

Review Article

Digital Fatigue and Orthopedic Injuries: The Postural Burden of the Digital Era - A Narrative Review

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Prolonged screen exposure and sedentary behaviors are increasingly associated with musculoskeletal dysfunction in the digital era. This narrative review synthesizes current literature examining the relationship between digital behavior and orthopedic pathology, outlining proposed mechanisms, clinical presentations, and preventive strategies. Searches of PubMed, Google Scholar, and ScienceDirect (2000–2025) identified clinical, biomechanical, and epidemiologic evidence related to posture-associated musculoskeletal disorders. Sustained screen use and poor ergonomics are associated with cumulative strain on the cervical, thoracic, and lumbar spine. Proposed physiologic mediators, including muscle fatigue, altered proprioception, and altered spinal loading

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patterns, may contribute to neck pain, shoulder impingement, carpal tunnel syndrome, and lumbar strain. These conditions are commonly reported among students, remote workers, and healthcare professionals. Interventions focused on ergonomic modification, postural re-education, and osteopathic or physical rehabilitation demonstrate improvements in pain and functional outcomes in selected populations. Although screen-related biomechanical strain is increasingly prevalent, additional longitudinal research is needed to clarify causality and long-term orthopedic implications. Early preventive strategies may help mitigate chronic musculoskeletal dysfunction.

INTRODUCTION

The proliferation of smartphones, laptops, and virtual workstations has substantially altered daily movement patterns and postural behaviors. With average daily screen time increasing across multiple age demographics, clinicians increasingly encounter “digital fatigue,” a term used to describe physical, cognitive, and visual strain associated with prolonged device engagement (Devi and Singh 2023). This phenomenon has been linked to behavioral patterns characterized by sustained forward head positioning, rounded shoulders, and prolonged static sitting (Jung et al. 2016).

Socioeconomic shifts, including remote work and virtual education, have further increased these postural demands (Oakman et al. 2020). Adults now average more than seven hours of daily screen time, frequently blurring the boundaries between work and rest (Toko et al. 2025). Emerging epidemiologic studies suggest associations between prolonged screen exposure and musculoskeletal or postural alterations; for example, a 2025 cross-sectional study involving 1,231 adolescents reported an association between excessive after-school screen time and suspected scoliosis (Chen et al. 2025). Concurrent increases in neck pain, carpal tunnel symptoms, and forward head posture have drawn greater attention to the orthopedic implications of screen-based lifestyles (Green 2008; Waersted et al. 2010). However, the current body of evidence spans multiple disciplines, including occupational health, biomechanics, rehabilitation, and public health, and remains heterogeneous in both methodology and outcome measures. This narrative review synthesizes available evidence regarding digital fatigue, posture-related biomechanical adaptations, and musculoskeletal injury risk while highlighting opportunities for clinical prevention and future research.

METHODS

LITERATURE SEARCH STRATEGY

This narrative review integrates behavioral, physiologic, biomechanical, and orthopedic perspectives on screen-based musculoskeletal disorders. A literature search was conducted using PubMed, Google Scholar, and ScienceDirect to identify peer-reviewed studies evaluating digital ergonomics, screen exposure, posture-related adaptations, and musculoskeletal outcomes. Search terms included combinations of “digital fatigue,” “screen time and posture,” “forward head posture,” “sedentary behavior,” and “muscu-

loskeletal pain.” Reference lists of relevant articles were additionally reviewed to identify supplemental studies.

STUDY SELECTION

Eligible studies included English-language clinical studies, observational cohorts, biomechanical analyses, randomized or interventional studies, systematic reviews, and narrative reviews published between January 2000 and March 2025. Greater emphasis was placed on literature published between 2015 and 2025 to reflect recent changes in remote work, virtual education, and mobile technology use. Studies were included if they examined biomechanical or physiologic adaptations associated with prolonged digital device use or evaluated musculoskeletal outcomes related to screen-based behaviors. Non-human studies, opinion articles, and occupational studies unrelated to digital device exposure were excluded.

