investigating autonomic and cardiovascular correlates of technostress. Blood pressure regulation may also be influenced by persistent stress. Repeated sympathetic activation may increase vascular tone and peripheral resistance, contributing to transient elevations in blood pressure. With sustained exposure, alterations in autonomic and vascular regulation may contribute to changes in blood pressure variability and vascular function [29].

The hypothalamic-pituitary-adrenal (HPA) axis may further contribute through cortisol-mediated effects on inflammation, vascular function, and metabolic regulation [30]. Sleep disturbance represents an additional pathway linking persistent digital engagement with cardiovascular regulation. Continuous technology use and work-related digital demands may interfere with sleep duration and quality. Poor sleep can increase sympathetic activity, reduce HRV, elevate blood pressure, and impair physiological recovery [31]. Thus, disrupted sleep may represent an important pathway through which persistent digital demands interact with autonomic and cardiovascular regulation. Cardiovascular regulation is closely interconnected with brain function through bidirectional neural and physiological pathways. Brain regions involved in cognitive and emotional regulation, including the prefrontal cortex, amygdala, insula, and anterior cingulate cortex, contribute to the central autonomic network that regulates heart rate, blood pressure, and vascular function [32]. Persistent stress may alter these brain-heart interactions, while changes in cardiovascular regulation may, in turn, influence cerebral perfusion and cognitive performance.

This reciprocal relationship supports a systems-level view in which neural and cardiovascular processes are considered as interconnected components of technostress rather than isolated responses. In addition to direct physiological mechanisms, persistent digital engagement may be associated with sedentary behavior, reduced physical activity, disrupted sleep, and other lifestyle

changes that may influence cardiovascular regulation [33,34]. These direct and indirect pathways may interact over time, particularly in middle-aged adults experiencing multiple occupational and lifestyle demands. Taken together, autonomic regulation, blood pressure control, sleep, and brain-heart interactions represent interconnected pathways through which persistent digital demands may influence cardiovascular and cognitive functioning.

Mind-Body Practices as Resource-Restorative Strategies

The multisystem nature of technostress requires approaches that extend beyond the management of psychological symptoms. Within the framework of COR Theory, effective mind-body practices may support recovery, restore depleted resources, and enhance adaptive capacity. Mind-body practices, including āsana, prāṇāyāma, meditation, relaxation, and related self-regulatory practices, may influence interconnected neural, cardiovascular, respiratory, and psychological processes involved in stress adaptation. Meditation and mindfulness-based practices may provide a behavioral strategy for strengthening attentional regulation and reducing stress reactivity. By cultivating sustained attention, present-moment awareness, and emotional regulation, these practices may support cognitive control and reduce perceived stress. Evidence from a randomized pilot study in adults with low back pain demonstrated that a 4-week yoga-based relaxation intervention improved sustained attention, assessed using the Sustained Attention to Response Task (SART), alongside reductions in pain-related disability. Improvements in sustained attention were positively associated with reductions in pain, suggesting that yoga-based relaxation may support attentional performance through multiple interacting psychological and behavioral pathways [35]. Neuroimaging research suggests that meditation influences brain regions involved in attention and stress processing, including the prefrontal cortex, anterior cingulate cortex, insula, and amygdala [36-41].

These effects may support cognitive resilience and the capacity to regulate responses to persistent digital demands. From a brain perspective, meditation and mindful practices may help counteract the attentional fragmentation associated with continuous notifications, information overload, and multitasking. By cultivating sustained attention, present-moment awareness, and emotional regulation, these practices may support cognitive control and reduce perceived stress. Neuroimaging research suggests that meditation influences brain regions involved in attention and stress processing, including the prefrontal cortex, anterior cingulate cortex, insula, and amygdala. These effects may support cognitive resilience and the capacity to regulate responses to persistent digital demands. From a heart perspective, mind-body practices may promote autonomic balance and cardiovascular recovery. Evidence from yoga-based interventions suggests enhanced vagal modulation, improved HRV, reduced resting heart rate, and greater parasympathetic activity [42]. By facilitating physiological recovery, these effects may help counteract persistent sympathetic activation associated with stress. Mind-body practices may also influence broader cardiovascular pathways through changes in vascular function, sleep, and stress regulation.

