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Occupational Therapy Innovation for Technology-Related Functional Strain

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Abstract

Technology-intensive work has altered the physical, visual, cognitive, and organizational demands associated with everyday occupational performance. Prolonged computer use, repetitive keyboard and pointing-device activity, sustained visual attention, restricted postural variation, poorly matched workstations, and inadequate recovery opportunities may contribute to neck, shoulder, upper-back, hand–wrist, and visual discomfort. Occupational therapy is particularly suited to this problem because it evaluates the interaction among the individual, task demands, work environment, habits, equipment, and meaningful occupational performance rather than addressing symptoms independently from the activity producing them. The present study develops a simulation-based occupational therapy model for technology-related functional strain among adults engaged in computer-intensive work.

A hypothetical sample of 320 workers was constructed to evaluate an individualized intervention combining occupational analysis, workstation adaptation, task redesign, postural variation, micro-recovery scheduling, visual-demand management, alternative input strategies, and self-management education. Because no empirical participant dataset was supplied, all numerical outcomes are explicitly synthetic. Mean simulated functional-strain scores declined from 62.1 at baseline to 45.3 after the occupational therapy intervention, while the proportion reporting substantial interference with work activities declined from 48% to 27%.

Existing evidence indicates that customized workstation recommendations, participatory ergonomics, forearm support, ergonomics education, and selected workstation modifications can improve particular musculoskeletal or visual outcomes, although systematic reviews show that intervention effects differ according to the intervention and outcome studied.

Keywords: occupational therapy; technology-related strain; ergonomics; computer work; occupational performance; musculoskeletal discomfort; digital eye strain; workstation adaptation; functional health; work participation.

1. Introduction

Digital technologies now mediate substantial portions of professional work, education, administration, communication, documentation, design, analysis, and service delivery. Computer-intensive occupations may require workers to sustain visual concentration while simultaneously performing repetitive keyboard, mouse, touchpad, or touchscreen actions within relatively restricted working postures. These demands do not automatically produce injury, but prolonged or poorly organized exposure can contribute to musculoskeletal and visual discomfort when the physical workstation, activity pattern, task demands, and individual worker are poorly matched. Earlier systematic evidence examining computer users identified musculoskeletal and visual symptoms as important occupational-health concerns and showed that workstation, equipment, and behavioral interventions have been investigated as potential preventive strategies.

Technology-related functional strain is broader than a single musculoskeletal diagnosis. It can include neck stiffness, shoulder fatigue, upper-back discomfort, forearm or wrist symptoms, ocular fatigue, dryness, blurred vision, headache, reduced tolerance for sustained screen activity, difficulty maintaining concentration, and repeated interruption of work because of discomfort. Sheppard and Wolffsohn described digital eye strain as a collection of ocular and visual symptoms associated with digital-device use and noted that symptoms can arise through both visual mechanisms and ocular-surface mechanisms. Musculoskeletal research likewise demonstrates that computer work can expose users to repetitive and sustained upper-extremity demands and that selected ergonomic interventions can modify these risks. Functional strain is therefore best viewed as the cumulative influence of multiple demands rather than as evidence that one posture or one device is inherently harmful.

Occupational therapy offers a particularly relevant framework because the discipline focuses on participation in meaningful occupations and the fit among the person, activity, environment, tools, habits, and performance requirements. In computer-related work, this perspective allows the therapist to examine not only chair height or monitor position but also how long an individual performs a task, how often activities change, whether the input device matches the person's capabilities, how documents are positioned, whether visual demands are modifiable, how work is sequenced, and whether discomfort alters productivity or participation. Gardner-Harbeck and Fisher reported that individualized computer workstation analysis and recommendations made by an occupational therapist were associated with reduced musculoskeletal discomfort in six of seven participants in their small case study, alongside reported improvements in comfort and productivity. Although the study was small, it illustrates the occupation-centered potential of customized rather than generic workstation recommendations.

