Rīga Stradiņš University

Faculty of Medicine

2nd level higher professional study programme “Medicine”

“The impact of remote work during the COVID-19 pandemic on the musculoskeletal system”

SCIENTIFIC THESIS

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Rīga, 2025

DECLARATION

(In Rīga)

I hereby declare that:

Scientific thesis “The impact of remote work during the COVID-19 pandemic on the musculoskeletal system”

(hereinafter referred to as Paper) has been developed lawfully and in good faith, to wit:

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ABSTRACT

Background: the COVID-19 pandemic drove a rapid shift to remote and hybrid work, raising concerns about musculoskeletal disorders (MSDs) due to extended sitting, improvised workstations, and psychosocial stress.

Objectives: To synthesize evidence on the prevalence, severity, and determinants of MSDs amongst adult remote workers during the COVID-19 pandemic period

Methods: Narrative literature review of quantitative studies published January 2020 – May 2025. Searches in PubMed, Scopus, Web of Science, and Google Scholar identified 3,942 records; 24 studies met the inclusion criteria after screening. Data were extracted on population, MSD measurement, body regions, ergonomic/behavioral/ psychosocial factors, confounders, and key findings. Heterogeneity in designs and outcomes precluded meta-analysis.

Results: reported MSD prevalence among remote workers ranged from 26 % to more than 70 % with 18/24 studies indicating increases relative to pre-pandemic or retrospective baseline. The neck, shoulders, and lower back were most affected. Poor workstation ergonomics (e.g., non-adjustable seating, lower screens, sofa/bed setups), increased sitting time, reduced physical activity, and adverse psychosocial factors were consistently associated with symptoms, though several studies found null or mixed associations. Measurement approaches varied widely (validated tools vs custom questionnaires), and most outcomes were self-reported.

Conclusion: Remote work during COVID-19 was commonly associated with elevated MSD symptoms, especially in spinal and upper limb regions, likely due to suboptimal ergonomics and sedentary behavior in combination with psychosocial stressors amplifying risk. Standardized assessment tools, longitudinal designs, and objective behavioral measures are needed.

Keywords: remote work; telework; musculoskeletal disorders; ergonomics; sedentary behavior; COVID-19; occupational health

KOPSAVILKUMS

Konteksts: COVID-19 pandēmija izraisīja strauju pāreju uz attālinātu un hibrīddarbu, radot bažas par balsta un kustību aparāta slimībām (BKAS) ilgstošas sēdēšanas, improvizētu darba staciju un psihosociālā stresa dēļ.

Mērķi: apkopot pierādījumus par BKAS izplatību, smagumu un noteicošajiem faktoriem pieaugušo attālināto darbinieku vidū COVID-19 pandēmijas periodā.

Metodes: teorētisks literatūras apskats par kvantitatīviem pētījumiem, kas publicēti no 2020. gada janvāra līdz 2025. gada maijam. Meklējot PubMed, Scopus, Web of Science un Google Scholar, tika identificēti 3942 ieraksti; 24 pētījumi atbilda iekļaušanas kritērijiem pēc atlases. Dati tika iegūti par populāciju, BKAS mērījumiem, ķermeņa reģioniem, ergonomiskajiem/uzvedības/psihosociālajiem faktoriem, traucējošiem faktoriem un galvenajiem atklājumiem. Pētījuma dizaina un rezultātu neviendabīgums neļāva veikt metaanalīzi.

Rezultāti: ziņotā BKAS izplatība attālināto darbinieku vidū svārstījās no 26% līdz vairāk nekā 70%, un 18/24 pētījumos tika norādīts pieaugums salīdzinājumā ar pirms pandēmijas vai retrospektīvo sākotnējo stāvokli. Visvairāk tika skarts kakls, pleci un muguras lejasdaļa. Slikta darba vietas ergonomika (piemēram, neregulējami sēdekļi, zemāki ekrāni, darbs uz dīvāna/gultas), palielināts sēdēšanas laiks, samazināta fiziskā aktivitāte un nelabvēlīgi psihosociālie faktori pastāvīgi bija saistīti ar simptomiem, lai gan vairākos pētījumos tika konstatēta nulles vai jaukta saistība. Mērīšanas pieejas bija ļoti dažādas (validēti rīki pretstatā pielāgotām anketām, un lielākā daļa rezultātu tika ziņoti pašnovērtējumā).

Secinājums: Attālinātais darbs COVID-19 laikā bieži bija saistīts ar paaugstinātiem MSD simptomiem, īpaši mugurkaula un augšējo ekstremitāšu reģionos, iespējams, nepietiekamas ergonomikas un mazkustīga uzvedības dēļ kombinācijā ar psihosociāliem stresa faktoriem, kas pastiprina risku. Ir nepieciešami standartizēti novērtēšanas rīki un garengriezuma pētījumi, kā arī objektīvi uzvedības mērījumi.

Atslēgvārdi: attālinātais darbs; teledarbs; muskuļu un skeleta sistēmas traucējumi; ergonomika; mazkustīga uzvedība; COVID-19; arodveselība

Introduction

The COVID-19 pandemic triggered a rapid global transition from conventional office-based work to remote work arrangements. To reduce virus transmission and maintain business continuity, remote work became a widespread necessity, affecting over 40% of the workforce in the European Union during 2020 (1). While remote work offered benefits such as flexible schedules and improved work-life integration, it also created new occupational health risks, particularly related to physical ergonomics.

Musculoskeletal disorders (MSDs) – pain or dysfunction in muscles, joints, and other soft tissue (2), emerged as a significant concern among remote workers (3,4). Many lacked ergonomically suitable workstations, instead relying on makeshift setups such as sofas, kitchen tables, or beds. Combined with increased screen time, prolonged sitting, reduced physical activity, and blurred boundaries, have heightened the risk of discomfort and chronic pain (5,6). As remote and hybrid work models continue beyond the pandemic, it is critical to understand the long-term musculoskeletal health impact to guide ergonomic design, occupational health standards, and workplace policy.

Despite the growing body of research, findings remain inconsistent due to variations in study design, study populations, and measurement tools. To address this gap, a structured synthesis of the evidence is needed to evaluate the prevalence, severity, and contributing factors of MSDs in remote work settings – integrating ergonomics, behavioral, and psychosocial dimensions that are often studied in isolation.

Aim: to synthesize existing research on the relationship between working from home (WFH) during the COVID-19 pandemic and the prevalence and severity of musculoskeletal disorders.

Objectives:

1. To examine the prevalence and reported severity of musculoskeletal symptoms among remote workers during the COVID-19 pandemic.
2. To analyze ergonomic and behavioral factors most associated with musculoskeletal complaints in a home-based work setting.
3. To evaluate the types and consistency of MSD assessment methods used across studies, including pain scales and body region specificity.
4. To identify methodological strengths, limitations, and research gaps within the existing literature.