Given the narrative design of this review, studies were synthesized qualitatively rather than through formal meta-analytic methods. Evidence was interpreted within the context of study design and methodological limitations, recognizing that much of the available literature is cross-sectional and demonstrates association rather than causation. The synthesis aimed to contextualize proposed relationships between digital exposure, postural behavior, and musculoskeletal symptoms while highlighting areas requiring further longitudinal investigation. Because this review includes heterogeneous study designs ranging from experimental biomechanics to epidemiologic analyses, findings should be interpreted within the context of varying evidence strength. No formal quality assessment tool was applied because of the narrative design of the review.

REVIEW

TRANSLATIONAL MECHANISMS: FROM DIGITAL BEHAVIOR TO PHYSICAL INJURY

Habitual screen engagement has been associated with biomechanical and postural adaptations that may contribute to musculoskeletal strain (Jung et al. 2016; Green 2008; Waersted et al. 2010). Prolonged device use is commonly linked to sustained neck flexion, rounded shoulders, and static sitting positions, which may increase cervical and lumbar loading. A 2021 study reported that children using smartphones for more than four hours daily demonstrated significantly greater head and neck flexion angles compared with shorter-duration users (Abdel-Aziem et al. 2022). At the physiologic level, prolonged static postures have been

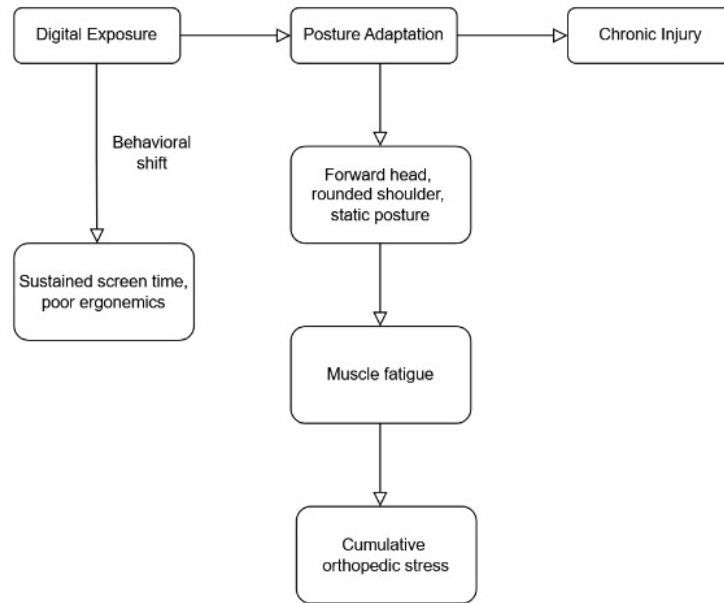


Figure 1. Conceptual model illustrating proposed pathways linking digital exposure, postural behavior, physiologic adaptation, and musculoskeletal symptoms. These relationships are supported by mixed levels of evidence and should not be interpreted as a proven linear causal pathway.

associated with muscle fatigue, altered proprioception, and changes in spinal loading mechanics. Electromyographic studies demonstrate that individuals with forward head posture exhibit reduced activation of deep neck flexors alongside compensatory overactivation of superficial cervical musculature (Lee et al. 2015a). These neuromuscular patterns may contribute to altered stabilizer recruitment and broader kinetic-chain dysfunction, although longitudinal evidence establishing causality remains limited. Interventions targeting posture modification, including standing desk implementation, have shown improvements in spinal alignment, perceived discomfort, and muscle fatigue in selected populations (Lee and Lee 2024).

PATHOPHYSIOLOGY AND BIOMECHANICS OF DIGITAL POSTURE-RELATED INJURIES

Posture-related musculoskeletal complaints in the digital era are commonly associated with sustained, low-grade mechanical loading rather than acute trauma (Devi and Singh 2023; Green 2008). Repetitive or prolonged postural behaviors may contribute to chronic biomechanical adaptations within the musculoskeletal system.

