Systematic Literature Review

Musculoskeletal pain and risk factors in office workers versus teleworkers: A systematic review

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Abstract

Background: Musculoskeletal pain is common in office workers and teleworkers, but the causes remain not enough visible in society.

Objective: This systematic review examines main risk factors for work-related musculoskeletal disorder (WRMSD) in office workers versus teleworkers.

Methods: PubMed/ Medline, Scopus and Web of Science databases were searched using keywords based on the theme, CoCoPop was used to define the inclusion criteria, also used the PRISMA guidelines, the QuADs tools to evaluate the quality of the studies, risk of bias analyses was done with the Navigation Guide for Systematic Reviews in environment and occupational health.

Results: Of 468 studies identified, 17 were included in the final selection. Both office workers and teleworkers have working conditions at risk of developing or aggravating MSD, but results highlighted the poor teleworkers workplaces, ICT equipment's as laptops, psychosocial and organizational demands that increased the working time and family conflicts, and environmental risk factors associated to teleworkers increased WRMSD symptoms/pain.

Conclusions: This review underline the lack of appropriate working conditions at home and that is a contribute for increasing WRMSD pain in teleworkers. Employers should give more importance ensuring ergonomic workplace at teleworkers home, including also worker's organizational companies support.

Keywords

telework, office work, working conditions, musculoskeletal pain, occupational health, workplace condition

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Introduction

Work-related musculoskeletal disorders (WRMSD) are prevalent in many countries, involving an important economic and social burden.[1] These disorders are one of the most widespread and costly Occupational Health and Safety (OHS) problems around the world.[2] WRMSD affects the human locomotor system including muscles, tendons, ligaments, joints, and nervous.[1] Musculoskeletal disorders tend to limit mobility and dexterity, leading to early retirement from work, and reduce the ability to participate in society.[3] Risk factors include physical, ergonomic, organizational, and psychosocial elements present during work activities.[4] WRMSD have significant implications on cost and productivity, and considering future implications it is necessary to understand the causes, ensuring for effective ways to prevention.[1]

Working with computers or other electronic devices that demand workers exposure to ergonomic risk factors, as a seated posture, high arms, hands, and fingers repetitivity, has been frequently linked to WRMSD.[5–8] Musculoskeletal symptoms and pain among employees working with visual

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display units (VDU) has been an important topic in occupational health for many years.[6] With a tendency of advancements in information and communication technology (ICT) many office workers can do their jobs from anywhere if there is an internet connection.[8] Nowadays telework is growing around the world, mainly after the COVID-19 pandemic.[9] The pandemic prompted a significant shift towards remote work for many individuals. The rapid shift has contributed to a frequently negative increase of home OHS conditions, mostly contributing to worst worker's physical and mental health.[10] With the COVID-19 pandemic and the isolation to prevent contamination, remote work/telework became fundamental for employees to maintain their work. So, teleworking became a necessary practice as an alternative to office work during COVID-19, allowing a "safe place" to work.[11]

During pandemic teleworkers had been sent to work at home without having a defined workspace and conditions to accommodate a full-time teleworking job.[12,13] Many teleworkers didńt have a private room specially designed for work and/or adequate equipment's, internet connection, and digital devices to work. Teleworkers were also forced to support their children in the distance learning during work with the closure of schools,[13] increasing the psychosocial demands. If the home office was the possible alternative to maintain work activities, it is necessary to highlight that in the domestic environment the working conditions do not always resemble those found in company offices, demanding a different exposure to ergonomic risk factors, that we believe contributes to an increasing in WRMSD symptoms. Working at the kitchen or living room tables, in chairs without armrests, or sitting on a couch, exposes teleworkers to greater levels of risk that may increase the WRMSD symptoms presence. The inadequate and non-ergonomic workplaces and equipment's in telework may be etiologically responsible for pain or for the aggravation of musculoskeletal disorders.

But there are positive factors of working from home, that may include control over work, effectiveness, and balanced management between professional and personal life.[14] Also, saving time in commuting is highlighted as a positive factor.[15] Although, during pandemic there were negative factors related to inadequacy of communication tools, and losses in social interactions.[14] The working conditions during pandemic included not having adequate ergonomic workstation, and the use of other spaces, and different furniture's to work, as dinning table and chairs.[16,17] Also, there are reports of increased: (i) workload at home,[15] (ii) stress[18,19] and (iii) interruptions/disturbances at work.[16,20]

In a review carried out by Wütschert et al.,[21] it was identified unsatisfactory working conditions in teleworkers, with the presence of ergonomic risk factors and musculoskeletal pain. Some studies standouts that there has been an increase in musculoskeletal discomfort following the transition to telework in the COVID-19 pandemic.[16,19,22] With the growth of telecommuting and the number of people working remotely, research on working conditions and risk factors exposure at home that are frequently the causes of WRMDS has grown to assure the society is on the right path, to prevent work-health relationship and ensuring workplace health promotion.[12]

The present review had the purpose to identify the main risk factors in office workers and teleworkers, analysing if there are musculoskeletal symptoms/pain differences, facing different working conditions and different exposure patterns to ergonomic risk factors. We hope that will allow contributing to WRMSD prevention strategies in the future.

Methods

Selection of studies

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement.[23] The Condition, Context, Population (CoCoPop) used to define the inclusion criteria for selection in this review were: (i) Condition – office workers and teleworkers with work-related musculoskeletal pain in at least one body region; (ii) Context – working in an office or at home or out of the company or both (e.g., type of contract, working hours/day, ergonomic workplace conditions, using computers and/or laptops, or other external devices, and organizational demands, as frequency of pauses and tasks); (iii) Population – office workers and teleworkers male and female, aged between 20 to 65 years old, from all ethnic groups, all educational levels, all family composition, and all professions, from public or private sector or both, sedentary or not. The exclusion criteria were: books, book chapter, proceedings, letters, conference papers, editorial material, correction, review studies, case study articles, intervention study articles, treatment studies, current topics and opinions, short communications, qualitative studies and others written in languages other than English, articles published out of the selected period, and full research articles that did not attended the CoCoPop defined inclusion criteria. Also, only articles published in peer-reviewed journals were included. It was considered office workers who mainly work with computers in an office environment and with the worker sat at a purpose-built computer workstation, and teleworkers those who mainly work with computers or laptops in a home-based environment, also during COVID-19 pandemic.

The literature search was performed according to Peer Review of Electronic Search Strategies guidelines in the PubMed/Medline, Scopus and Web of Science database from the period of 01/01/2000 until 30/12/2022. The search began in March 2022 and was completed in July 2022. The search terms used MESH words and keywords most used in papers about the theme, also using Booleans operators as AND, OR, and symbol* to find variants of the term. For PubMed/Medline: ("Teleworking"[Mesh]

OR " remote work*" OR "work* from home" OR "telecommuting" OR "visual display unit" OR "office work") AND ("Musculoskeletal Diseases"[Mesh] OR "musculoskeletal disorder*" OR "workplace ergonomics" OR "musculoskeletal pain" OR "work-related musculoskeletal disorder*"); for : For Scopus: ("Teleworking" OR " remote work*" OR "work* from home" OR "telecommuting" OR "visual display unit" OR "office work") AND ("Musculoskeletal Diseases" OR "musculoskeletal disorder*" OR "workplace ergonomics" OR "musculoskeletal pain" OR "work-related musculoskeletal disorder*"); and for Web of Science: ("Teleworking" OR " remote work*" OR "work* from home" OR "telecommuting" OR "visual display unit" OR "office work") AND ("Musculoskeletal Diseases" OR "musculoskeletal disorder*" OR "workplace ergonomics" OR "musculoskeletal pain" OR "work-related musculoskeletal disorder*").