Hypothesis

Remote work during the COVID-19 pandemic increased musculoskeletal discomfort, particularly in the back and upper limbs, due to poor ergonomic setups, increased sedentary time, and psychosocial stressors.

1.0 Theory and conceptual framework

This section defines the core concepts used throughout the thesis and outlines the theoretical foundations linking remote work to musculoskeletal health. It draws on occupational health, ergonomics, and behavioral models to establish an analytical framework for interpreting the literature.

1.1 Musculoskeletal disorders in the context of work

Musculoskeletal disorders (MSDs) are conditions affecting muscles, tendons, ligaments, nerves, and supporting structures. They are commonly characterized by pain, stiffness, or reduced mobility, and are a leading cause of lost productivity and long-term disability (7)

Work-related MSDs may result from either acute trauma or cumulative exposure to physical stressors such as repetitive motion, awkward postures, or sustained loading. In sedentary occupations, including most remote work, MSDs develop gradually due to microtrauma, muscular imbalance, and insufficient recovery periods. Early symptoms such as discomfort or mild pain can progress to chronic dysfunction if unaddressed. (7).

In this thesis, the term pain refers to self-reported perception of physical discomfort in body regions such as the lower back, neck, as described in the studies reviewed.

1.2 Ergonomic and load tolerance model

Ergonomics is the scientific discipline focused on optimizing the interaction between people and their work environment to improve well-being and performance (8). Physical ergonomics involves designing workstations, postures, and tools to minimize biomechanical strain and promote healthy movement patterns.

One fundamental framework for understanding how MSDs develop in occupational settings is the load tolerance model. This model conceptualizes musculoskeletal injuries as a result of physical load exceeding tissue tolerance over time. Load includes all mechanical forces placed on the body, such as postural strain, repetitive movements, static muscle activation, vibrations,

and thermal stress. Tolerance, in contrast, refers to the body's physiological ability to withstand or recover from these forces without injury (9).

In a remote work context, poor workstation ergonomics often increase the biomechanical load on the musculoskeletal tissue. These exposures may not cause acute injury but lead to cumulative trauma, where repetitive or sustained strain exceeds the tissue's ability to recover, resulting in discomfort or chronic pain. This model is especially relevant given the prolonged, low-movement conditions reported in many remote work scenarios (3)

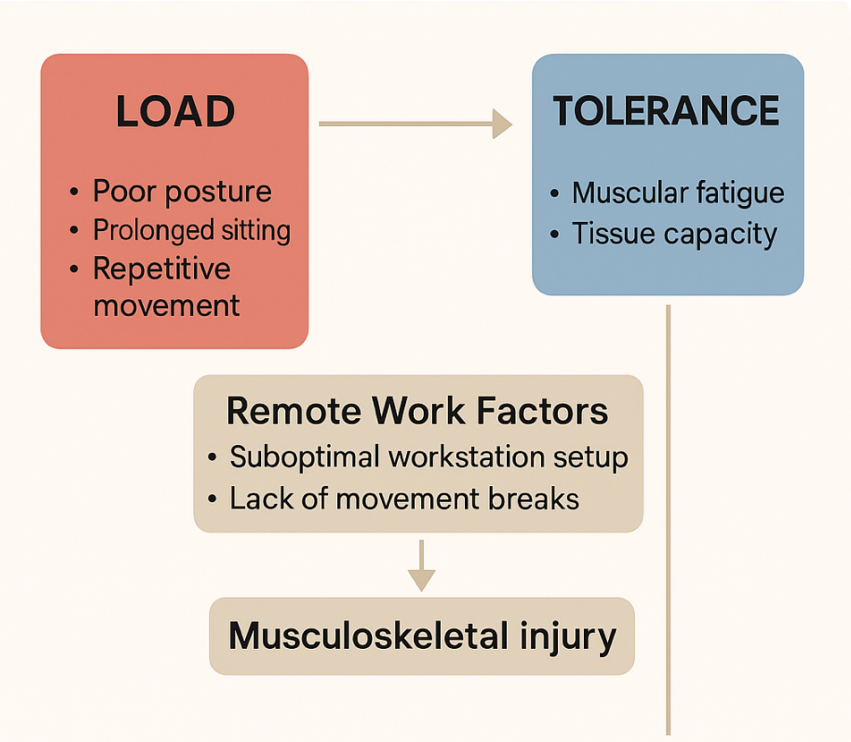

Figure 1.1. Conceptual model of the load tolerance framework in remote work contexts

1.3 Sedentary behavior and physical activity

Sedentary behavior is defined as any waking activity with energy expenditure of <1.5 metabolic equivalents (METs), typically performed while sitting or reclining (10). This behavioral pattern has become increasingly common in remote work, with studies reporting daily sitting durations exceeding eight hours per day during the pandemic (11).

Prolonged sitting reduces intervertebral disc perfusion, increasing spinal stiffness, and promotes postural fatigue. Common sustained postures such as forward head tilts, thoracic rounding, or slouched lumbar positioning exacerbate musculoskeletal strain. During remote work, reduced physical activity and fewer breaks limit recovery, accelerating microtrauma accumulation (12).

2.0 Method

This study was conducted as a narrative literature review synthesizing findings from quantitative studies on musculoskeletal disorders (MSDs) related to remote work during the COVID-19 pandemic. While the primary studies employed quantitative methods such as surveys and structured questionnaires, the present review uses a qualitative, thematic synthesis to interpret trends, compare findings, and identify methodological gaps across the literature.

2.1 Search strategy

A structured literature search was performed across four academic databases: PubMed, Scopus, Web of Science, and Google Scholar. Boolean operators were used to combine search terms such as:

- “Musculoskeletal disorders” OR “MSDs” OR “Musculoskeletal pain” OR “pain”
- AND “remote work” OR “working from home” OR “teleworking”
- AND “COVID-19” OR “pandemic”
- AND “ergonomics” OR “sedentary behavior”

The search was limited to articles published between January 2020 and May 2025, aligned with the timeframe of the COVID-19 pandemic and its aftermath.

The initial search yielded a total of 3,942 results. After removing duplicates and screening titles and abstracts, 78 full-text articles were reviewed for eligibility. Of these, 24 studies met all inclusion criteria and were retained for analysis.

2.2 Inclusion and exclusion criteria

Studies were included if they:

- Focused on adult participants (age 18 or older) engaged in remote work or hybrid work due to the COVID-19 pandemic

- Reported on the prevalence, severity, or nature of musculoskeletal symptoms
- Examined ergonomic, behavioral, or psychological factors as part of the analysis
- Employed quantitative methods, including surveys, questionnaires, or validated MSD assessment tools
- Were published in English

Studies were excluded if they

- Solely focused on mental health outcomes
- Did not specifically link musculoskeletal symptoms to the context of pandemic-related remote work.
- Were review articles or editorials, opinion pieces, or conference abstracts without original data.