Cervical Spine: Forward head posture shifts the head's center of gravity anteriorly, potentially increasing compressive and shear forces across the lower cervical spine, particularly at C5–C7. Repetitive loading of the levator scapulae and upper trapezius, combined with reduced deep neck flexor activation, has been associated with altered cervical mechanics and may contribute to degenerative changes over time (Almutairi et al. 2024).

Thoracic and Lumbar Spine: Sustained flexion during prolonged sitting may reduce lumbar lordosis and alter the spine's load-distribution capacity. These postural adaptations are associated with increased paraspinal muscle fatigue and altered spinal loading mechanics. Biomechanical modeling studies suggest that slumped postures may increase stress on the annulus fibrosus and nucleus pulposus (Tsantili et al. 2022).

Shoulder Complex and Upper Limb: Prolonged typing and screen viewing are frequently associated with scapular protraction and altered scapulohumeral mechanics. These changes may reduce subacromial space and contribute to shoulder discomfort, impingement symptoms, or rotator cuff strain in susceptible individuals (Cho et al. 2023).

Neuromuscular Adaptations: These regional postural changes are often described within the framework of Upper Crossed Syndrome (tight pectorals and upper trapezius with weak deep neck flexors and rhomboids) and Lower Crossed Syndrome (tight hip flexors and lumbar extensors with weak abdominals and gluteals). Kinematic and electromyographic studies report delayed stabilizer activation and altered proprioceptive control in individuals with chronic postural dysfunction, although the long-term clinical significance of these findings remains incompletely understood (De Carvalho and Callaghan 2022).

EPIDEMIOLOGY OF DIGITAL-RELATED PAIN

Digital posture-related musculoskeletal symptoms are commonly reported in both occupational and academic settings. Observational studies suggest that between 50% and 70% of office workers report neck or shoulder discomfort

associated with prolonged computer or device use (Green 2008). Among students, musculoskeletal pain, particularly involving the cervical region, has been reported at similarly high rates (Almutairi et al. 2024; Kett et al. 2021; El Shunnar et al. 2024).

The transition to remote work during the COVID-19 pandemic was associated with increased screen exposure and reduced ergonomic optimization across multiple professions (Lucka et al. 2024). Similar trends have been observed in pediatric populations, where prolonged screen exposure has been associated with increased reports of neck and shoulder discomfort (Janwantanakul et al. 2008).

Certain populations, including students, healthcare professionals, and information technology workers, may be at elevated risk because of prolonged daily screen exposure and repetitive postural loading (Walankar et al. 2021). Healthcare professionals represent a particularly relevant high-risk group because of prolonged electronic medical record use, telehealth demands, and extended static postures during clinical and administrative tasks. In addition to individual health effects, these symptoms may contribute to reduced productivity, increased healthcare utilization, and broader occupational burden (Hoy et al. 2014).

CLINICAL MANIFESTATIONS OF DIGITAL FATIGUE

Clinical presentations range from transient discomfort to chronic musculoskeletal pain syndromes. Symptoms commonly localize to regions subjected to prolonged static loading or repetitive postural stress (Kazeminasab et al. 2022). Frequently reported symptoms include neck stiffness, trapezius tenderness, and occipital headaches (Tsan-tili et al. 2022).

Forward head posture has been associated with increased loading across the lower cervical spine and may contribute to referred pain involving the shoulders or upper thoracic region (Rahimian et al. 2024). In more severe cases, foraminal narrowing and cervical irritation may produce radicular symptoms such as paresthesia or upper-extremity weakness (Lee et al. 2015b).

The shoulder complex may also be affected through repetitive reaching and prolonged forward-leaning postures, which can alter scapulohumeral rhythm and contribute to impingement-related symptoms (Spanhove et al. 2021). Lower-back discomfort has similarly been associated with sustained sitting postures, reduced lumbar lordosis, and diminished core activation (De Carvalho and Callaghan 2022).

Distally, poor wrist positioning during keyboard use has been linked to carpal tunnel symptoms (Al Shahrani et al. 2019), while repetitive thumb motion during smartphone use may contribute to De Quervain's tenosynovitis (Banadaki et al. 2024). Prolonged sitting with limited lower-extremity activation may additionally contribute to hip flexor tightness and gluteal inhibition, potentially influencing broader postural mechanics (Tsan-tili et al. 2022).