From a breath perspective, breathing practices may represent an important pathway within the context of technostress. Persistent stress may be associated with altered breathing patterns, while slow breathing practices may promote diaphragmatic breathing, improve respiratory efficiency, and enhance vagal activity [43,44]. Because respiratory patterns influence CO_2 regulation and cerebrovascular tone, breathing regulation may also influence cerebral perfusion and cortical oxygenation [45]. However, the specific effects of breathing practices on these pathways in individuals experiencing technostress require direct investigation. Mind-body practices may also influence broader biological processes associated with stress. Evidence from yoga-based interventions suggests potential effects on cortisol, inflammatory activity, oxidative stress, psychological well-being, and sleep quality [46,47]. These multidimensional effects are consistent with the COR Theory concept of resource gain, whereby interventions may strengthen psychological and physiological resources and enhance the capacity to cope with future stressors. Thus, mind-body practices provide a plausible resource-restorative approach for addressing the multisystem consequences of technostress. Their potential to influence interconnected brain, heart, and breath pathways provides the conceptual basis for the proposed Brain-Heart-Breath Model of Technostress, presented in the following section.

A Brain-Heart-Breath Model of Technostress

The preceding sections suggest that technostress extends beyond a psychological response to digital overload and may be understood as a multisystem phenomenon involving interconnected neural, cardiovascular, and respiratory processes. Existing models of technostress have primarily emphasized organizational, behavioral, and psychological outcomes, with comparatively limited attention to the biological pathways through which persistent digital demands may influence cognitive and physiological functioning. To address this gap, we propose a Brain-Heart-Breath Model of Technostress, integrating these interconnected systems within the framework of resource depletion, stress regulation, and recovery, as illustrated in Figure 1. Persistent digital demands may increase cognitive and physiological resource demands and may contribute to interconnected changes in neural, autonomic/cardiovascular, and respiratory regulation, with potential consequences for cognitive and physiological functioning. Yoga-Based Lifestyle Medicine is proposed as a multimodal, resource-restorative approach that may support regulation across these interconnected systems. The framework represents hypothesized pathways and potential interactions rather than established causal relationships.