2.3 Study selection and data extraction

The initial screening was conducted in two phases: title and abstract review, followed by full text review. Each eligible study was reviewed independently to confirm that it met all criteria. From each of the 24 included studies, key data were extracted into a comparative evidence matrix. The matrix captured the following variables:

- Author (s), year of publication, and country
- Study population and sample size
- MSD assessment methods and target body regions
- Confounding variables analyzed
- Major findings related to MSD prevalence, severity, and associated factors
- Limitations as reported by authors

2.4 Data synthesis

Due to the heterogeneity of the study design, population, and outcome measures, a formal meta-analysis was not feasible. Instead, a narrative synthesis approach was used. Studies were organized thematically according to the four primary objectives of the review:

- Prevalence and severity of musculoskeletal symptoms
- Ergonomic and behavioral risk factors
- Methodological consistency and measurement tools
- Research limitations and gaps.

This thematic framework enabled a qualitative comparison of findings across geographic regions, occupational settings, and population subgroups, allowing for the identification of patterns, divergences, and unresolved issues in the current literature.

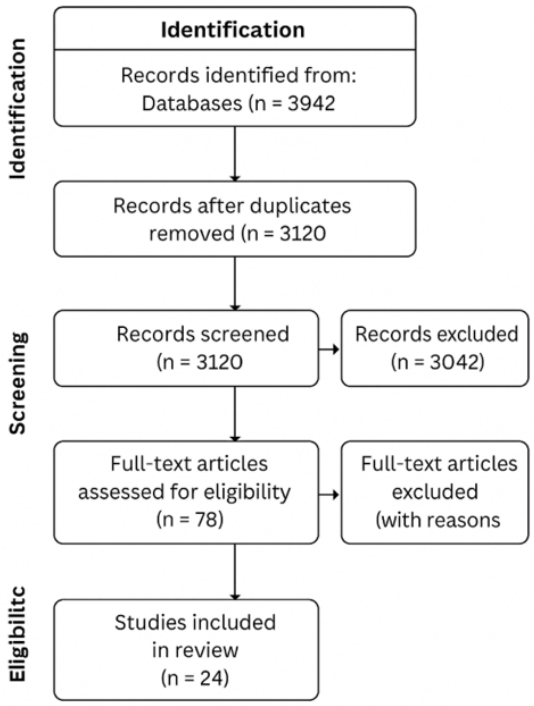

Figure 2.1. PRISMA flow diagram of study selection process

3.0 Results

3.1 Prevalence trends in musculoskeletal disorders

Musculoskeletal disorders (MSDs) were frequently reported among remote workers during the COVID-19 pandemic. Among the 24 included studies, prevalence rates varied substantially from 25.6 % to over 70 %, depending on occupation, country, assessment method, and how MSDs were defined.

Eighteen studies (3–6,13–26) reported increased MSD prevalence either through direct pre-/post-comparisons or retrospective self-assessments. For example, Gupta et al. (4) found that MSD rates increased from 47,6 % pre-lockdown to 53,6% during remote work, including lower back (39,1%), upper back (45,7%), and hands (27,2 %). Oakman et al. (3) reported that over 70% of the participants experienced musculoskeletal pain by the end of a typical work day, though no baseline data were available.

Conversely, two studies (Aegerter et. al and Argus, and Paasuke) found no significant increase in musculoskeletal complaints during remote work, despite reduced physical activity or poor ergonomic conditions. These contrasting findings reflect the heterogeneity of outcomes, with some studies providing descriptive trends while others used statistical comparisons.

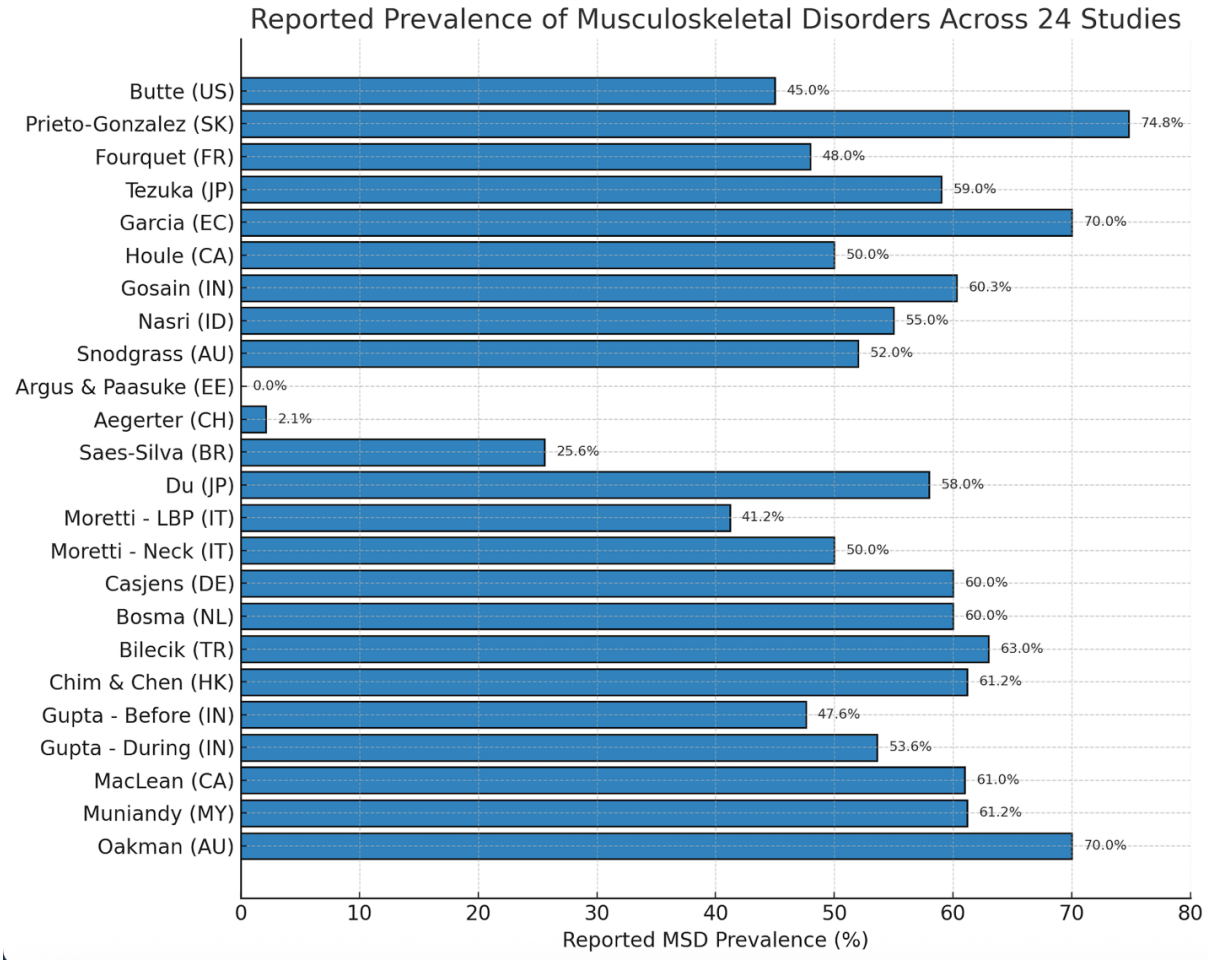

Figure 3.1. Reported prevalence of musculoskeletal disorders (MSDs) during the COVID-19 WFH period across studies. Where exact values were unavailable, estimates were based on the pattern described in each study

3.2 Pain severity and affected body anatomical regions

Seventeen of the twenty-four studies identified the neck, shoulders, and lower back as the most affected regions. For instance, Chim and Chen (15) found that 61,2% of respondents experienced musculoskeletal pain, primarily in the lumbar, upper back, and neck. Muniandy et al. (16) also observed that 61,2% of their participants experienced lumbar pain. Moretti et al. (17) reported worsening neck pain in 50% of home workers.