DIAGNOSTIC AND ASSESSMENT TOOLS

Clinical evaluation begins with visual postural assessment to identify deviations from neutral alignment, including forward head carriage, shoulder asymmetry, and pelvic tilt (Vieira et al. 2019). This is followed by range-of-motion testing and palpation to identify areas of muscular tension or myofascial tenderness. Quantitative tools, including digital photogrammetry, can quantify angular postural deviations (Marimon et al. 2023), while surface electromyography (EMG) may identify altered muscle recruitment profiles (Nishikawa et al. 2022).

Validated patient-reported outcome measures, such as the Nordic Musculoskeletal Questionnaire (NMQ), Neck Disability Index (NDI), and Visual Analog Scale (VAS), are commonly used to assess pain and functional impairment. Reduced craniovertebral angle measurements have been associated with higher NDI and VAS scores (Subbarayalu and Ameer 2017). Imaging modalities, including radiographs, magnetic resonance imaging (MRI), and ultrasound, are generally reserved for persistent or severe presentations to evaluate disc pathology, neural compression, or tendinopathy.

MANAGEMENT AND PREVENTION OF DIGITAL FATIGUE AND INJURIES

Effective management strategies integrate ergonomic modification, rehabilitation, manual therapy, and behavioral interventions (Devi and Singh 2023; Cho et al. 2023). Proper workstation setup—including monitor positioning at eye level, neutral wrist alignment, lumbar support, and appropriate lower-extremity positioning—may help reduce prolonged static spinal loading (Lee et al. 2021). Sit-stand workstations have also been associated with improvements in circulation, posture variability, and perceived discomfort. The “20-20-20” rule (looking 20 feet away for 20 seconds every 20 minutes) encourages periodic movement and may help reduce sustained muscular strain (Radas et al. 2013).

Rehabilitation approaches frequently focus on postural re-education through interventions such as chin-tuck exercises and scapular stabilization training. Stretching tight anterior musculature while strengthening weakened posterior stabilizers may help improve postural mechanics and functional alignment (Ruivo et al. 2017; Argyrou et al. 2025). Osteopathic manipulative treatment (OMT) and physical therapy modalities, including myofascial release and muscle energy techniques, may complement active rehabilitation programs. Combined manual therapy and stabilization exercises have demonstrated improvements in neck pain and forward head posture in selected patient populations (Fathollahnejad et al. 2019).

Wearable posture-monitoring devices are emerging as adjunctive tools for behavioral feedback and ergonomic awareness, although adherence and long-term efficacy remain variable (Figueira et al. 2024). At the institutional level, workplace ergonomics programs and school-based posture education initiatives have been associated with re-

ductions in musculoskeletal symptom burden (Santos et al. 2025).

LONG-TERM ORTHOPEDIC IMPLICATIONS

Persistent postural strain and prolonged sedentary behavior may contribute to chronic musculoskeletal dysfunction over time. Forward head posture and sustained cervical loading have been associated with degenerative cervical findings in observational and biomechanical studies (Hong et al. 2021). Similarly, prolonged lumbar flexion may contribute to altered spinal mechanics and chronic low-back discomfort (Donnally et al. 2025).

Some authors have proposed that chronic postural maladaptations may influence broader kinetic-chain mechanics, including compensatory changes involving the pelvis, hips, and lower extremities (Cho et al. 2023). However, longitudinal evidence directly linking digital posture behaviors to these downstream orthopedic outcomes remains limited.

Chronic musculoskeletal discomfort may additionally contribute to sleep disruption, fatigue, and psychosocial stress, factors that can amplify pain perception and disability. Proposed mechanisms include central sensitization and neuroinflammatory pathways, although these relationships remain incompletely characterized in the context of digital fatigue specifically (Ji et al. 2018). These findings underscore the importance of early ergonomic and rehabilitative interventions aimed at reducing cumulative musculoskeletal strain (Kazeminasab et al. 2022).