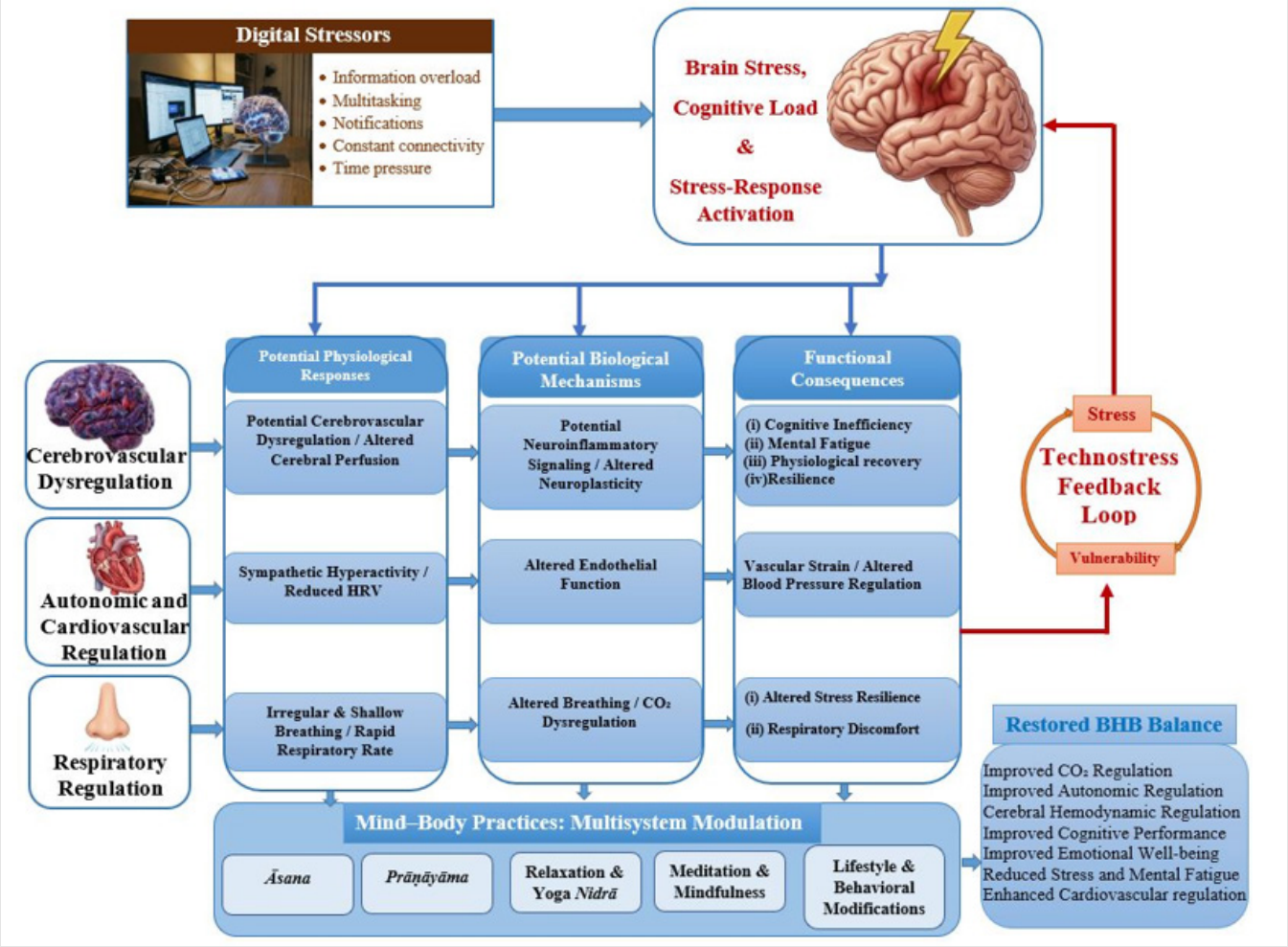


Figure 1: Conceptual Brain-Heart-Breath Framework of Technostress.

The model begins with persistent digital stressors, including information overload, multitasking, continuous connectivity, frequent notifications, virtual meetings, and technology-driven performance demands. These stressors impose sustained demands on attention and executive control and may increase perceived uncertainty and time pressure. Prolonged exposure, particularly in the absence of adequate recovery, may progressively deplete cognitive, emotional, and physiological resources, consistent with the COR framework. At the brain level, persistent digital demands may engage neural systems involved in sustained attention, executive control, and stress processing. Sustained cognitive workload and repeated interruptions may contribute to mental fatigue, attentional lapses, and reduced cognitive efficiency [48,49]. These cognitive and stress-related processes are closely linked to autonomic and neuroendocrine regulation and to the central autonomic network, providing a pathway through which neural processes may influence cardiovascular function. At the heart level, repeated stress activation may shift physiological regulation toward sympathetic predominance and reduced parasympathetic recovery. Alterations in heart rate variability, blood pressure regulation, and vascular function may reflect changes in cardiovascular flexibility and physiological strain.

Importantly, cardiovascular function also influences the brain through effects on cerebral perfusion and vascular regulation, creating a bidirectional relationship between neural and cardiovascular processes. The breath represents an important intermediary within this framework. Stress-related changes in breathing may influence ventilation and CO_2 regulation, which in turn can affect cerebrovascular tone and cerebral blood flow. Reductions in arterial CO_2 can promote cerebral vasoconstriction, providing a plausible physiological pathway linking respiratory regulation with cerebral hemodynamics and cognitive functioning. However, whether persistent digital demands consistently produce such respiratory

and CO_2-related changes remains unclear and requires direct investigation. Within the proposed model, respiratory regulation therefore represents a potential interface linking stress-related neural activation with cerebral and cardiovascular processes. The model therefore emphasizes dynamic and bidirectional interactions among the brain, heart, and breath. Persistent digital demands may initiate a cycle in which sustained cognitive load and stress activation interact with autonomic and respiratory regulation, while changes in cardiovascular and cerebral function may, in turn, influence cognitive efficiency and resilience [48-52]. This potentially self-reinforcing process may increase vulnerability to subsequent stressors and is conceptually consistent with the resource loss spirals described in COR Theory.