One reviewer author (MCBA) excluded clearly the records accordingly to the exclusion criteria. Two reviewer authors (MCBA, NRS) independently screened abstracts to exclude studies that did not attended the CoCoPop inclusion criteria, and then read the full texts for eligibility also based on inclusion criteria. PRISMA flow diagram was used (Figure 1).

Extracted data

The researchers followed the software CADIMA that is a systematic review tool designed to create protocols and processes of screening and data extraction (https://www.cadima.info/index.php). For the included studies the authors extracted the following information: authors, year of publication, study characteristics (research design and country), the population characteristics (sample size, age

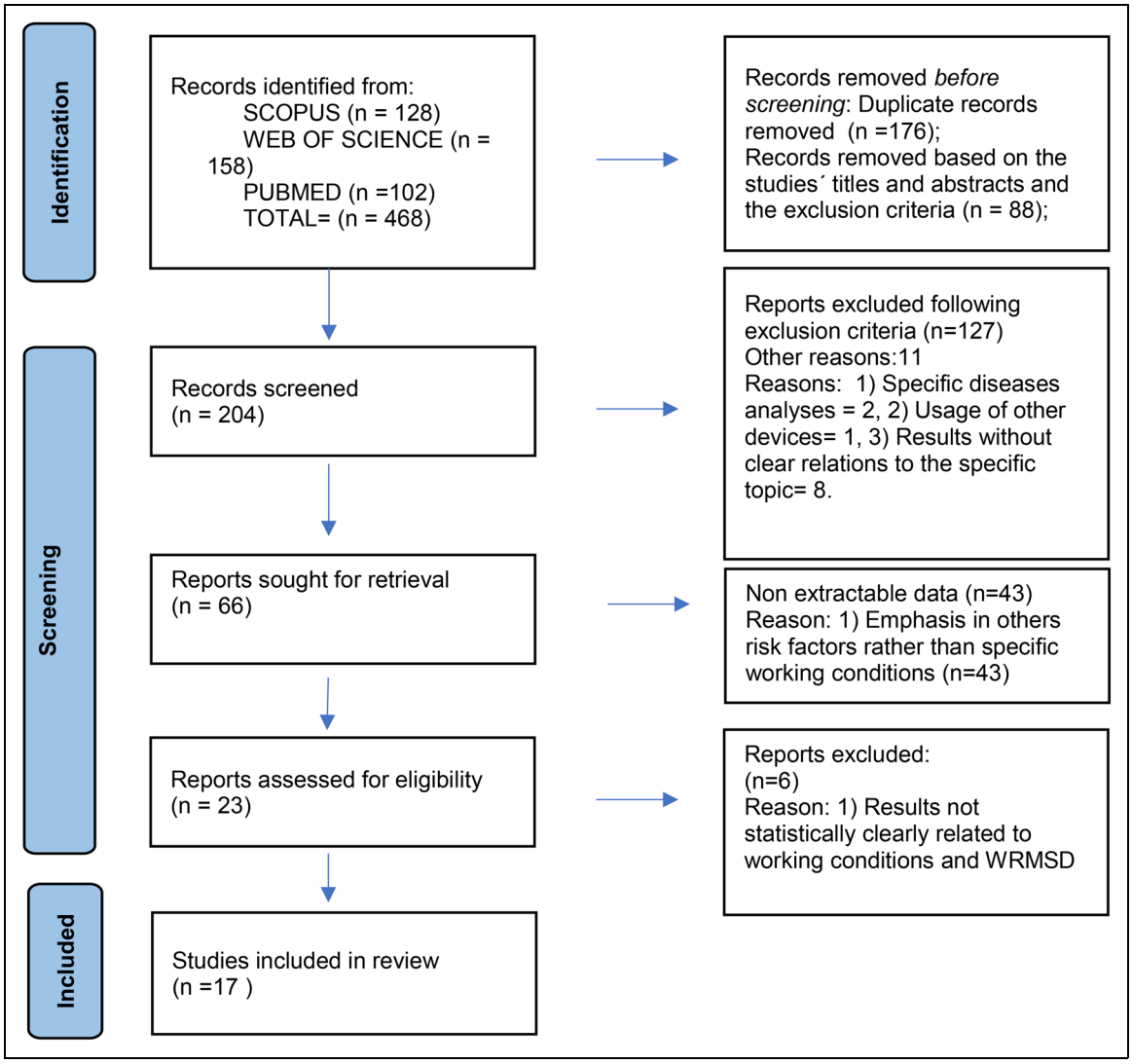

Figure 1. PRISMA flow diagram for this systematic review.

Table 1. General information and characteristics of the included studies (n = 17).

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
[24]	Korhonen, 2003	Finland	Cohort study	180	Municipal Administrative Units	25–43 = 32% 44–51 = 33% 52–61 = 35%	F = 80 M = 100	To investigate the work related and individual factors for incidence neck pain among office employees working with VDUs	The incidence of neck pain or radiating neck pain was 34.4% (95% CI = 25.5–41.3). It was associated with an inappropriate physical work environment and poor VDU related ergonomics. From the individual factors: prevalence in the female sex (OR 2.3 CI = 1.2- 4.4) and those with smoking habits (OR 1.3 CI = 1.2–4.4).	2.81
[7]	Wu, 2012	China	Cross-sectional study	560	Chinese service industry	19–25 (22.3%) 26–30 (35.9%) 31–40 (27.3%) 41–59 (14.5%)	F = 237 M = 323	To estimate the prevalence of self-reported WMSDs for office-workers who regularly perform VDU work	The results showed the 12-month prevalence of neck (55.5%), shoulder (50.7%), wrist/hand (31.5%), upper back (26.2%) and low back pain (6.6%) among participants. It was found association with WRMSDs with VDT operating hours per day ($p = 0.02$), not having enough time to rest ($p = 0.02$), holding the neck at 10–20° flexion angle had an odds ratio of 2.54 (95% CI = 1.56- 4.14, $p < 0.000$) compared with a reference level, and individual factors included: female sex (OR = 2.16, $p = 0.01$), educational level ($p = 0.02$), and practice of physical exercise ($p = 0.04$).	2.73
[25]	Ye, 2017	China	Cross- sectional study	417	Financial organizations	29.1 ± 6.8	F = 254 M = 163	To identify the risk factors of non-specific neck pain and low back	The prevalence of NP and LBP were 86.3% and 75.5%. The differences in sex, marital status, history of neck injury and cold office	2.96

(continued)

Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
								pain among computer workers	temperature among the NPQ tertiles were significant ($p < 0.05$). Having the computer monitor located not in front of the operator had significantly associated to NPQ tertile ($p < 0.05$). History of neck/ low back pain injury, longer office work years were significant risk factors for LBP ($p < 0.05$).	
[18]	Rodriguez-Nogueira, 2021	Spain	Cross-sectional study	472	Universities workers	F = 45.3 (11.2) M = 48.1 (10.9)	F = 283 M = 189	To analyze the impact of the confinement period of teleworking that could give rise to consequences for the musculoskeletal system	The areas of pain noted during confinement period concluded that it was less in all cases ($p < 0001$). Being a woman had a direct influence on the probability of developing musculoskeletal pain (OR = 2.3 CI 1.25 to 4.44; $p < 0.01$). Also, it was observed an increase of physical activity (OR = 0.9 CI 0.63 to 1.33).	2.73
[17]	Du, 2022	Japan	Cross-sectional study	4112	Homeworkers	Younger than 40 (26.3%) 40–49 (39%) 50 and older (34.7%)	F = 2182 M = 1930	To survey homework conditions, specifically the living furniture and computer use in terms of how furniture and computer use affects self-reported musculoskeletal problems and work performance for homeworkers	Reported neck/shoulder (grade 1 in 50.1% and grade 2 in 19.3%) and low back pain (grade 1 in 47.1%, and grade 2 in 18.3%). Female workers were approximately 3 times more likely to develop mild neck/shoulder pain (OR = 3.11 CI 3.62–5.51) and 4 times more likely to develop severe neck/ shoulder pain (OR = 4.47 CI 3.62 -5.61). Working	2.62

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Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
									time of more than 9 h was associated with higher risk of developing severe neck/ shoulder pain compared with a working time less than 7 h (OR = 3.40 CI 2.56- 4.52). Using "other tables" showed a significant association with severe neck/shoulder pain (OR = 1.60 CI 1.05–2.44), and using floor cushion (OR = 2.23 CI 1.33–3.74) and sofa (OR = 1.89 CI 1.05–3.41) were associated to mild neck/shoulder pain.	
[19]	Gerding, 2021	USA	Cross- sectional survey	843	Home-offices of university employees	Less than 30 (n = 36) 31–40 (n = 201) 41–50 (n = 219) 51–60 (n = 212) 61–70 (n = 128) 71 and above (n = 24) NR = 23	F = 509 M = 289 Other = 1 NR = 44	To survey the faculty staff, and administrators at an university about their home-office, specifically the ergonomic stressors and musculoskeletal discomfort	40% of survey respondents noted moderate to severe discomfort levels in neck/ head, upper back/ shoulders, and lower back regions (46.9%, 49.7%, 42.8%). Laptop usage was inversely related to desktop computer usage ($p < 0.001$) and tablet usage ($p < 0.05$). Use of an office chair with armrest was negatively correlated to laptop usage ($p < 0.0001$). The opposite was case of dinning room chair (laptop: $p < 0.001$ and desktop computer: $p < 0.0001$), couch (laptop: $p < 0.001$ and desktop computer $p < 0.01$). Usage of couch was found to be correlated to bed usage ($p < 0.0001$). Couch and no workstation	2.69

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Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
									($p < 0.0001$) laptop monitor and no workstation ($p < 0.001$). It was clear there has been a dramatic increase in discomfort symptoms following the transition to telework. Many of the respondents had poor ergonomic conditions.	
[26]	Johnston, 2008	Australia	Cross-section survey	333	Health administration, educational and municipal workplaces organizations	Under 20 (1.8%) 20–24 (6.3%) 25–29 (12.3%) 30–34 (12.7%) 35–39 (15.4%) 40–44 (12.3%) 45–49 (17.8%) 50–54 (12.7%) 55–59 (6.6%) Above 60 (2.1%)	F = NR M = NR	To determine the level of neck pain and disability in a sample of female workers and explore the relationship between individual and workplace risk factors	Workers reported nil (32%), mild (53%), moderate (14%) and severe (1%) neck pain. Most risk factors were associated with workstation. The factors associated with greater score on NDI were: rarely perform physical activity ($p = 0.03$), had a history of neck trauma in the past ($p = 0.03$), typed with greater force ($p = 0.03$), used the keyboard and mouse over 6 h/day ($p = 0.03$), spent more than 2 h sitting at their workstation before taking a break ($p = 0.03$) and spent more than 2 h on computer-based tasks ($p = 0.000$).	2.81
[27]	Janwantanakul,2009	Thailand	Cross-sectional survey	1185	Social Security Office	35.2 ± 8.4	F = 807 M = 378	To investigate the relationships between the self-reported prevalence of musculoskeletal in the neck, upper-back and low back and certain individual,	Working in an uncomfortable posture was strongly correlated to complains of musculoskeletal pain in the neck/head ($p < 0.01$). Workers who reported frequently working in an uncomfortable posture were at greater risk of	2.58

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Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
								work-related physical and psychosocial factors	experiencing neck symptoms compared to those who never or occasionally worked in an uncomfortable posture (OR = 1.81, CI 1.35–2.44). Also, high repetitive trunk bending during work increased the risk of experiencing upper back symptoms (OR = 1.80 CI 1.32–2.44) and working in a job that required little interactions with others (OR = 0.42 CI 0.25–0.68). Also working for >8 h a day elevated the risk of low back symptoms (OR = 1.66 CI = 1.25–2.22).	
[33]	Sillanpaa, 2003	Finland	Cross-sectional study	979	Office workers, Customer service workers, Designers	F = 43.7 M = 35.9	F = 290 M = 8	To estimate the prevalence of musculoskeletal disorders among full-time VDU users	Pain in the shoulders ($p < 0.001$), elbows ($p < 0.001$) and fingers ($p < 0.05$) was dependent on age. Age was associated with excess risk of elbow pain (OR = 1.06 CI = 1.01–1.11). Working with a computer <4 h per day lowered the risk for shoulder pain (OR = 0.3 CI = 0.085–1.026). For customer service workers, the poor ergonomic rating raised the risk of neck pain (OR = 2.3 CI = 1.1–4.5). For office workers ergonomically poor workstations increased the risk of fingers pain (OR = 2.8 CI = 1.3–6.1). For women, the risk of pain	2.81

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Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
									was greater than for the men (OR = 4.35 CI = 1.69–11.11).	
5	Fogleman, 2002	USA	Cross sectional study	292	Corporate Office site	42.7 ± 9.2	F = 143 M = 149	To identify the risk factors associated with self-reported musculoskeletal discomfort in a population of VDT operators.	The most consistent risk factor identified as contributor to discomfort reporting was hours worked (for all body regions): neck (OR = 1.2 CI 1.1–1.3), lower back (OR = 1.1 CI = 1.1–1.4), shoulders (OR = 1.2 CI = 1.1–1.4), elbows/forearms (OR = 1.2. CI = 1.1–1.5), wrists/hands (OR = 1.2 CI = 1.4). Also, having the monitor too low was associated with body disconfort in the shoulders (OR = 2.5 CI + 1.1–5.9) and lower back (OR = 2.9 CI = 1.2–7.4). There was evidence that workstation setup was a risk factor.	2.50
8	Argus, 2022	Estonia	Case-control study	110	Office workers	40.9 ± 9.9	ABW F = 78.57% M = 21.43% Control F = 82.35% M = 17.65%	To evaluate the prevalence of MSDs and associated factors among office workers working in ABW	Workers with ABW experienced significantly more wrist, hand and finger pain in the right hand during the past 6 months than workers with a designated workplace (OR = 2.88 CI = 1.21–6.82). There were no significant results ($p < 0.05$) in the neck and shoulder region when ABW workers were compared with non-ABW workers. Office workers in ABWs have a high prevalence of MSD, similar	2.65