DISCUSSION

Modern digital behaviors appear to be associated with observable changes in postural habits and musculoskeletal symptom patterns (Table 1). Prolonged screen exposure and suboptimal ergonomics have been linked to chronic, low-grade mechanical stress involving the cervical spine, shoulders, and lumbar region (Mahmoud et al. 2019). Over time, repetitive postural loading may contribute to muscular imbalance, discomfort, and functional limitation in susceptible individuals (Lee and Son 2025). Psychological and behavioral factors, including attention fatigue, stress, and reduced movement variability, may further influence symptom severity and pain perception (Devi and Singh 2023).

The orthopedic and public health implications of these trends may be substantial, particularly given the increasing prevalence of chronic musculoskeletal complaints and associated healthcare utilization (Mahmoud et al. 2019). Current management strategies are often reactive rather than preventive. Although ergonomic and rehabilitative interventions demonstrate promising short-term benefits, high-quality longitudinal intervention studies remain limited. A more comprehensive approach may involve integrated prevention models incorporating ergonomic redesign, structured movement breaks, postural education, and digital health literacy (Gorce and Jacquier-Bret 2023). Emerging technologies, including AI-assisted posture monitoring and virtual rehabilitation platforms, represent promising adjunctive tools for improving ergonomic awareness and fa-

cilitating remote musculoskeletal rehabilitation, although additional long-term outcome data are needed (Nilmar et al. 2025).

LIMITATIONS AND FUTURE DIRECTIONS

This narrative review has several limitations. Much of the current literature on digital fatigue and posture-related musculoskeletal symptoms consists of cross-sectional or observational studies, limiting the ability to establish causal relationships. Additionally, variability in study populations, exposure definitions, ergonomic assessments, and outcome measures contributes to substantial methodological heterogeneity, making direct comparisons across studies difficult. The absence of a universally accepted definition of “digital fatigue” further complicates standardization and interpretation of findings. Many proposed biomechanical and physiologic mechanisms are supported primarily by experimental or associative evidence rather than longitudinal clinical data. As a result, the long-term orthopedic consequences of sustained digital device use remain incompletely characterized.

Future research would benefit from prospective longitudinal studies incorporating objective biomechanical assessment tools, including motion analysis, surface electromyography (EMG), wearable posture-monitoring systems, and advanced imaging modalities, to better evaluate musculoskeletal adaptations over time. Additionally, the development and validation of standardized assessment frameworks, such as a potential Digital Posture Index integrating biomechanical metrics with patient-reported symptom measures, may help improve consistency across future investigations.

CONCLUSION

Prolonged screen exposure and sustained postural behaviors are increasingly associated with muscular imbalance, joint strain, and musculoskeletal discomfort in the digital era. Although the long-term orthopedic consequences of these behaviors require further longitudinal investigation, current evidence suggests that repetitive postural loading and poor ergonomics may contribute to reduced functional capacity and chronic pain syndromes in susceptible populations. Many of these effects may be modifiable through preventive strategies such as ergonomic optimization, structured movement, targeted rehabilitation, and postural education. Clinicians should consider posture within the broader context of behavior, repetitive mechanical loading, occupational demands, and environmental factors when evaluating patients with digital-related musculoskeletal complaints. As screen-based activities continue to expand across occupational, educational, and healthcare settings, proactive musculoskeletal prevention and early intervention may play an increasingly important role in reducing symptom burden and improving long-term functional outcomes.

Table 1. Summary of studies evaluating digital exposure, posture mechanics, and musculoskeletal health outcomes.