The Brain-Heart-Breath Model also provides a framework for considering potential intervention pathways. Mind-body practices may simultaneously target multiple components of the proposed system. Meditation may support sustained attention and emotional regulation; breathing practices may influence respiratory regulation and autonomic reactivity; and physical practices and broader lifestyle behaviors may support cardiovascular regulation, sleep, and stress recovery. Through these potentially complementary effects, mind-body practices may facilitate resource restoration and enhance physiological adaptability. The proposed model is intended as a conceptual framework rather than a definitive causal account. Its pathways require empirical validation using multimodal assessments integrating cognitive, autonomic, cardiovascular, respiratory, and neurophysiological measures. Potential markers include sustained-attention and cognitive-performance measures, HRV, blood pressure variability, end-tidal CO_2, cerebral blood flow velocity, and cortical oxygenation. Integrating these measures may help identify physiological signatures of technostress and empirically test the interactions proposed within the model. In summary, the Brain-Heart-Breath Model conceptualizes technostress as a dynamic interaction among cognitive, neural, cardiovascular, and respiratory processes.

By integrating stress physiology with COR Theory and mind-body practices, the model provides a systems-level framework for investigating how persistent digital demands may influence cognitive resilience and physiological regulation.

Future Directions

As digital technologies continue to transform modern life, technostress may become an increasingly important determinant of cognitive and physiological well-being. Future research should move beyond self-report measures and organizational outcomes to investigate the underlying biological mechanisms using an integrative, multimodal approach. A key priority is the identification of objective physiological markers of technostress. Future studies could combine heart rate variability, blood pressure variability, electroencephalography (EEG), functional near-infrared spectroscopy (fNIRS), transcranial Doppler ultrasonography (TCD), capnography, and cognitive assessments. Simultaneous evaluation of autonomic function, cerebral perfusion, cortical oxygenation, respiratory physiology, and cognitive performance may help test and refine the proposed Brain-Heart-Breath Model. Longitudinal studies are needed to determine whether persistent digital stress is associated with changes in cognitive functioning, cardiovascular regulation, and physiological resilience, particularly among middle-aged adults. Randomized controlled trials may also evaluate whether mind-body practices can reduce technostress and improve objective cognitive and physiological outcomes.

Advances in wearable sensors, artificial intelligence, and digital health technologies may enable real-time monitoring of stress-related physiological responses and personalized interventions. Integrating these technologies with mind-body practices could facilitate early identification of individuals experiencing persistent stress and support scalable strategies for enhancing cognitive resilience, physiological recovery, and adaptive capacity in increasingly digital environments.

Conclusion

Technostress may be understood as a multidimensional response to persistent digital demands that extends beyond psychological and occupational experiences to potentially involve cognitive, autonomic, cardiovascular, and respiratory processes. Within the Conservation of Resources framework, sustained digital demands may increase the expenditure of cognitive, emotional, and physiological resources, particularly when opportunities for recovery are insufficient. The proposed Brain-Heart-Breath Framework integrates these processes and identifies sustained attention, autonomic and cardiovascular regulation, respiratory, CO_2 physiology, and cerebral hemodynamics as interconnected pathways through which persistent digital demands may influence cognitive and physiological functioning. Mind-body practices, including meditation, breathing practices, yoga-based movement, relaxation, and related behavioral strategies, are proposed as potential resource-restorative approaches that may act across these interconnected systems. The framework does not assume that these pathways are established specifically for technostress; rather, it integrates evidence from stress physiology, technology-related stress, and mind-body research to generate testable mechanistic hypotheses.

Future longitudinal, experimental, and controlled intervention studies using multimodal assessments are needed to determine whether the proposed Brain-Heart-Breath interactions characterize technostress and whether mind-body practices can modify these processes. This framework therefore provides a systems-level foundation for investigating technostress and for developing integrative approaches to cognitive resilience, physiological recovery, and adaptation in increasingly connected environments.

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Declaration of Conflicting Interests

The author declares that there is no conflict of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Ethics Statement

Not applicable.

Informed Consent

Not applicable.

Artificial Intelligence Disclosure

Google Gemini (Gemini Pro) was used to generate selected illustrative components of Figure 1. The generated components were subsequently reviewed, edited, and assembled by the authors to create the final representative illustration. No generative AI tool was used to generate or modify research data, results, analyses, or conclusions. The author takes full responsibility for the accuracy, originality, and integrity of the final figure and the manuscript.

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