Pain severity and anatomical regions were measured using diverse tools, including numerical rating scales (e.g., 0-10), or Likert-type scales, and validated instruments like the Brief Pain Inventory (BPI) and Neck Disability Index (NDI). Bilecik et al. (21) found that neck pain scores increased over a year, alongside a rise in neck disability. However, some studies Butte et al. (27) Houle et al. (28) reported limited or no association between posture or sitting time and pain intensity.

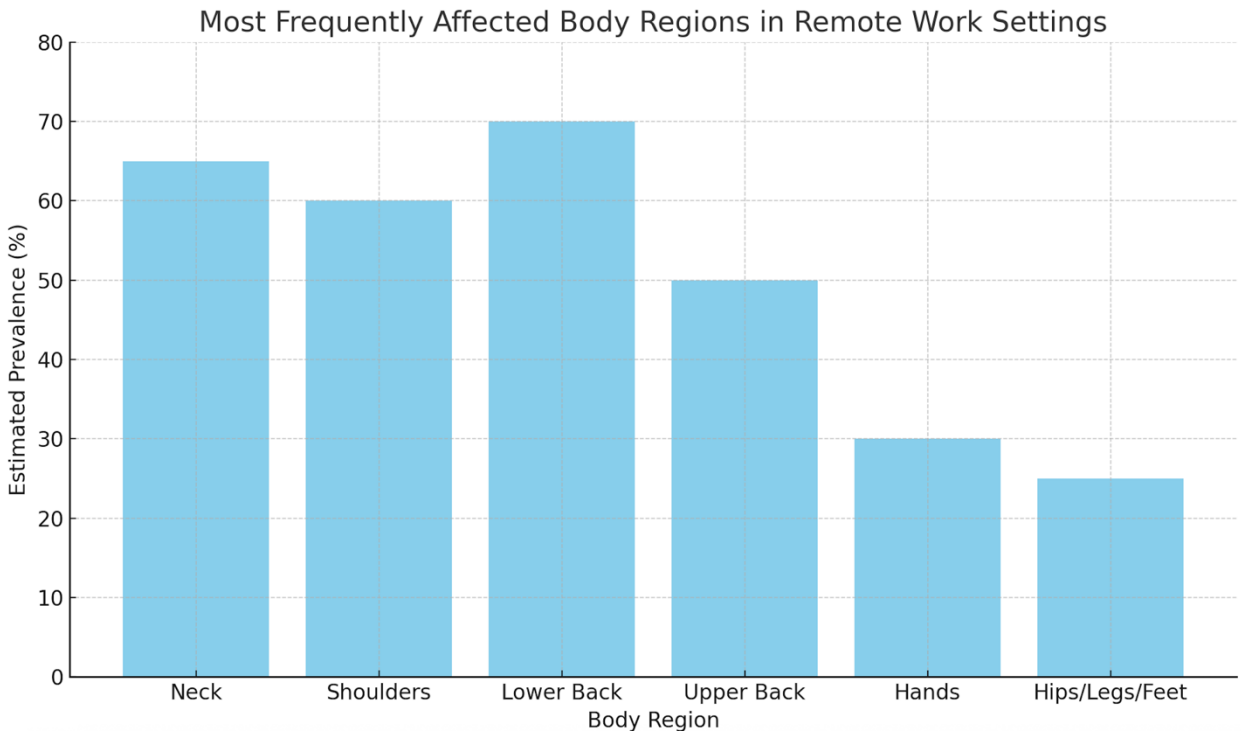

Figure 3.2. Overview of musculoskeletal regions most affected during work-from-home arrangements identified across included studies

3.3 Workstation Ergonomic and physical setups

Twenty studies (3,5,6,13–19,19–26,29,30) evaluated ergonomic factors, most of which assessed home workstation design, seating, device placement, and posture. Findings consistently linked non-ergonomic setups ups such as working on sofas, beds, or dining tables, to increased pain.

Du et al. (14), MacLean et al (30), Chim and Chen (15) , and Garcia et al. (23) all found stands, poor chair support, and screen height misalignment contributed to discomfort in the neck, shoulders, and lower back. Oakman et al. (3) and Casjens et al. (6) found that workstation discomfort was significantly correlated with higher pain scores

Although several studies included ergonomics in broader multivariable models Bosman et al. (22), Tezuka et al. (26), Snodgrass et al. (5), Minoura et al. (20) , and Prieto-Gonzalez et al. , only a few Bilecik et al. (21) and Aegerter et al. (29), iolated workstation quality as a core variable. Three studies Houle et al. (28), Butte et al. (27) and Argus and Paasuke (31) found no notable association between ergonomic variables and pain outcomes.

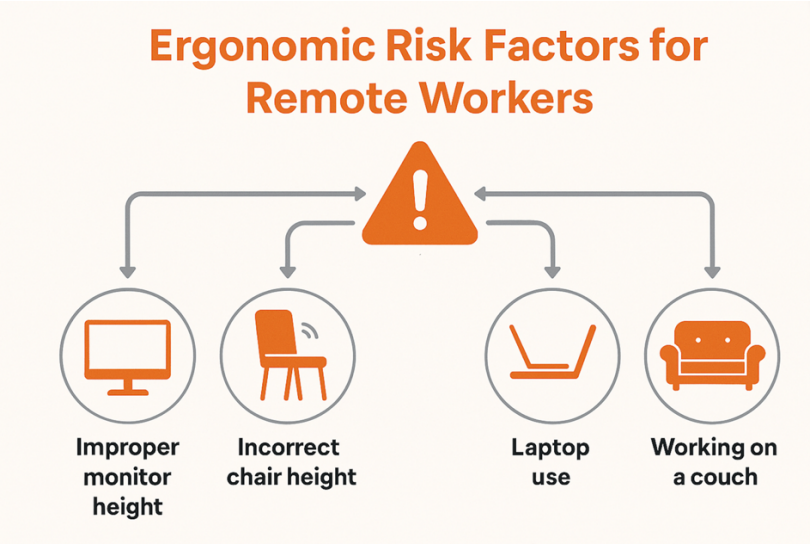

Figure 3.3. Ergonomic risk factors associated with remote workers

3.4 Behavioral and psychosocial factors

Seventeen studies explored behavioral and psychosocial contributors to MSDs (3–6,16–26,28,32). High sitting time was a common factor (6,16,23,25,27). Butte et al. (27) found an average of 9 hours/day of sitting, with remote workers sitting longer than office-based workers (569 vs. 477 minutes/day). Garcia et al. (23) noted that sitting more than 8 hours/day was associated with greater discomfort.