Research also suggests that changing equipment without corresponding behavioral adaptation may be insufficient. Berner and Jacobs identified a gap between exposure to computer ergonomics information and implementation of appropriate workstation practices, indicating that awareness does not necessarily translate into sustained behavioral change. Jacobs and colleagues later reported reductions in self-reported notebook-computer discomfort among university students receiving accessories and participatory ergonomics education. Robertson, Ciriello, and Garabet similarly found that combining office-ergonomics training with a sit–stand workstation influenced posture variation and musculoskeletal and visual discomfort in an experimental office-work context. Collectively, these studies support the principle that effective intervention often requires both environmental modification and behavioral integration.

At the same time, the evidence does not justify portraying workstation adjustment as a universal solution. The 2018 Cochrane review by Hoe and colleagues found uncertainty across several categories of ergonomic intervention for preventing work-related upper-limb and neck disorders among office workers. Van Eerd and colleagues likewise found strong evidence for workplace resistance training and moderate evidence for certain approaches such as forearm support, stretching, and mouse-use feedback, while evidence for other ergonomic combinations was mixed. The present study therefore proposes an occupational therapy model that does not rely on one universal ergonomic correction. Instead, it evaluates technology-related strain as an occupational-performance problem requiring individualized analysis and adaptive intervention. As no real workplace dataset was provided, the quantitative analysis is simulation-based and intended to define a rigorous framework for subsequent empirical study.

2. Objectives of the Study

2.1 To Examine Technology-Related Functional Strain

The first objective is to conceptualize technology-related strain through functional rather than exclusively diagnostic outcomes. The study therefore considers musculoskeletal discomfort, visual fatigue, task tolerance, interruption of work, perceived effort, and ability to complete technology-dependent activities. This broader approach is consistent with occupational therapy because a relatively modest symptom can become clinically important when it repeatedly restricts the person's ability to perform essential work.

Functional assessment also helps avoid assuming that all computer workers face identical risks. Two individuals may use similar equipment but differ in anthropometry, vision, previous injury, work habits, task variety, keyboard demand, pointing-device use, recovery opportunities, and workstation adjustability. Occupational therapy assessment should therefore determine which specific combinations of person, task, environment, and technology are producing functional difficulty rather than beginning with a fixed list of standardized corrections.

2.2 To Evaluate an Individualized Occupational Therapy Intervention

The second objective is to evaluate a simulated occupational therapy pathway combining workstation analysis with task-level adaptation. Intervention components include equipment positioning, external support where appropriate, input-device selection, document positioning, screen arrangement, task sequencing, postural variation, scheduled micro-recovery periods, visual-demand management, and education concerning self-monitoring.

Evidence supports the plausibility of several components while also emphasizing that effects vary. Rempel and colleagues found benefits from a forearm-support intervention among computer operators, while Esmaeilzadeh reported improvements following a comprehensive ergonomic program for computer workers. Participatory ergonomics evaluated by Baydur and colleagues was also associated with reduced development of musculoskeletal complaints and disability or symptom levels among office employees using computers.

2.3 To Develop an Adaptive Prevention and Self-Management Model

The third objective is to shift technology-related strain management from one-time workstation correction toward continuous occupational adaptation. Work demands can change with software, hardware, location, workload, deadlines, hybrid working arrangements, and job responsibilities. A workstation configured appropriately for one activity may be less suitable when the task shifts from typing to document review, drawing, videoconferencing, or data analysis.

Accordingly, the proposed model develops workers' capacity to recognize emerging strain and modify relevant aspects of their performance within safe limits. Occupational therapy intervention is therefore intended not simply to provide equipment recommendations but to establish transferable skills in task analysis, activity pacing, postural variability, environment adjustment, symptom-responsive modification, and timely escalation when symptoms indicate the need for medical or rehabilitation assessment.