Study / Year	Population & Design	Digital Exposure / Postural Factor	Region / Mechanism	Key Outcomes	Takeaway
Devi et al., 2023	Review	Excessive screen time	Physical and mental strain	Screen overuse leading to physical and mental health decline	Excessive digital usage has been associated with adverse wellbeing outcomes
Jung et al., 2016	Experimental n=25 adults	Smartphone usage time	Respiratory and cervical posture	Longer use worsened posture and respiratory function	Long-term smartphone use has been associated with altered posture and respiratory mechanics
Oakman et al., 2020	Rapid review	Work from home digital exposure	Ergonomics and psychosocial stress	Home-based digital work has been associated with increased musculoskeletal strain	Work-from-home setups require ergonomic support
Toko et al., 2025	Survey study n=300 Diverse age groups	General digital posture habits	MSK consequences of bad posture	High prevalence of poor posture linked to pain	Poor posture is common in digital age
Chen et al., 2025	Cross-sectional, n=1,231 adolescents	Screen time and low physical activity	Spinal posture	High screen time leading to increased scoliosis risk	Youth screen time may influence spinal posture and development
Green, 2008	Review	Computer use	Neck strain mechanisms	Computer work has been associated with neck pain	Early recognition prevents chronicity
Waersted et al., 2010	Systematic review	Computer work duration	Neck and upper extremity load	Repetitive digital tasks associated with increased MSK symptom burden	Digital ergonomics essential
Abdel-Aziem et al., 2022	Observational, n=34 Elementary school male children	Smartphone viewing posture	Head and neck flexion	Long screen viewing worsens craniovertebral angle	Children may be particularly susceptible to posture-related adaptations
Lee et al., 2015	Experimental, Young adults n=20	Forward head posture	Neck flexor and extensor activation	FHP alters muscle activation patterns	Muscle imbalance may contribute to neck pain
Lee & Lee, 2024	Experimental Adults with FHP n=24	Standing desk use	CVA, muscle fatigue	Standing desk improved posture and discomfort	Standing workstations beneficial
Almutairi et al., 2024	Cross-sectional, University students n=263	Screen time	Neck and visual strain	Higher screen time linked with neck pain	Students major risk group
Tsantili et al., 2022	Review	Text neck mechanisms	Cervical flexion strain	Text neck linked to chronic cervical pain	Smartphone posture has been associated with neck strain
Cho et al., 2023	Finite element model	Slumped sitting	Lumbar discs	Slumped posture increases disc stress	Lumbar flexion may contribute to degenerative loading patterns
De Carvalho & Callaghan, 2022	Experimental, adults n=20	Prolonged sitting	Lumbar biomechanics	Spinal manipulation improved discomfort	Interventions reduce sitting strain
Kett et al., 2021	Experimental Biomechanics study, Adolescents n=16	Sitting posture types	Low back muscle stiffness	Sustained flexion increases stiffness	Frequent posture changes recommended
El Shunnar et al., 2024	Cross Sectional Survey, n=56	Smart device overuse	Neck and MSK symptoms	High device use associated with increased MSK pain	Digital use associated with increased symptom reporting
Lucka et al., 2024	Cross-sectional study, Healthcare workers n=418	Increased screen time during COVID	Upper MSK regions	Screen time spike increases MSK disease rise	Pandemic intensified digital strain