(continued)

Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
									to workers who have a designed workplace.	
[28]	Woods, 2005	UK	Case- control study	304	Workforce office based in a distribution sector	Data processors 35.5 ± 7.1 Controls 38.6 ± 10.3	F = NR M = NR	To estimate the prevalence of musculoskeletal pain/ discomfort and visual strain symptoms among data processing workers and to explore associations with work factors	Data processors were twice likely to report pain/ discomfort in the last year (OR = 2.3 CI = 1.31–4.18), and more likely to report problems in the last 7 days (OR = 1.8 CI = 1.16–2.8). The main body areas of concern for data processors were the neck, upper and lower back, wrists/hands and shoulders. The main areas of concern for controls were the lower back, neck and ankles/feet. The risk factors identified by data processors were mainly physical work factors.	2.54
[6]	Klussmann, 2008	Germany	Cross-sectional study	1060	Employees who regularly perform VDT work	39.9 ± 9.5	F = 381 M = 679	To determine the prevalence and predictors of musculoskeletal symptoms of the upper extremities and neck at visual display terminal (VDT) workstations	With regard to 12-months prevalence of the whole sample, the highest values were described in the neck (55%) and shoulder region (38%). Significant effect of gender on the neck (OR = 2.02, $p < 0.001$), and shoulder region (OR = 1.83, $p < 0.001$), and elbow/ forearm (OR = 1.02, $p < 0.05$). Some of the risk factors identified: typing more than 6 h/day at a VDT workstation had a significant impact on neck symptoms (OR = 1.10, $p < 0.01$). Other factors such as the desk, arrangement of	2.92

(continued)

Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
									monitor, keyboard and mouse had no significant effects on symptoms in all body regions.	
[29]	Hsu, 2003	Taiwan	Cross-sectional Study	119	Semiconductor manufacturing company	30.1 ± 4.1	F = NR M = NR	To evaluate the contribution of psychosocial risk factors on physical discomforts among the VDT users and their interactions with physical/ ergonomic variables	Neck symptoms (29%) were the most frequently reported, followed by shoulder (28%). Daily VDT exposure time was found to be significantly correlated with several areas of physical discomfort, including neck, shoulder, upper arm, finger, and back discomfort (OR = 1.25 CI = 1.25–1.74). Inadequate monitor height was significantly correlated with neck (OR = 0.00 CI = 0.00–0.03), and shoulder (OR = 0.42 CI = 0.20–0.89) discomforts. Inadequate working desk was significantly associated to back (OR = 0.46 CI = 0.18–1.15). Inadequate seat high was significantly associated with forearm/ elbow (OR = 0.21 CI = 0.07–0.58) discomfort. The findings indicate that physical/ergonomics variables were more dominant than psychosocial factors as regards upper extremity symptoms.	2.65
[30]	Snodgrass, 2022	Australia	Cross-sectional study	511	Computer users	42.6	F = 359 M = 152	To understand the flexible work practices during	Most respondents (88%) had work-related pain. The common painful areas	2.62

(continued)

Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
								COVID-19 pandemic and their impact on MSDs and depression in frequent computer users	were: neck (63%), shoulder (58%), low back (55%), and upper back (31%). Compared with prepandemic to setting used most during pandemic showed significant changes in work location: fewer people working at an office desk ($p < 0.001$), fewer people using laptop with an external monitor, keyboard and mouse ($p < 0.001$), and fewer people sitting straight up ($p < 0.001$). There was significant association between work location and upper back pain ($p < 0.01$). Compared with prepandemic more people worked in nonergonomic environments.	
[16]	Radulovic, 2021	Croatia	Cross sectional study	232	Telecommunications company workers	M = 23–62 (52.2%) F = 23–53 (47.8%)	F = 111 M = 121	To identify musculoskeletal pain that may have resulted from COVID-19 changes in the work environment at home	Compared to previous work at the office, 39,1% participants reported stronger pain in the lower back, 45,7% in the upper back/neck, and 27,2% in theirs hands. Among participants who reported stronger musculoskeletal pain than in the office, woman exercised less often than men ($p = 0.02$), and more of them had no separate workspace ($p = 0.007$). Significant correlation between age and stronger hand pain at	2.46

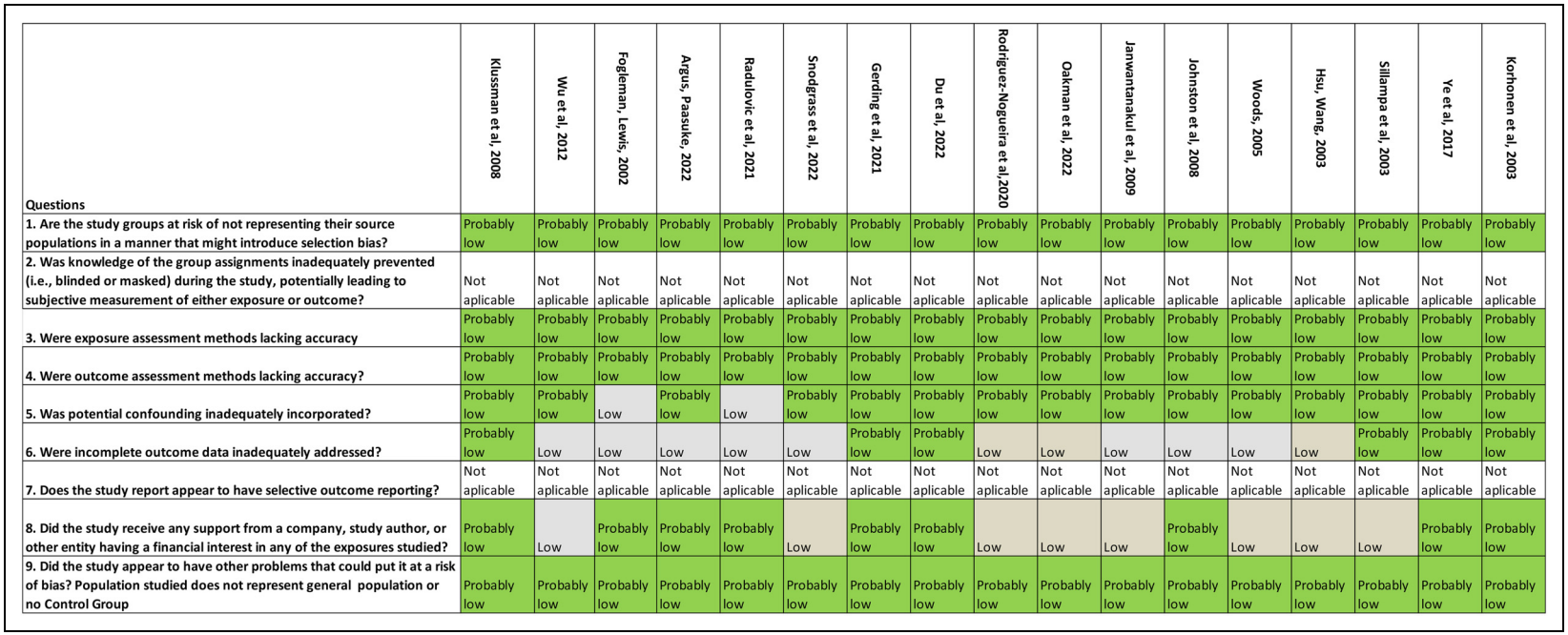
(continued)

Table 1. Continued.