Postural strain was also frequently reported. Snodgrass et al. (5) found that trunk-leaning postures were linked to a nearly threefold increase in back pain (OR ≈ 2,9). Nasri et al and Gosain et al. (24) reported associations between phone use posture and upper body complaints.

Physical activity decline was commonly reported in (4,6,16,19,20,23,25,27). Gupta et al. (4) found that only 10% of respondents maintained their pre-pandemic activity levels. Butte et al. (27) found that remote workers performed muscle strengthening activities 2,2 days/week on average versus 0,5 among office workers. Casjens et al. (6) and Saes-Silva et al. (19) found that lower physical activity levels were linked to higher musculoskeletal symptom prevalence.

Psychosocial stress also played a role (3,5,6,17,19,21,25,32). Snodgrass et al. and Fourquet et al. (5,32) found that depressive symptoms and lower remote work satisfaction were associated with increased back pain reporting.

3.5 Assessment tools and confounding variables

Measurement tools varied. Four studies (18,23,24,31) used the Nordic Musculoskeletal Questionnaire (NMQ) or an adapted version. Two studies (6,17) used the Brief Pain Inventory (BPI). The Neck Disability Index (NDI) was used in (21,29). The other studies (3–5,13–16,19,20,22,25–28,30,32) used custom-designed or general questionnaires with Likert-type scales to measure pain frequency or intensity across body regions.

Symptom timeframes varied. Some studies (4,13,20,26,31)asked participants to report on symptoms both before and during the COVID-19 pandemic. Longitudinal data collection was used in (3,21,22,29). The remaining studies (5,6,14–19,23–25,27,28,30,32) assessed symptoms only during the pandemic without baseline comparisons

Confounding variables were reported and adjusted for to different degrees. Demographic factors like age, sex, and BMI were included in (5,14,18–21,23,26,28,31,32). Physical activity levels were assessed in (4,6,16,19,20,23,25,27). While (3,5,6,14–18,23–25,30,31) assessing ergonomic quality or specific workstation characteristics.

Author, year and country	Population	Number included	MSD assessment scale and body region	Confounders	Results	Limitations
MacLean et al. **Canada 2022**	University staff WFH	445	Self-reported survey (Likert-type). **Neck, shoulder and lower back**. Compared WFH to pre-pandemic	Gender, ergonomic design variables, seat height, monitor distance	61% reported increased pain levels, effects of gender mediated by poor ergonomics. Improper seat height and monitor distances were significant predictors of overall WMSD	Possible uneven gender distribution, self-reported data
Huršidić Radulović et al. **Croatia, 2021**	Telecomunicati on workers Aged 23 – 62	232 workers, 121 men and 111 women	Web survey (Likert scale) **Pain in lower back, upper back/neck, and hands** Pre vs during lockdown	Gender, work setting, ergonomic factors, disturbances from household members, working hours	Increased pain was reported in the lower back (39.1%), upper back (45.7%), and hands (27.2%), with women reporting more severe symptoms. Among those living with others, 70.7% experienced household disturbances. Poor ergonomic setups were significantly linked to higher pain levels	Small sample size, self-reported data, subjective assessments, potential bias from disturbances in shared workspaces, lack of objective measurements
Aegerter et al. **Switzterland, 2021**	Office workers aged 18-65, working more than 25 h/week from two Swiss organizations	69 (followed longitudinally)	**Neck pain** (intensity via Numeric rating scale, (0-10) and neck disability (Neck disability index, 0-100) During lockdown and follow up	Ergonomic quality of workstation, number of work breaks, hours at computer, age, gender (assessed in sensitivity analysis)	No meaningful change in neck pain or disability was found between pre-COVID office work and the WFH period—neck pain slightly decreased (mean 2.26 to 2.14). However, each additional hour at the computer increased neck pain by 0.36 points (95% CI: 0.09–0.62), while each work breaks reduced neck disability by 2.30 points (95% CI: –4.18 to –0.42). Home ergonomics were notably poorer.	Small sample, short follow up (5 weeks), self-reported measure, no baseline home-work data, limited generalization, recall bias (asked to recall their office workstation ergonomics)
Du et al. **Japan 2022**	Homeworkers in a large insurance company aged 20-65	4,112 (1930 males, 2182 females)	Survey with custom 4-level ordinal scale (0-3) measuring pain severity Self-reported **neck/shoulder and lower back pain** During lockdown	Computer type, furniture type (desk/ chair) WFH hours, break, WFH frequency, gender and age	Use of non-ergonomic setups (e.g. dining tables, floor chairs, tablets) significantly associated with increase in MSD complaints and lower work performance. Pain was most reported in neck/shoulders and lower back. Type of computer was found to have no association with neck/shoulder pain or low back pain	Self-reported data, cross sectional design, no clinical assessment, no baseline MSD data, variability in home environment
Saes-Silva et al. **Brazil 2023**	Adults ≥18 (avg 42, range 18–93) in two cities,	1016 remote workers	Self-reported back pain (**cervical, thoracic,**	BMI strata (normal vs overweight/obese)	25.6% prevalence; remote overweight/obese had ↑risk of acute cervical (PR 2.82), thoracic (PR 1.81), chronic low	Cross-sectional, self-reported, no ergonomic assessment, recall bias,