3. Review of Literature

3.1 Computer Work, Musculoskeletal Strain, and Ergonomic Intervention

Early evidence examining computer-intensive occupations established that upper-body discomfort and work-related musculoskeletal disorders were relevant concerns among computer operators. Rempel and colleagues conducted a one-year randomized controlled trial involving 182 call-center operators and evaluated a wide forearm support and trackball as workstation interventions. Their findings supported forearm support combined with ergonomic training for reducing upper-body pain and preventing selected musculoskeletal disorders. The study is important because it demonstrates that comparatively specific equipment changes may influence outcomes when they address an identifiable exposure.

Brewer and colleagues subsequently conducted a systematic review of workplace interventions addressing visual and musculoskeletal symptoms among computer users. The evidence was heterogeneous, with the effectiveness of interventions depending on the design and outcome under investigation. This remains a relevant methodological lesson: ergonomic effectiveness should not be evaluated as though "ergonomics" were one intervention. Equipment, training, rest breaks, workstation redesign, input-device modification, visual interventions, participatory programs, and exercise represent different therapeutic or occupational-health strategies.

Later evidence reinforced this distinction. Van Eerd and colleagues' systematic update reported strong evidence supporting workplace resistance training and moderate evidence supporting selected strategies including stretching, mouse-use feedback, and forearm supports for prevention or management of upper-extremity musculoskeletal symptoms. Evidence for some combinations of ergonomics training and workstation adjustment was mixed. Similarly, the Cochrane review by Hoe and colleagues concluded that uncertainty remained regarding several ergonomic approaches used for preventing upper-limb and neck musculoskeletal disorders among office workers. These findings argue for individualized intervention selection rather than indiscriminate application of multiple ergonomic recommendations.

3.2 Visual Demand, Postural Variation, and Technology Use

Visual discomfort is an important component of technology-related functional strain. Sheppard and Wolffsohn described digital eye strain as including symptoms associated with accommodative or binocular stress and external ocular symptoms related to the ocular surface. This has implications for occupational therapy because visual discomfort may alter posture and occupational behavior. For example, a worker who cannot comfortably view text may move closer to a monitor or sustain an altered head position, creating an interaction between visual and musculoskeletal demand.

Office-ergonomics research has provided evidence that workstation and training interventions can affect both visual and musculoskeletal outcomes. Amick and colleagues reported that a highly

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adjustable chair combined with ergonomics training reduced visual symptoms in a public-sector office intervention, and a related replicated field investigation also reported reductions in visual symptoms. Robertson and colleagues' controlled study of ergonomics training and sit–stand workstation design also reported lower levels of musculoskeletal and visual discomfort among trained participants and greater postural variation.

These results should not be interpreted as proof that any particular workstation configuration is universally optimal. Postural variability may be more meaningful than maintenance of a rigid "ideal posture," because technology-dependent tasks frequently change throughout the working day. An occupational therapy approach can therefore focus on providing several usable work positions, organizing transitions among activities, reducing unnecessary reach or sustained loading, and supporting visual access without requiring workers to hold one theoretically perfect posture continuously.

3.3 Occupational Therapy Contribution and the Remaining Research Gap

Occupational therapy literature provides direct evidence of the profession's potential contribution. Gardner-Harbeck and Fisher examined individualized computer-workstation recommendations delivered through occupational therapy and reported improved musculoskeletal comfort among most participants in their case study. Jacobs, Blanchard, and Baker further explored telehealth and ergonomics, including proof-of-concept application of remote ergonomic assessment and intervention. These studies demonstrate that occupational therapy can address computer-related occupational performance through both direct and technology-mediated assessment.

A further strength of occupational therapy is its emphasis on implementation. Berner and Jacobs specifically examined the gap between exposure to ergonomic information and implementation within computer workstations. Jacobs and colleagues' study of notebook-computer users similarly showed that accessories combined with participatory ergonomics education were associated with reduced self-reported discomfort and increased rest-break behavior. Such evidence suggests that simply telling workers the correct equipment configuration may be less effective than involving them in identifying problems and establishing workable changes.