Ref.	Author[a], year	Study location	Study Design	Workers included	Occupation sector	Age range	Gender	Aim of the study	Study outcomes	Score (0–3)
									home ($p = 0.04$). The findings suggest that the poorer working conditions at home (workspace and ergonomic considerations) present a risk for development of musculoskeletal pain.	
[20]	Oakman, 2022	Australia	Cross section study	964	Residents working from home	18–35 (26.9%) 36–55 (57.3%) 56 years and above (16.4%)	F = 728 M = 230 Other = 6	To investigate the impacts on mental and physical health of a mandatory shift to working from home during COVID-19 pandemic	Over 70% of all respondents reported experiencing musculoskeletal pain and discomfort towards the end of the working day. A disproportionate number of women worked in spaces with frequent interruptions ($p < 0.001$). For woman, stress ($p < 0.001$) and neck/shoulder pain ($p < 0.001$) were higher than men. More females reported not having a dedicated workstation and so were using whatever location was available to them.	2.62

Note: F - female subjects, M - male subjects, VDU - visual display unit, VDT- visual display unit terminal, ABW - activity-based workplace, NP - neck pain, NPQ- Neck pain questionnaire, NDI- neck disability index, LBP - low back pain, PA - physical activity, NR - not reported.

[a]Only the first author is named by each study, full authors details can be found in the references.



Questions	Klussman et al, 2008	Wu et al, 2012	Fogleman, Lewis, 2002	Argus, Paasuke, 2022	Radulovic et al, 2021	Snodgrass et al, 2022	Gerding et al, 2021	Du et al, 2022	Rodriguez-Nogueira et al,2020	Oakman et al, 2022	Janwantanakul et al, 2009	Johnston et al, 2008	Woods, 2005	Hsu, Wang, 2003	Siliampa et al, 2003	Ye et al, 2017	Korhonen et al, 2003
1. Are the study groups at risk of not representing their source populations in a manner that might introduce selection bias?	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low
2. Was knowledge of the group assignments inadequately prevented (i.e., blinded or masked) during the study, potentially leading to subjective measurement of either exposure or outcome?	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable
3. Were exposure assessment methods lacking accuracy	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low
4. Were outcome assessment methods lacking accuracy?	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low
5. Was potential confounding inadequately incorporated?	Probably low	Probably low	Low	Probably low	Low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low
6. Were incomplete outcome data inadequately addressed?	Probably low	Low	Low	Low	Low	Low	Probably low	Probably low	Low	Low	Low	Low	Low	Low	Probably low	Probably low	Probably low
7. Does the study report appear to have selective outcome reporting?	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable	Not aplicable
8. Did the study receive any support from a company, study author, or other entity having a financial interest in any of the exposures studied?	Probably low	Low	Probably low	Probably low	Probably low	Low	Probably low	Probably low	Low	Low	Low	Probably low	Low	Low	Low	Probably low	Probably low
9. Did the study appear to have other problems that could put it at a risk of bias? Population studied does not represent general population or no Control Group	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low	Probably low

Figure 2. Assessment of risk of bias according to the navigation guide for systematic review.
Risk of bias assessment: red cell = high, orange cell = probably high, green = probably low, gray = low.

Table 2. Methods: questionnaire and instruments used in different included studies.

Author[a], year	Methods: questionnaire and instruments
Korhonen, 2003	Structured mailed questionnaires, with questions about work related and individual variables as potential predictors for the outcome.
Wu, 2012	Self-administered questionnaire. Pain symptoms measures based on the Nordic Musculoskeletal Questionnaire (NMQ). They used variables of working conditions related to WRMSDs derived from the standardized Dutch Musculoskeletal Questionnaire, and questions of ergonomic factors were derived from a workplace health and safety brochure of the Queensland Government, Australia. Also they used questions for the accumulated VDT use, workplace, workstation and individual factors.
Ye, 2017	Mailed questionnaires, which included the Northwick Park Neck Pain Questionnaire (NPQ) and the Oswestry Low Back Pain Questionnaire (ODI). They also collected individual and demographic information.
Rodriguez-Nogueira, 2021	Evaluation questionnaire with the instruments The Standardized Kuorinka Modified Nordic Questionnaire (SNQ), Perceived Stress Scale (PSS), individual factors and frequency and type of physical activity done.
Du, 2022	Mailed questionnaire, with baseline characteristics of the homeworkers, working conditions, self-reported musculoskeletal problems (history of pain in the neck/shoulder and lower back pain during working from home period), and work performance during their work from home setup.
Gerding, 2021	A survey evaluation inquired about demographic information and working conditions specifically related to workplace and environmental factors, also about stress/tiredness levels experienced relative to typical stress and fatigue in the typical office setting.
Johnston, 2008	Posted questionnaire with individual factors, history of neck trauma, negative affectivity using a shortened version of the Multidimensional Personality Index, Neck Disability Index (NDI) and workplace factors.
Janwantanakul, 2009	A self-administered questionnaire was used, with individual, work-related physical, psychosocial factors and musculoskeletal symptoms adapted from the Standardized Nordic Questionnaire and Dutch musculoskeletal questionnaire.
Sillanpaa, 2003	Questionnaire with personal history, the work task and pain during the previous 12 months in neck, shoulders, elbows, lower arms, and fingers. Modified version from other authors.
Fogleman, 2002	The questionnaire was used based on the NIOSH Symptoms Survey, consisting in job characteristics, non-occupational activities, workstation setup, and self-reported discomfort in all body regions.
Argus, 2022	A questionnaire was used, and after that there were measures of height and body weight. The questionnaire had the instruments: Nordic musculoskeletal Questionnaire (NMQ), Baecke habitual physical activity questionnaire (BHPAQ), Work ability Index (WAI), Copenhagen Psychosocial Questionnaire (COPSOQ), and Fear-avoidance beliefs questionnaire (FABQ).
Woods, 2005	Questionnaires were distributed and completed in work time. A preliminary visit to the data processing center to observe the working environment and tasks performed occurred to inform the questionnaire design. The questionnaire had individual information and work-related items used in other studies, the instruments Nordic Musculoskeletal Questionnaire (NMQ), questions based on the Display Screen Equipment Regulations.
Klussmann, 2008	The questionnaire used consisted of demographic factors, about musculoskeletal symptoms based on the Nordic Musculoskeletal Questionnaire (NMQ), with parts of the Copenhagen Psychosocial Questionnaire (COPSOQ), and questions about working conditions. A checklist regarding the workstation was also used based on a German VDT questionnaire (BIFra).
Hsu, 2003	A preliminary survey occurred in this study. A questionnaire was designed to assess individual factors, physical/ergonomic factors, and physical discomforts.
Snodgrass, 2022	An online survey was used. The questionnaire included: demographic data, work practices, prevalence, intensity and impact of MSD, the pain visual analog scale was uses (VAS), general health including the Goldin Leisure-time Physical Activity Questionnaire, and a depression screen from the Center for Epidemiologic Studies Short Depression Scale (CEDS-10).
Radulovic, 2021	A questionnaire designed by authors was used. The questionnaire included individual data and frequency of exercising over the week, characteristics of the workplace, ergonomic properties of their workspace related to furniture and equipment, organization of the work at home, and perception of their mood while they work.
Oakman, 2022	An on-line questionnaire was used with demographic data, general experience of working at home, satisfaction with the divisions of tasks and duties, provision and comfort of workstation equipment along with location at work, sedentary behavior and musculoskeletal discomfort, technologic support, and productivity. Included the instruments: Occupational sitting and Physical Activity Questionnaire, items of the Copenhagen Psychosocial Questionnaire (COPSOQ).