	Working remote during the pandemic		**lumbar; acute/chronic + intensity**)		back (PR 1.85); pain intensity higher (PR 1.51); BMI moderated outcomes	variable statistical power, no causality
Ishimaru et al. **Japan 2021**	Adult desk workers between ages 18-65 registered within a Japanese internet survey agency.	4227	Self-reported occurrence of **lower back pain** in the last month and time of first appearance, before or after the pandemic	Age, gender, sex, BMI, marital status, income education, lifestyle habits	Increased work from home was associated with lower back pain.	Cross sectional design, low response rate to survey. Selection bias, no information of the medical LBP diagnosis and quality of work environment.
Gupta et al. **India 2023**	281 responders working Indian professionals	281 (119 females and 162 male respondents)	Self-reported survey. **General MSD** during lockdown	Weight gain or loss, physical activity profile, number of working hours, total sedentary time, satisfaction	Reports of MSDs increased from 47.6% before lockdown to 53.6% during WFH. A decline in physical activity was noted by 10% of participants. MSDs were significantly associated with gender, prior discomfort, prolonged sitting, and extended work hours.	Self-reported data, limited sample size, cross-sectional design, lack or ergonomic assessment.
Muniandy et al. **Malaysia 2022**	University staff/ students	1500 participants	**Back pain incidents**	Increased sitting time, reduced exercise time, poor ergonomic sitting conditions	Among students and lecturers, 346 new cases of back pain were identified, with 61.2% experiencing lumbar pain. Back pain was strongly linked to increased sitting, reduced exercise, and poor ergonomic posture (OR 2.0; 95% CI: 1.2–3.6)	Population made of higher education people, difficult to generalize. Survey online and self-reported data.
Oakman et al. **Australia 2022**	Employes working from home. Age was categorized as 18–35 years (n = 121), 36–55years (n = 289) and 56 years and over (n = 78	The study followed 488 participants (113 males, 372 females, 3 other) over 13 months (Oct 2020–Nov 2021), focusing on the long-term impact of WFH on musculoskeletal pain.	Multi-region: 5-point frequency Likert + 3-point intensity Likert scales; instrument validated **Neck/shoulders, hands, arms, lower back, hips/legs/feet**	Workstation comfort, workstation location, working hours, psychosocial work conditions, and domestic living arrangements	Musculoskeletal pain was common, with over 70% of participants reporting discomfort by the end of the workday—most frequently in the neck, shoulders, hips, legs, and feet, especially among women. Four pain trajectories were identified: high stable (36.5%), mid-decrease (29.7%), low stable (22.3%), and rapid increase (11.5%). The latter was linked to poor ergonomics and high job demands, highlighting the role of inadequate home setups and work-life imbalance in persistent MSP	Potential selection bias due to geographical and gender representation in the sample Cross sectional design
Moretti, Menna, Aulicino, Paoletta, Liguori, Lolascon Italy 2020	Mobile workers working from home during Covid 19	51	Brief pain inventory questionnaire (BPI) **for lower back pain, neck pain and** covering intensity and interference	Home workplace conditions, job satisfaction, work related stress and musculoskeletal pain	39.2% of participants reported lower productivity, while 39.2% felt less stressed. 41.2% experienced low back pain (LBP), and 23.5% reported neck pain. Neck pain worsened in 50% of home workers, while LBP remained stable in 47.6% of cases. Lower job satisfaction was observed among those with MSK pain	Small participant pool, focused on only individuals from a single region in Italy. Cross sectional study, and some confounder not accounted for.
Bosma, Loef, H van OOstrom	Dutch workers from the Lifelines	40,702	Repeated self-report questionnaires;	Sedentary screen work, home workplace	Working from home was associated with higher risks of musculoskeletal pain in the	Questioner,

Netherland 2022	COVID-19 cohort		likely Likert-based for **multi-region MSP** **Longitudinal**	ergonomics, hybrid work conditions and physical activity levels	lower back. (OR: 1.05), upper back (OR: 1.24), and neck/shoulder/arm (OR: 1.18). Hybrid workers also had increased risks of MSP in the upper back (OR: 1.09) and neck/shoulder/arm (OR: 1.14). Both home and hybrid workers had higher risks of severe MSP compared to location workers	
Chim and Chen Hong kong 2023	Office workers who worked from home during COVID-19 pandemic	232 participants	Survey **Neck upper/ lower back** During lock down	Workstation setups, work arrangements, prolonged computer use, living space constrains	MSD was reported by 61.2% of participants. Risk increased for those working in living/dining areas (51%) or bedrooms (24.6%). Prolonged computer uses and flexible work styles contributed to discomfort. Poor ergonomics—such as using a chair without a backrest, a sofa, or a laptop screen—increased the risk of neck, upper back, and lower back pain by 2–3 times.	Small sample size, self-reported data, cross-sectional design
Argus, Paasuke Estonia 2021	Office workers transitioning to remote work during the covid 19 lockdown	161 participants	Nordic Musculoskeletal Questionnaire (NMQ) comparing pre- and during-lockdown reports Multiple regions	Physical activity levels, workplace ergonomics and comfort rates, work-related physical activity, individual factors influencing MSP	No significant difference in MSP prevalence before and during the lockdown. Total physical activity (PA) decreased, with a significant drop-in sport-related PA ($p < 0.001$). Work-related PA increased, pointing to a shift in movement patterns due to remote work. Workplace comfort and ergonomics ratings declined significantly ($p < 0.05$ and $p < 0.001$, respectively). Several individual factors influenced MSP, highlighting the importance of ergonomic workspace setups and maintaining physical activity.	Self-reported data, small sample size, cross sectional design.
Casjens, Swaantje Germany 2025	Office workers using computer workstations (≥4 hours/day) were recruited via German social accident insurance. Participants were aged between 18 and 70	722	Brief Pain Inventory (BPI) with 0–10 scales covering 7 domains **Multiple regions** **Pre vs during lockdown**	Key factors assessed included workstation ergonomics (seating, desk, monitor, input devices), physical activity, mental health (PHQ-4), headaches, eye strain, work-family conflict, and weight changes during the pandemic.	Poor ergonomics—such as working on a sofa or using a laptop screen—increased neck and back pain. Compared to pre-pandemic levels, pain in the lower back, upper back, neck, and shoulders worsened. Higher MSP was also linked to mental distress, reduced exercise, and work-family conflict. Although work-related movement increased, it did not offset the decline in overall physical activity.	Self-reported data, potential selection bias, cross sectional design.