The remaining research gap concerns a comprehensive functional-strain model integrating musculoskeletal, visual, behavioral, and occupational-performance variables. Much ergonomic research isolates pain, workstation geometry, or equipment outcomes, whereas technology-intensive work creates interconnected demands. The present study therefore proposes an occupational therapy intervention that evaluates whether individualized adaptation changes not only discomfort but also task interruption, sustained-work tolerance, self-management confidence, and perceived occupational performance.

4. Research Methodology

4.1 Research Design and Simulated Participants

The study uses a simulation-based pre-intervention/post-intervention design. A hypothetical cohort of 320 adults engaged in computer-intensive occupational activity was constructed. Eligible workers were conceptually defined as adults using a desktop or laptop computer for at least four hours during a typical workday and reporting recurrent technology-associated functional strain affecting at least one musculoskeletal, visual, or occupational-performance domain.

Because no original participant dataset was supplied, all numerical values are synthetic. The study is not presented as a completed workplace trial. A future empirical investigation should use prospective recruitment, informed consent, appropriate ethics approval, standardized baseline assessment, and predefined referral procedures for participants whose symptoms suggest conditions requiring medical, ophthalmic, neurological, musculoskeletal, or other professional assessment.

Baseline variables in a real study should include age, sex, occupation, average screen exposure, keyboard and pointing-device exposure, workstation configuration, number of monitors, laptop use, corrective-lens use, previous musculoskeletal diagnosis, perceived workload, rest-break opportunity, and previous ergonomic training. These variables would permit adjustment for important sources of variation rather than attributing every change to occupational therapy.

4.2 Occupational Therapy Assessment and Adaptive Intervention

The occupational therapy assessment begins with an interview concerning occupational roles, specific technology-dependent tasks, symptom timing, functional limitations, and worker priorities. This is followed by direct observation of typical work activity and analysis of task–environment interactions. Gardner-Harbeck and Fisher's occupational therapy case study supports the feasibility of customized workstation analysis, while Jacobs and colleagues demonstrated that ergonomic assessment can also be explored through remote delivery where appropriate.

Intervention is individualized rather than standardized. Potential modifications include chair and desk adjustment, monitor arrangement, keyboard or pointing-device placement, forearm support, external accessories for laptop users, alternative input equipment, document positioning, task rotation, postural variation, micro-recovery scheduling, visual-demand modification, and worker education. Equipment recommendations are introduced only when they correspond to an identified functional problem.

Table 1: Proposed Occupational Therapy Assessment and Intervention Framework

Domain / Code	Proposed assessment or questionnaire item	Therapeutic purpose	Possible OT response
Musculoskeletal demand	Neck, shoulder, back, forearm, hand, and wrist symptom pattern during technology use	Identify task-related physical strain	Workstation or task adaptation
Visual demand	Screen tolerance, ocular fatigue, blurred vision, headache, viewing distance	Identify visually mediated functional difficulty	Display and environmental modification; referral where indicated
Activity pattern	Continuous task duration, task switching, recovery opportunities	Identify sustained-exposure pattern	Pacing and micro-recovery planning
Technology interaction	Keyboard, mouse, trackpad, laptop, monitor and accessory use	Identify equipment–person mismatch	Alternative positioning or equipment trial
Occupational impact	Interruption, reduced productivity, avoidance, task	Establish functional	Goal-directed occupational

	difficulty	relevance	intervention
Q1	"Technology-related discomfort interferes with my ability to complete my work activities."	Functional interference	1–5 Likert scale
Q2	"I can adjust my workstation to match the task I am performing."	Adaptive confidence	1–5 Likert scale
Q3	"I recognize when I need to change position or briefly recover from sustained computer work."	Self-monitoring	1–5 Likert scale
Q4	"My computer equipment and work environment support comfortable task performance."	Person–environment fit	1–5 Likert scale
Q5	"I can manage technology-intensive work without symptoms substantially limiting my performance."	Occupational self-efficacy	1–5 Likert scale

4.3 Outcome Measurement and Statistical Strategy

The primary simulated outcome is a Technology-Related Functional Strain Score ranging from 0 to 100, with higher scores representing greater combined functional burden. For methodological illustration, the composite incorporates musculoskeletal discomfort, visual fatigue, task interruption, perceived effort, and reduced tolerance of sustained technology use. This score is hypothetical and must not be confused with a validated clinical instrument.