Study / Year	Population & Design	Digital Exposure / Postural Factor	Region / Mechanism	Key Outcomes	Takeaway
Janwantanakul et al., 2008	Cross-sectional study, Office workers n= 1,185	Computer work	General MSK load	High prevalence of neck and shoulder pain	Office ergonomics critical
Walankar et al., 2021	Cross-sectional study, University students n=2,000	Smartphone use	Neck and shoulder strain	Heavy phone use associated with frequent MSK pain	Youth highly vulnerable
Hoy et al., 2014	Global epidemiologic analysis (GBD database study)	Population level neck strain	Cervical region	Neck pain is leading disability cause	Neck pain major global issue
Kazeminasab et al., 2022	Epidemiologic review	Neck pain risk factors	Cervical region	Identified global forward head posture related risks	Neck pain rising worldwide
Rahimian et al., 2024	Cross-sectional study, University students n=204	Smartphone characteristics	Hand and wrist load	Phone dimensions associated with discomfort	Device design affects MSK health
Spanhove et al., 2021	Systematic review	Shoulder instability mechanics	Scapular motion	Altered kinematics worsen symptoms	Shoulder instability exacerbated by posture
Yang et al., 2016	Cross Sectional, Workforce Survey n=13,915	Psychosocial stress and digital load	Neck region	Stress and digital strain associated with neck pain	Behavioral factors amplify MSK issues
Al Shahrani et al., 2019	Cross-sectional study, General adult users n=711	Electronic device use	Carpal tunnel mechanism	Device overuse associated with CTS symptoms	Hand posture matters
Banadaki et al., 2024	Cross-sectional study, College students n=213	Use duration and posture	Hand tendon load	Poor posture associated with increased hand pain	Texting contributes to tendon injury
Vieira et al., 2019	Cross-sectional diagnostic accuracy study, Adults n=60	Photogrammetry	Neck posture measurement	CVA effective for pain detection	Useful diagnostic tool
Marimon et al., 2023	Validation & reliability study n=42	Computer vision posture tool	Head and neck alignment	Automated tools highly reliable	Tech improves posture assessment
Nishikawa et al., 2022	Experimental, Young adults n=19	Forward head posture	Trapezius activation	Forward head posture associated with increased trapezius loading	Muscle overload contributes to pain
Subbarayalu & Ameer, 2017	Cross-sectional Correlational study, Adults with neck pain n=84	Forward head posture severity	Deep neck flexors	Forward head posture correlated with pain and disability	Neck flexor weakness important
Lee et al., 2021	Randomized controlled clinical trial,	Workstation adjustment	Spinal alignment	Ergonomic adjustments decreased MSK pain	Ergonomics effective

Study / Year	Population & Design	Digital Exposure / Postural Factor	Region / Mechanism	Key Outcomes	Takeaway
	Office workers n=95				
Radas et al., 2013	Randomized controlled trial, Office workers n=60	Sitting reduction interventions	General MSK load	Education and ergonomics reduce sitting time	Behavioral training effective
Ruivo et al., 2017	Experimental training intervention, Adolescents n=130	Strength and stretch program	Shoulder and neck posture	Program improved forward head posture and shoulder posture	Exercise interventions improve postural alignment
Argyrou et al., 2025	Randomized control trial, Adults n=55	Motor learning exercise	Forward head posture correction	Exercise significantly improved alignment	Motor learning enhances posture change
Fathollahnejad et al., 2019	Intervention study, Adults n=60	Manual therapy and stabilization	Cervical and shoulder posture	Combined therapy improved forward head posture	Manual therapy beneficial
Figueira et al., 2024	Workplace review	Wearable posture monitors	Postural feedback mechanisms	Wearables promising but adherence varies	Digital tools useful adjuncts
Santos et al., 2025	Meta analysis, Workers n=4,086	Ergonomic interventions	Work related MSK regions	Ergonomics leading to significant pain reduction	Strong evidence supporting ergonomics
Hong et al., 2021	Pilot study, Post-menopausal females n=116	Cervical posture	Bone density and degeneration	Poor posture linked with degeneration	Posture influences aging spine
Donnally et al., 2025	Narrative Review	Lumbar degeneration mechanisms	Lumbar disc pathology	Repetitive flexion associated with degenerative disc loading patterns	Poor digital posture may contribute to degenerative lumbar loading
Ji et al., 2018	Narrative Review	Chronic pain mechanisms	Central sensitization	Chronic strain increases sensitization	Digital fatigue may influence pain perception
Mahmoud et al., 2019	Meta analysis	Forward head posture effects	Cervical strain	Forward head posture strongly associated with neck pain	Major evidence linking posture to pain
Lee & Son, 2025	Narrative review	Smartphone use	Posture and gait	Use alters gait stability	Screen use may influence posture and gait mechanics
Gorce & Jacquier-Bret, 2023	Survey-based cross-sectional study, Students n=263	Smartphone weekday use	Habitual posture	Students spend long periods in flexed posture	Daily habits determine MSK risk
Nilmart et al., 2025	Randomized control trial, Adults n=50	Telerehab vs in-person	Cervical posture rehab	Telerehab equally effective	Remote posture therapy viable

This table synthesizes evidence from experimental, observational, epidemiologic, and review studies examining how digital device use, ergonomics, and postural behaviors contribute to musculoskeletal strain across various body regions.

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