[a]Only the first author is named by each study, full authors details can be found in the references.

Table 3. Synthesis of risk factors for WRMSD related to workstation, use of other places or furniture to work, work climate ambient, organizational, psychosocial, and individual factors.

Variables	Synthesis of risk factors for WRMSD	
Workstation factors and use of other places or furniture to work	Office workers	Teleworkers
Work chair	- Not adequacy of seat high[26,29] - Poor seating[28] - Not having an adequate chair[26]	- Not having an adequate office chair[16,17,19]
Work desk	- Inadequate leg room and desk that does not enable the things to be fully supported[26] - Long periods in an uncomfortable posture related to the desk[27]	- Lack of office desk[16,17,30]
Monitor	- Monitor height[5,7,29] - Having the computer monitor not located in front[25] - Computer set-up[28]	- Monitor height[19]
Keyboard	- Poor placement of the keyboard[5,24,33]	- Laptop use without external keyboard[19,30]
Mouse	- Poor placement of the mouse[33]	- Laptop use without external mouse[30]
Work climate ambient	- Cold office temperature[25]	None
Use of other places or furniture to work	None	- Use of kitchen bench/counter[16,30] - Use of dining table and chairs[16,17] - Not having a dedicated workstation in a private room[20] - Working in non-traditional workstations[19] - Use of floor cushion, and floor chairs[17]
Organizational factors	- Longer hours of work/day[6,7,26,27,29,33] - Duration of the keyboard and mouse use[26] - Prolonged sitting time[26,28] - Frequency of doing repetitive tasks[6,27,28] - Work intensively[28] - Longer office work years[6,25] - Not enough rest interval[6,7,29] - Not being able to decide when take breaks[28] - Stress at work[6,24] - Monotonous work[29]	- Longer hours of work/day[16,17,30] - Not enough rest breaks[16] - Frequent interruptions/ disturbances at work[16,20] - Stress at work[18,19]
Psychosocial factors	- Levels of interaction with others[27] - Lack of job control[29] - Work-related decision latitude[27] - Lack of social support[29] - Lack of job satisfaction[6,28,29] - Lack of choice in deciding what they did at work[28] - Help was not available if time was limited[28] - Not enough time to do their work and reach targets[28]	- Low job recognition[20] - Job insecurity[20]
Individual factors	- Female sex[6,7,24,25,33] - Married status[25] - Touch typing with greater force[26] - Frequency of physical activity[6,7,24,26] - Low education level[7] - Older age[6,33] - History of MSD injury[25,26]	- Female sex[16–18,20] - Frequency of physical activity[16,18]

range, gender), occupation sector, aim of the study, study outcomes and quality assessment score. The extracted information of the included studies can be found in Table 1.

We also conducted (MCBA, NRS) the critical tool Quality assessment with all studies – QuADs (Table 1), that has a criterion of 12 items, each one with a score from 0 to 3. The 12 items are: 1. Theoretical or conceptual underpinning to the research; 2. Statement of research aim/s; 3. Clear description of research setting and target population; 4. The study design is appropriate to address the stated research aim/s; 5. Appropriate sampling to address the research aim/s; 6. Rationale for choice of data collection tool/s; 7. The format and content of the data collection tool is appropriate to address the stated research aim/s; 8. Description of data collection procedure; 9. Recruitment data provided; 10. Justification for analytic method selected; 11. The method of analysis was appropriate to answer the research aim/s; 12. Evidence that the research stakeholders have been considered in research design or conduct. The QuADs tool demonstrates substantial intercharacter readability and constant validity.[31] We used k statistic (Cohen's kappa) to assess the agreement between reviewers.

For the risk of bias analyses, we used the Navigation Guide for Systematic Reviews in environment and occupational health.[32] Two authors (MCBA, NRS) assessed the nine risks of bias domains, although two of them were not applicable for the observational studies. A consensus was obtained among the three reviewers authors (MCBA, NRS, FS). Results show low risk of bias (Figure 2).

Results

The research identified a total of 468 records from: Scopus (n = 128), Web of Science (n = 158), PubMed (n = 102). Before screening 176 duplicated records were removed, and 88 were removed based on the studieś titles and abstracts and the exclusion criteria. After full text analyses of 66 articles, 43 were excluded resulting in a subtotal of 23 articles assessed for eligibility. A total of 17 articles fulfilled the inclusion criteria. Figure 1 show the flow diagram of the study selection.

There was a relatively good representation of countries throughout the world: Australia (3), China (2), USA (2), Finland (2), Spain (1), UK (1), Japan (1), Taiwan (1), Thailand (1), Estonia (1), Germany (1), Croatia (1). The general information and characteristics of the studies are shown in Table 1. About the studies design, we found eleven (11) cross-sectional studies, three (3) cross-sectional surveys, two (2) case-control studies, and one (1) cohort study. From the selected studies, six (6) were realized from 2020 to 2022,[16–20,30] a ten (10) were published before 2020.[5–7,28,29]

The general information and characteristics of the included studies (n = 17) and the papers analysis show a good quality of the studies (Table 1), with all the studies scored equal or above 2.50 (maximum 3.0). According to Harrison et al.,[31] QuADS tool demonstrates strong reliability and ease of use for application to multi or mixed-methods health services research and we obtained a satisfactory agreement between reviewers k = 0.71 in this systematic review.

The populations included in the studies were from various occupational sectors such as administrative units, industry service, financial organizations, health administration and municipal workplace organizations, secure service offices, home workers, and others. All employees with an office-based work regularly performed VDT work. The number of participants varied from 110[8] to 4112.[17] Questionnaires were used in all studies, with some of them also using additional instruments. Table 2 present the information about questionnaires and instruments used by the researchers in each study.

As observed (Table 2), various instruments were used, including the Nordic Musculoskeletal Questionnaire, utilized in four studies,[6–8,28] and the Copenhagen Psychosocial Questionnaire (COPSOQ) in three studies.[6,8,20] Other instruments were used with varieties in the studies according to the objective.

The prevalent reported musculoskeletal pain was in neck in most of the studies related to office workers,[6,7,24–29,28] and in teleworkers.[17,20,30] And upper back in some studies related to teleworkers.[19] The shoulder region had also prevalence reported in office workers,[5–7,27–29,33] and in teleworkers.[16,17,19,20,30] There was also found a prevalence of low back pain in office workers[5,7,25,27,29] and in teleworkers,[16,17,19,20,30] besides other body regions referred with less prevalence. The lower back region has the highest prevalence musculoskeletal symptom in some studies related to teleworkers.[16,19]

The synthesis of the risk factors reported in the selected studies is demonstrated in Table 3.