Snodgrass, Kang, Edwards, Heneghan, Puentedura, James Australia 2024	Frequent computer users working during COVID-19 (office-based professionals, mix of home and hybrid work styles)	634 participants	Body-region pain questionnaire + 7-point posture scale, plus CES-D short for depression **Lower back and posture type**. During lockdown	Work location: Home/office/dining table/other - Sitting posture: pre-defined body position diagrams - Depressive symptoms: CES-D Short - Sleep quality: Good/average vs. poor - Gender	Sitting posture ("trunk a little bent forward" vs. "straight up, back against back rest"): OR ≈ 2.9 (95% CI 1.3–6.5), p=0.008 - Female gender: OR ≈ 2.2 (1.2–4.1), p=0.008 - Depressive symptoms: OR ≈ 3.4 (1.7–6.6), p<0.001 - Poor sleep quality also related to LBP, but association overlapped with depressive symptoms - Work location (home vs office) not significantly associated with LBP	Self-selection bias, social media and emailing recruitment, lack of random sampling, survey-based responses (recall bias)
Nasri, Susilowati, Hasiholan Indonesia, 2023	Lecturers, university students and administrative staff	1083 respondents	Self-reported musculoskeletal symptoms based on Nordic Body Map approach) **Neck, shoulders, upper back, lower back, arms/ wrists, hips and knees**	Age, gender, role (student vs staff) Duration of gadget use, posture and device handling technique	Higher MSD risk associated with older age, female gender, holding phone with both hands – thumbs	Self-reported data, cross – section design, limited generalization
Houle, Lessard, Marineau-Belanger Canada, 2021	Telecommuters aged 18-65 working home during covid-19	162	**Headache** disability (6-item headache impact test). **Neck disability** (Neck Bournemouth Questionnaire). Daily NRS	Age, sex, baseline headache and neck disability, BMI, designated workspace, telecommuting daily hours	Only baseline headache predicted new headache: odds ratio: 1.094 per point (95 % CI: 1.042–1.148), $p < 0.001$ Only baseline neck pain predicted new neck pain: OR: 1.182 per point (95 % CI: 1.102–1.269), $p < 0.001$ Workspace setup and hours worked had no effect.	Self-reported, small sample, short follow up
Garcia, Auiar, Bonilla, Yepez Ecuador, 2022	Full time employees at the academic institution in Quito, working during COVID – 19	201 participants	Cornell Musculoskeletal Discomfort Questionnaire Nordic Musculoskeletal Questionnaire Head, eyes, neck, shoulders, elbows, upper back, lower back, hips, knees and ankles.	Age, gender, BMI, telework hours, sitting/standing/ walking time, break frequency/ duration/ working space ergonomics (monito height, chairs, lighting)	>70% reported discomfort during pandemic in head, eyes, neck, and lower back During COVID-19 telework, discomfort in various body regions was linked to poor home office setups. Among staff, not using a laptop stand significantly increased head and eye discomfort. For faculty, discomfort in the head, eyes, neck, shoulders, hands, and lower back was associated with factors like poor lighting, uncomfortable desks, long sitting hours, and lack of ergonomic equipment. Notably, sitting over 8 hours/day and teleworking more than 5 days/week increased discomfort, while some protective effects were seen, such as using only	Self-reported, survey

					one monitor and having more people in the household.	
Belecik, Belibagli, Cetin Turkey, 2023	Teachers working in public and private schools	1032 teachers 679 participants completed baseline and 1-yesr follow up.	**Neck** disability index and numerical rating scale	Age, gender, employment duration, smoking status, weekly teaching hours	Pain & Disability increased over time: Mean NDI: 11.61 → 12.65 Mean NRS: 3.05 → 4.75 Women had significantly higher NDI and NRS scores than men ($p < 0.001$) Weekly session hours were significantly associated with: NDI score ($p = 0.011$) Disability group classification ($p < 0.001$) NRS score ($p < 0.001$) Age and employment duration had weak correlations with NRS and disability Strong correlation between baseline and 1-year NDI and NRS scores ($r = 0.821$ for NDI, $r = 0.691$ for NRS)	Electronic survey data collection, limited to neck region
Butte, Cannavan, Hossler, travis USA 2022	Full time sedentary employees	53	**Lower back** and **hip posture** ActivPAL (objective measure of sitting time) Thomas test: posture Self-report: Lower back pain Godin PA Questionnaire	No significant differences in aerobic PA or steps/day between work settings. Many participants self-managed mild LBP, possibly masking stronger associations.	High sitting time (avg. 9 hrs/day) significantly predicted poor hip posture ($p < 0.046$). Sitting time was NOT significantly associated with low back pain ($p = 0.43$). Poor posture showed a non-significant trend toward increased LBP ($p = 0.11$). Participants working from home had higher sitting time (569 min/day vs. 477 offices; $p < 0.02$), but also did more muscle-strengthening PA (2.2 vs. 0.5 days/week; $p < 0.04$).	Small sample, remote data collection,
Tezuka, Nagata, Saeki, Fukutani et al. Japan 2021	Full-time employees who were non-teleworkers before the pandemic	917	Self-reported physical symptoms **(focused on stiff shoulders, eyestrain, and lower back pain)**	Age, sex, BMI, marital status, occupational status, pre-existing symptoms	Telework ≥5 days/week significantly increased odds of symptoms: stiff shoulders (OR 3.02), eyestrain (OR 5.31), and low back pain (OR 5.57), compared to non-teleworkers. Effects were dose-dependent across telework frequency levels.	Cross sectional design, recall bias (survey months after exposure), low response rates, male dominant sample
Fourquet et al, France 2024	Adults, employed during Frances' 3rd lockdown, including only those who worked telework ≥1 day/week and were free from LBP at baseline	466	**Onset of back pain (LBP)** assessed via binary yes/no question before and after lockdown, based on **Nordic Musculoskeletal Questionnaire principles.**	Age, gender, depressive symptoms, satisfaction with telework conditions	Structural Equation Modeling (SEM) showed telework conditions had both direct (biomechanical) and indirect (psychosocial) effects on LBP onset. Indirect effects were mediated through lower satisfaction and higher depressive symptoms. Women and those with depression had higher risk of LBP. Unexpectedly, a second monitor	Cross sectional design, recall bias, bidirectionality between pain and satisfaction possible, no objective ergonomic measures or work organized data known.

					was associated with increased LBP.	
Gosain, Kaushal, Gaur India, 2022	Computer useers working from home during the COVID-19 lockdown, for more than 6 hours/ day	121 (68 males and 53 females)	Standardized Nordic Musculoskeletal Questionnaire (NMQ) **Neck, lower back, shoulders**	Eye strain, lack of ergonomic workstation, postural stress, eye strain, mental stress due to work	Higher MSD prevalence in females than males. Strong association between non-ergonomic setups and pain intensity. Neck (60,3 %), lower back (59,5 %) and shoulders (49,6) were the most commonly reporter pain areas	Self-reported data -> subject to bias. Limited to Indian population, affecting generalizability. No clinical validation or longitudinal follow up.
Prieto-Gonzalez, šutvajová, Lesňákova Slovakia, 2021	Female teachers working remotely during COVID-19	782	Self-administered 18 item online questionnaire, rating pain 1-5 scale Body regions: **cervical**, **lumbar**, **thoracic**	Region of residence, school type (primary vs secondary). Frequency of online classes. Physical activity. Ergonomic compliance, stress levels, time spent sitting	High backpain prevalence: cervical (74,8 %), lower back (67,7%). Over 60% reported pain in multiple spinal regions. Pain was more severe in this with no physical activity, high stress, poor ergonomics and who sat most of the day.	Self-reported data, no medical verification or clinical diagnoses, online-only format limited control over participant accuracy. Did not account for prior conditions or medication use

Table 3.1. Overview of results

4.0 Discussion

4.1 Prevalence and severity of MSDs in remote work contexts

Most studies reviewed – eighteen out of twenty-four – reported a rise in musculoskeletal disorders (MSDs) among remote workers during the COVID-19 pandemic. The trend suggests that many employees struggled with the abrupt move to remote work, which likely added a physical strain as they adapted. Symptom rates ranged widely – roughly 25,6 % to more than 70% - and those figures should be viewed cautiously, since few studies include solid pre-pandemic comparisons. Only a few studies, such as Gupta et al. (4) and Tezuka et al., (26), include direct before and after comparisons. Their findings pointed to only modest increases in symptoms, implying that remote work played a role in increased discomfort but was not the sole contributing factor.