Secondary outcomes include work interference, visual fatigue, upper-body discomfort, adaptive workstation confidence, frequency of self-initiated task or position variation, and overall occupational-performance confidence. An empirical study should also use established validated instruments relevant to the specific occupational and symptom populations rather than relying only on a newly developed composite.

5. Analysis

5.1 Simulated Changes in Functional Strain

The simulated dataset produced a mean baseline functional-strain score of 62.1/100. Following the occupational therapy intervention, the modeled mean declined to 45.3/100, corresponding to a synthetic reduction of 16.8 points. The change is deliberately presented as a methodological illustration and not as evidence that occupational therapy will produce the same magnitude of improvement in an actual workforce.

The most prominent modeled changes occurred in perceived workstation fit, technology-related work interference, and neck–shoulder discomfort. The simulation assumes that workers with identifiable workstation or task mismatches benefit more than workers whose strain arises predominantly from

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factors outside the intervention's direct scope. This assumption reflects the variable intervention effects reported across ergonomic literature rather than presuming universal response.

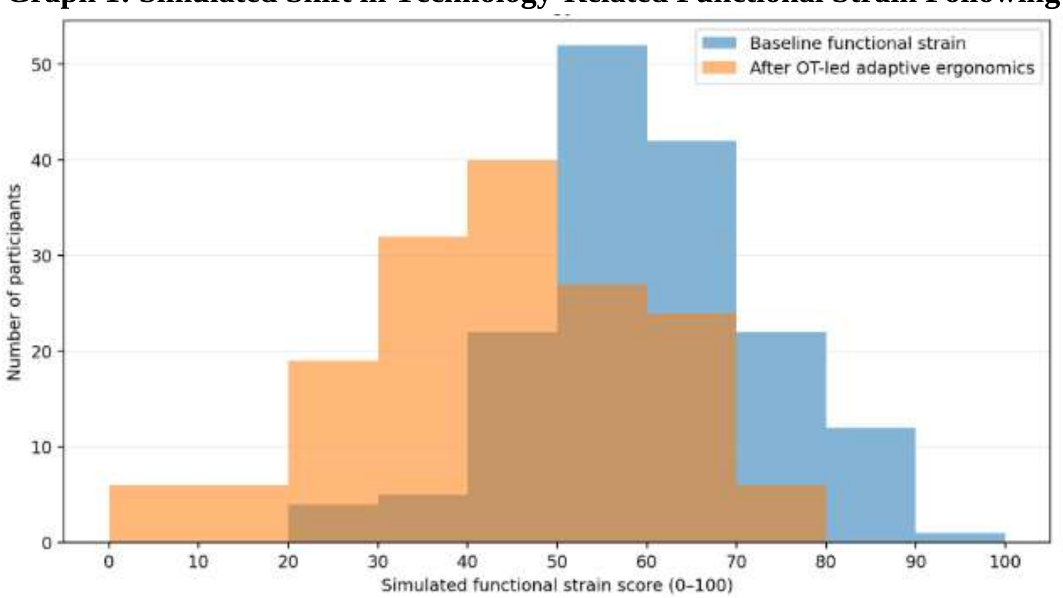
Table 2: Simulated Occupational Therapy Outcomes for Technology-Related Functional Strain