As observed (Table 3), studies related to office workers demonstrate the presence of poor ergonomic workstation related to an inadequate chair[26,28,29] and also for teleworkers, indicating the lack of an office chair.[16,17,19] Related to the desk for office workers, it was found inadequate leg room and desks that does not enable things to be fully supported[29] and long periods in an uncomfortable posture,[27] and for teleworkers the lack of an office desk.[16,17,30] About the monitor for office workers: inadequate monitor heigh,[5,7,29] having the computer not located in front[25] and in general about the computer set-up[28]; and for teleworkers, the monitor height was referred in only one study.[19]

For office workers it was referred the poor placement of the keyboard,[5,24,33] and for teleworkers the laptop uses without external keyboard.[19,30] About the mouse, only one study referred the poor placement for office workers[33] and for teleworkers also only one study referred the laptop use without external mouse.[30] The laptop was frequently used by teleworkers in working at home situation

and was common the use of other places and furniture to work during pandemic, without an adequate workstation, situation that was not observed in office workers because they had a workstation in the companies. About the working temperature, it was only found one study that referred an association of the cold office temperature to MSD, in office workers.[25]

Considering the organizational factors, the most referred factor found was long hours of work/day in office workers[6,7,16,17,27–29,33] and also in teleworkers.[16,17,30] Repetitive tasks frequency, was also strongly referred in office work.[6,26–28] Also, it was found in office workers references about the duration of the keyboard and mouse use,[26] and prolonged sitting time.[26,28] Other organizational factors were analyzed and related to WRMSD in office workers (Table 3). For teleworkers organizational factors, it was found frequent interruptions/disturbances at work[16,20] and stress working at home.[18,19]

Some studies also demonstrated the relationship between the musculoskeletal symptoms and psychosocial factors in office workers,[6,27–29] with the lack of job satisfaction found in three studies.[6,28,29] Not all studies investigated the psychosocial factors involved in office work and telework. Only one study used an instrument to investigate psychosocial factors related to WRMSD in teleworkers.[20]

About the individual factors, being female was highly associated to WRMSD in some studies in office workers[6,7,24,25,33] and in teleworkers.[16–18,20] Also, relevant the low frequency of physical activity for office workers[6,7,24,26] and teleworkers.[16,18] Teleworkers working from home environment used frequently other workplaces and furniture to work, different than office workstation set-up in office workers (Table 3).

Discussion

In this exhaustive review emerged, as expected, some relations with pain and risk factors exposure in office work and telework (working conditions), mainly from poor ergonomic workstation, organizational and psychosocial demands, and also with some workers individual characteristics.

It was found a high prevalence of musculoskeletal symptoms in neck and shoulder regions in office workers. Assuming the workstation layout and equipment's influence the worker postures at work, and also organizational and psychosocial factors influence the postures and behaviour at work, it is well known the importance of an adequate and ergonomic workplace for prevention WMSD in office workers. In a systematic review about office work, several studies tried to accord the postures of the neck as a risk factor related to computer workstation layout and individual working techniques.[34] Some frequent postures and relations to musculoskeletal pain were described in articles in this review related to office workers. According to Ye et al.[25] the computer monitors not located in front of the operator were associated to neck pain. Also, in a study it was found that holding the neck frequently in a flexion angle (more than 30°) with no breaks during the work, was associated to neck pain.[7] For Flogeman and Lewis[5] the posture required when the keyboard is placed in a lower position, places strain in the upper back/neck region since the arms stays suspended. Azadchehr et al.[35] in a study with office workers found discomfort scores related to the vertebral column, shoulder, forearm that had a significant relationship with the ergonomic workstation. For the work-related non-specific neck pain, workload and body position at work are the most important contributors.[36]

For teleworkers in this review, it was also found high pain prevalence in neck and shoulder, but lower back had the highest prevalence body region in some studies.[16,19] An important ergonomic factor that may be associated with higher incidence of low back pain is excessive hours sitting, especially in an inadequate chair.[37] In a rapid review study, teleworkers had the highest prevalence of work-related musculoskeletal pain in neck, low back, and shoulders regions, also being significantly correlated with workstation ergonomic suitability.[38] The WRMSD are frequently linked to the need of ergonomically workstations, and a necessity for a better postural comfort.[39] In this review it was found studies with teleworkers that reported musculoskeletal pain associations to bad workstation set-up.[37,38]

It was also noted that teleworkers working at home during pandemic had different workspaces and workstations. The lack of an adequate office chair and desk for teleworkers working at home was observed in this review, some teleworkers were using dining tables and chairs, floor chairs and cushions, between other inadequate furniture to work. According to Du et al.,[17] WRMSD symptoms were common complaints related to their work from home setup, with a considerable proportion of teleworkers using other furniture different from those used in a typical office setup. The COVID-19 pandemic changed work activities and due to prevailing circumstances, the layout of the workplaces changed dramatically.[40] Working remotely during pandemic posed considerable challenges for employees, such as the lack of a designated workspace at home,[13,41] that may contribute to increase musculoskeletal pain prevalence.

Another study reported that the absence of a dedicated workspace was associated with greater WRMSD and psychosocial risks and, consequently, a higher incidence of WRMSDs.[42] According to a systematic review it was also found studies that reported an increase of WRMSD pain during pandemic compared to before pandemic, related with ergonomic and psychosocial risk factors.[43] Telework is the main difference that changed working with computers and it was a major contributor to the development or aggravation of work-related musculoskeletal disorders, where

unsuited workstation, laptop uses, sedentary behaviour, as well as psychosocial and organizational factors play a role in pain development.[44] According to Argus and Paasuke,[8] having to use different workspaces and work equipment daily might be a risk for musculoskeletal discomfort and disorders. The relations between WRMSD and having or not a dedicated workplace to work should be more explored in further studies. It is necessary to put in evidence that the telework environment varies from home to home and in many cases, it may not be the ideal work environment for some workers characteristics.[12]

According to Snodgrass et al.[30] during pandemic fewer people used a desktop computer at home. Laptops were frequently used in telework during pandemic, resulting in increased poor postures due mainly to a too low monitor position, no external keyboards, and a makeshift workstation.[19] The main problem with laptops is that the screen is coupled to keyboard, making it more difficult to maintain a neutral body position. Using the laptop computer for office work in telework may pose a higher risk of developing WRMSD,[8] and it is an important ergonomic consideration for telework.[12]

In another review study, working from home was referred to be a danger, because of the presence of improvised workplaces, inadequate lighting, non-ergonomic furniture and equipment, the use of tablets, cell phones and laptops as work tools, and these were factors associated with the risk of musculoskeletal disorders.[45] This study also pointed out the need to regulate teleworking as a strategy for preventing musculoskeletal disorders.[45] Companies that adopt teleworking should be mindful of employees' working conditions at home, the equipments, the furniture, including the demanding workload, and offer the necessary physical and psychosocial support, thus preventing the occurrence of WRMSD.[42]

Cold temperature in the workplace was also found as a risk for WRMSD in one study for office worker,[25] but this risk factor was not enough explored. A review study carried out by Farbu et al.[46] pointed to the cold temperature as an important musculoskeletal risk factor, and the authors highlighted the importance of investigating the time of exposure. Stjernbrandt et at.[47] concluded that the cold was statistically relevant to the presence of pain in the hands and upper arm region. Cold is not expected at office work but for teleworkers it can be a real problem if at home there are not a controlled temperature, or if it is expensive, as for instances, in low-income countries.