The heterogeneity in the findings across studies, including those that found no significant change, like Aegerter et al. (29) and Argus Päasuke (31), highlights contextual variability. Aegerter et al. (29) used a longitudinal design, suggesting that poorer ergonomics alone may not significantly increase the symptoms, pointing to possible moderating effects such as individual adaptation or prior pain management strategies.

Despite discrepancies in prevalence, the anatomical distribution of symptoms was consistent. Most studies identify the neck, shoulders, and lower back as the most affected regions, an observation aligning with the Load tolerance model, which conceptualizes injury as a result of cumulative loading that exceeds the tissues' suboptimal threshold. These regions are particularly vulnerable to static posture and suboptimal workstation configurations.

While severity assessments were typically self-reported, converging evidence from studies such as Chim and Chen (15), Muniandy et al. (16), and Gosain et al. (24) reinforces a cross-cultural pattern of regional discomfort. Furthermore, studies like Oakman et al. (3) and Casjens et al. (6) linked elevated symptom severity to high job demands and psychological distress, emphasizing the multifactorial nature of MSDs in remote settings.

Collectively, these findings support the hypothesis that remote work contributed to increased musculoskeletal complaints, although causality remains difficult to establish due to the methodological limitations discussed below.

4.2 Ergonomics risk factors

Ergonomic factors emerged as consistent and influential predictors of MSD outcome. Twenty of the included studies (3,5,6,13–19,19–26,29,30)assessed aspects of home workstation design, with the majority identifying a clear association between poor ergonomic conditions and increased pain. Common deficiencies included the non-adjustable seating, improper screen height, lack of lumbar support, and workspaces not designed for extended use (e.g., sofas or kitchen tables).

Chim and Chen (15) and Muniandy et al. (16) demonstrated that such setups significantly elevated the risk of discomfort in the neck, shoulders, and lower back. In Oakman et al. (3), poor workstation comfort was linked to distinct risk pain trajectories, highlighting the cumulative burden of physical and psychological stressors.

However, a minority of studies, Aegerter et al. (29), Houle et al. (28), and Butte et al. (27), reported no significant ergonomic association. These findings likely reflect differences in methodological design, sample characteristics, and how ergonomics was operationalized. Importantly, most studies (3,5,14,15,23) relied on self-reported assessments of workstation quality, lacking objective ergonomic evaluations. Definitions of ergonomic quality also varied, ranging from discrete variables (e.g., monitor distance) to subjective comfort ratings, limiting cross-study comparability.

In line with the interaction model, which posits that MSD outcomes emerge from the interplay of physical, behavioral, and psychological factors, these findings suggest that poor ergonomics alone may not predict symptoms unless compounded by inadequate recovery, high job strain, or behavioral risk factors.

4.3 Behavioral and lifestyle factors

Behavioral patterns, particularly physical inactivity, prolonged sitting, and poor posture were repeatedly identified as key contributors to MSDs. Extended sedentary time was associated with higher symptom rates in several studies (3–6,16–26,28,32), often exceeding 8 hours per day. Snodgrass et al. (5) demonstrated a near threefold increase in low back pain risk among participants with sitting posture.

Nonetheless, findings were not universally consistent. Butte et al. (27), using objective sitting time data, found no significant association between sitting duration and pain, though poor posture showed a non-significant trend toward increased discomfort. These mixed results highlight the importance of posture quality and recovery pattern rather than sitting time alone.

Physical activity reductions were another recurrent theme. Several studies, including Gupta et al. (4) and Argus and Pääsuke (31), documented declines in both structures and incidental activity. This lack of movement likely compounded the effects of static loading and poor ergonomics, accelerating musculoskeletal fatigue.

Psychosocial stressors such as job strain, depressive symptoms, and disrupted work-life balance amplify MSD risk in studies like Oakman et al. (3), . Casjens et al. (6), and Saes-Silva et al. (19). For example, depressive symptoms in Snodgrass et al. (5) were more strongly associated with lower back pain than posture or work location. These findings further support the interaction model, where psychosocial and behavioral factors modulate the physiological impact of biomechanical stressors.

4.4 Measurement tools and methodological considerations

A major barrier to cross-study synthesis was the inconsistency in how MSDs were measured. While some studies (4,18,23,31), employed validated tools like the Nordic Musculoskeletal Questionnaire (NMQ) or the Brief Pain Inventory, others relied on ad hoc surveys with non-standardized response formats. Most studies (3–6,13,15–24,26,30), used self-reported data, which introduced a recall bias and variability in symptom interpretation.

Objective measurement was rare Butte et al. (27) was one of the few studies to incorporate direct observation tools, including the activePAL device to quantify sitting time and the Thomas Test for assessing hip posture. While these methods enhanced the accuracy of behavioral data, even this study relied on self-reported pain outcomes, reinforcing the general dependence on subjective reporting across the evidence base. Longitudinal designs were rare; most studies were cross-sectional, limiting causal inference. Even among those attempting retrospective comparisons, the absence of clearly defined pre-pandemic baselines reduced reliability.

Control for confounders also varied widely. While most studies adjusted for age, gender, and BMI, few included psychosocial or behavioral variables. Those that did Snodgrass et al., Saes-Silva et al, and Casjens et al. (5,6,19) identified stronger and more complex associations, underscoring the importance of comprehensive modeling.

Methodological gaps across the literature emphasize the need for more rigorous longitudinal and standardized research. Future studies should adopt validated MSD instruments, incorporate direct ergonomic measurements, and account for the full range of physical, behavioral and psychological variables influencing musculoskeletal health in remote contexts.

4.5 Limitations of the review

This review has several limitations that should be acknowledged. First, it focused exclusively on quantitative studies published in English, which may have excluded relevant research in other languages or from qualitative perspectives. Second, despite efforts to apply a structured search strategy, the inclusion of studies from Google Scholar may have introduced selection bias or reduced reproducibility. Third, the narrative synthesis approach, while appropriate for heterogeneous data, is inherently subjective and lacks the statistical power of a meta-analysis. Finally, because most of the included studies relied on self-reported measures and lacked clinical verification, the conclusions drawn here are subject to the same limitations of primary data sources. These constraints should be considered when interpreting the generalizability and strength of the findings.

Conclusion

Remote work during the COVID-19 pandemic was consistently associated with elevated rates of musculoskeletal disorders (MSDs), particularly in the neck, shoulders, and lower back, reduced physical activity, and psychological stress. Although a few studies found no significant change, the majority reported higher symptom rates, reinforcing concerns about the physical health impacts of working from home. Limitations such as reliance on self-reported data, inconsistent definitions, and lack of baseline measurement temper the strength of causal claims but do not undermine the overall pattern. As remote and hybrid work arrangements persist, there is an urgent need for proactive ergonomic support, behavior interventions, and standardized research to mitigate long-term musculoskeletal risks in the remote work environment.

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