Outcome indicator	Baseline	After OT-led adaptive intervention	Simulated change
Mean functional-strain score /100	62.1	45.3	−16.8
Substantial neck/shoulder functional discomfort	57%	35%	−22 percentage points
Hand/wrist discomfort affecting technology use	39%	24%	−15 points
Frequent visual fatigue during screen-based work	52%	34%	−18 points
Technology-related strain substantially interfering with work	48%	27%	−21 points
Confident adjusting workstation for changing tasks	34%	76%	+42 points
Regularly using planned task/postural variation	31%	71%	+40 points
High confidence in self-managing early functional strain	29%	68%	+39 points

5.2 Distribution of Functional-Strain Scores

Mean values alone can obscure differences among workers. The simulated participant-level analysis therefore examines the distribution of functional-strain scores before and after intervention. The histogram shows a general leftward shift after occupational therapy, indicating that a larger proportion of hypothetical participants moved into lower strain ranges.

Graph 1: Simulated Shift in Technology-Related Functional Strain Following



The graph also demonstrates substantial overlap between pre- and post-intervention distributions. This is an important feature rather than an analytical weakness. Occupational therapy should not be expected to eliminate all technology-related strain because symptoms can arise from clinical conditions, workload, psychosocial demands, visual disorders, non-work activities, insufficient organizational control, or other factors that cannot be corrected through workstation adaptation alone.

The persistence of higher scores among some simulated participants therefore illustrates the importance of reassessment. A worker who remains substantially limited despite appropriate occupational adaptation may require more detailed medical, musculoskeletal, ophthalmic, psychological, organizational, or vocational evaluation rather than increasingly intensive ergonomic advice.

5.3 Functional Adaptation as the Primary Innovation

The largest modeled gains appear in the worker's ability to modify the workstation and activity pattern independently. Confidence in adjusting the workstation rises from 34% to 76%, while planned task or postural variation increases from 31% to 71%. These modeled outcomes reflect the occupational therapy emphasis on skill transfer rather than dependence on a therapist for every workstation change.

This approach is supported conceptually by earlier evidence demonstrating the importance of implementation. Berner and Jacobs identified a gap between ergonomic exposure and actual workplace implementation, while Jacobs and colleagues demonstrated that participatory ergonomics education can influence worker behavior as well as discomfort. A successful intervention should therefore leave the worker better able to manage changing technology demands after formal therapy concludes.

Adaptive capacity may be particularly important because digital work is not static. New applications, hybrid work locations, laptops, multiple displays, portable devices, and changing task mixes continually alter occupational demands. The most sustainable outcome may therefore be the ability to recognize mismatch early and respond appropriately rather than maintaining one fixed workstation configuration indefinitely.

6. Discussion

6.1 Occupational Therapy Beyond Conventional Workstation Correction

The present model positions occupational therapy as a bridge between ergonomics and occupational performance. Traditional workstation assessment often concentrates appropriately on equipment geometry, but occupational therapy adds a broader analysis of how that workstation interacts with the person's abilities, habits, work roles, task sequence, symptoms, and performance priorities. Gardner-Harbeck and Fisher's case study provides a direct example of customized occupational therapy workstation recommendations being associated with reduced upper-extremity discomfort and improved productivity perceptions.

This occupation-centered approach is especially important because no single workstation configuration can accommodate every task equally well. Typing, reading, detailed visual analysis, videoconferencing, graphic work, data entry, and document comparison create different physical and visual demands. The therapeutic objective should therefore be a functional range of workable configurations rather than continuous enforcement of a single posture.

The model also recognizes that workers need practical solutions that can be maintained within real organizational conditions. An intervention requiring frequent behavior that conflicts with workload, software design, job requirements, or workplace culture may demonstrate theoretical ergonomic merit without being sustainable. Occupational therapists can therefore incorporate feasibility into the intervention itself by identifying adaptations that the worker can realistically integrate into normal occupational routines.

6.2 Combining Equipment, Behavior, and Recovery Strategies

Evidence from workplace research suggests that combined interventions can be useful but that results are not uniform. Rempel and colleagues demonstrated benefit from forearm support combined with training among computer operators, while participatory ergonomic intervention evaluated by Baydur and colleagues reduced the development of musculoskeletal complaints and related disability or symptom levels. Robertson and colleagues found that ergonomics training combined with a sit–stand workstation influenced discomfort and postural behavior. These studies support multi-component approaches when intervention elements correspond to plausible risk mechanisms.

Systematic reviews, however, emphasize uncertainty and heterogeneity. Hoe and colleagues found insufficient or uncertain evidence for several ergonomic interventions, while Van Eerd and colleagues found stronger support for some specific intervention categories than for generic ergonomic programs. These findings have an important implication for occupational therapy: more intervention components do not automatically produce better outcomes.

The proposed adaptive model therefore uses assessment to decide which components are necessary. A worker whose primary difficulty is laptop-related neck positioning may require equipment separation and task reconfiguration, while a worker with high pointing-device exposure may benefit from forearm support or alternative input strategies. A worker whose principal complaint is visual fatigue may require a different combination of display, lighting, viewing, recovery, and eye-care considerations. Individualized clinical reasoning is consequently more defensible than a universal ergonomic checklist.

6.3 Visual Health, Work Organization, and Sustainable Participation

Technology-related strain also demonstrates why occupational performance should be analyzed across body systems. Digital eye strain may contribute to headache, visual fatigue, or changes in viewing behavior, while musculoskeletal discomfort may reduce concentration and task endurance. Sheppard and Wolffsohn's review emphasizes that digital eye strain contains multiple symptom mechanisms rather than representing a single uniform disorder. Similarly, office intervention research has shown that training and workstation modifications can influence visual symptoms under particular conditions.

Occupational therapy intervention should therefore include referral boundaries. Persistent visual symptoms may require professional eye examination; neurological symptoms, progressive weakness, substantial sensory changes, or persistent pain may require appropriate medical or rehabilitation evaluation. Ergonomic modification should not delay investigation of symptoms that cannot be adequately explained or managed through occupational adaptation.

Sustainable technology participation ultimately requires shared responsibility. Workers can develop self-management skills, but organizations influence workload, equipment availability, task autonomy, break opportunities, procurement decisions, and whether workstation recommendations can actually be implemented. Berner and Jacobs' work on the gap between ergonomic exposure and implementation illustrates the importance of organizational context. Occupational therapy innovation should consequently include collaboration with workers, managers, occupational-health personnel, information-technology teams, and other relevant stakeholders where system-level barriers contribute to functional strain.

7. Conclusion

Technology-related functional strain is a multidimensional occupational-performance issue involving interaction among the worker, digital equipment, visual demands, musculoskeletal loading, work organization, environmental conditions, and patterns of activity and recovery. Treating the problem exclusively as poor posture or inadequate workstation knowledge risks overlooking the reasons a worker continues to experience difficulty despite receiving conventional ergonomic advice.

The present simulation proposes an occupational therapy approach based on individualized occupational analysis and adaptive intervention. Under the synthetic model, mean functional-strain scores declined from 62.1 to 45.3, while substantial technology-related work interference decreased from 48% to 27%. Confidence in independently adapting the workstation and activity pattern showed some of the largest simulated improvements. These numerical findings are illustrative only and should not be interpreted as clinical effectiveness estimates.

The broader literature supports selected ergonomic and workplace interventions but also demonstrates substantial heterogeneity. Evidence exists for approaches including forearm support, participatory ergonomics, selected equipment changes, training, exercise, and combined workstation interventions, while systematic reviews caution that many intervention effects remain uncertain or outcome-specific. Occupational therapy can contribute by matching these options to the individual rather than assuming that every technology user requires the same intervention.

Future empirical research should evaluate the proposed framework through controlled workplace studies that include validated musculoskeletal and visual measures, occupational-performance outcomes, productivity or work-participation indicators where appropriate, intervention adherence, implementation feasibility, and long-term follow-up. Such research should also examine organizational barriers to adaptation.

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