Organizational factors as long hours of work/day and not enough rest breaks were found as an important risk factor for both office workers and teleworkers. Since there are many variables involved in the studies and different occupations besides other factors, it is not possible to compare it in office work and telework environment. Although it was consensus in most of the studies from this review that long hours worked daily influence WRMSD risk.[6,7,16,17,26,29,30,33] In a study with office workers, it was showed that spending 40 h working week in longer sitting in front of a computer screen doubled the risk of neck problems in females.[48] Studies have shown that the pandemic brought an increase of working hours but evidence about the relationship with increasing pain are scarse. According to Heggeness,[49] during COVID-19, parents of school-aged children had to juggle the demands of work and home life, with mothers experiencing increased working hours. In a study during the pandemic from this review, it was found that women work longer hours at home, took less breaks and got disturbed more frequently than men, which reflects the discrepancy of work based on traditional gender roles.[16] Du et al.[17] found that working more than 9 h a day was associated with developing severe neck and shoulder pain compared with working less than 7 h. In another study carried out with business service center workers the respondents who were working with a computer more than 8 h reported having high pain risk in lower back, shoulder, and neck.[50] For theses authors the risk of getting musculoskeletal symptoms in all body regions is higher when there is an increasing in the duration of daily computer usage.[50] Daily computer time uses was the most statistically significant risk factor for WRMSD in a study of Gondol and Anbese.[51]

Associations with work organizational demands and WRMSD were found in office workers related to the frequency of doing repetitive activities during work,[27] and having no breaks.[6] An old study related to office workers, reveals they were not able to decide when taking a break.[28] Failing to take regular breaks can increase the risk of physical and psychological fatigue.[52] Work organizational flexibility offers employees a balance between their professional and personal lives, leading to job satisfaction and increased performance.[53] Organizations need to ensure that employees take breaks to protect their physical and psychological health and avoid overwork.[54] According to Raisienė et al.[55] the flexibility of work organization represents a unique characteristic of telework, and managers should cooperate more effectively with teleworkers to keep them motivated. One study related to teleworkers, found there was not enough rest breaks.[16] They found that men were significantly taking more breaks than woman and most of them faced a great challenge to organize their work without disturbances.[16] This study show there is a need to better organize the working time and breaks and disconnect work and other daily home activities.[16]

Prolonged sitting time was related to WRMSD pain in office workers.[26,28] Authors found an increase of perceived discomfort in all body regions in office workers if they were seated for 4 h over time, and the body region with the highest discomfort after this period was lower back.[56] In a study it was revealed that office workers who frequently changed position at work were less likely to have

WRMSD pain than those who did not,[57] so it is important to change posture from sitting to standing and walking.

Stress is frequently found in work environment. In this review stress at work was referred mainly in teleworking.[18,19] With the teleworking mode imposed by pandemic, complaints of stress at work, anxiety, and depression increased.[58] Some psychosocial risk factors during pandemic favouring stress, anxiety, depression, and exhaustion, were the increased work, difficulty in reconciling professional and domestic activities, insecurity regarding maintaining employment, and financial management.[59] In a rapid review about musculoskeletal pain in teleworkers during pandemic, back pain was also significantly correlated to perceived stress.[38] Gerding et al.[19] reported that during COVID-19 pandemic respondents revealed that their tiredness levels increased since the transition to telework began, increasing stress levels. For these authors, that reflect the complexities workers had faced at working from home environments during this period.[19]

In this review for office workers, it was also found about not enough time to do their work and reach targets,[28] and this fact may influence job satisfaction which is a psychosocial risk factor. In this review, psychosocial risk factors were more explored in studies related to office workers. Perhaps the urgence of the studies to identify the working conditions of teleworkers during pandemic and in a working from home situation, was done with questionnaires that could be easily and fast applied, without using specific instruments to investigate psychosocial risk for WRMSD. Lack of job satisfaction was reported in three studies of this review related to office work and WRMSD.[6,28,29] A study that investigated musculoskeletal disorders and job satisfaction among office workers, found that 41% of the participants were moderately satisfied with their jobs, and it was significantly related to musculoskeletal disorders in the shoulders, elbows, lower back, wrists and knees.[60]

Teleworkers studies in this review found job satisfaction was not enough mentioned, although it could be found in some teleworkers during pandemic. In a study carried out in Portugal, teleworkers satisfaction levels were high during pandemic.[13] Even with difficulties in relation to workspace and concealing domestic activities, the findings reveled that work environment and organizational culture play an important role contributing to teleworkers satisfaction.[13] In another study with teleworkers, it was found that organizations where job characteristics and organizational factors were appropriate, employee job satisfaction was also at an appropriate level.[61]

Home working conditions includes workplace physical space, furniture, IT equipment's, relationships with co-workers and workload, physical activity, and also the presence of children, and distractions, as determinants for physical and mental health.[62] The conditions and situations may be very different for those who had a previous experience of working from home before the pandemic, from those who had to fastly adapt.

Lack of job control and social support was reported in one study related to office workers.[29] In a systematic overview, ten studies investigated the association between job control and musculoskeletal disorders, and the application of a rating system showed insufficiency evidence of an effect of low job control on work-related musculoskeletal disorders.[63] However, in another study also carried out with office workers, results concluded that increased work demand and a low level of social support, can put workers at risk for developing WRMSD.[48] For the authors the increase in social support can be used as an effective approach in reducing the risks of WRMSD symptoms.[48]

Strong evidence for psychosocial risk factors and WRMSD are high work demands, low social support, effort-reward imbalance, and injustice perceptions.[63] One study with office workers reported associations between upper back symptoms and workers decision latitude.[27] In another study with office workers results showed that decision latitude was significantly correlated to shoulder and back complains.[64] For teleworkers, it was found low job recognition and job insecurity in female teleworkers, and also stress and musculoskeletal pain were significantly higher in comparison to males.[20] Feelings at work interfere in the emotions and behavior and should have managers attention. At organizational level, meaningful recognition is used to acknowledge individuals for their successes and serves as an intrinsic motivator to others, and organizations that recognize and appreciate employees for their hard work send a powerful message to the recipient and other staff members.[65] It is important to establish a relationship of trust with staff to consolidate effective virtual teams, thereby achieving organizational objectives while safeguarding employee welfare.[66]

About individual factors, being female was associated with increased musculoskeletal discomfort and pain, and this occurred both in office workers and teleworkers. In office work Korkhonen et al.[24] reported that the poor placement of the VDU keyboard increased the risk of neck pain, and women had an almost three-fold risk compared to men. Also, for these authors, it was reported that different types of work tasks may be an explanation for the sex associations with WRMSD.[24] Women worked in more monotonous tasks, and were involved with a considerable amount of homework and childcare.[24] Nevertheless, according to Oakman et al.[20] most women in telework during COVID-19 pandemic reported increased musculoskeletal pain related with not having a dedicated workstation and with the use of a whatever place available at home. Especially for women, professional and domestic work were left without clear spaces, with the absence of temporal delimitation, worsening with the presence of small children in the family.[11] In the study of Muis et al.[67] female

participants reported conflicts due to performing multiple roles at work and home life, with a consequent decrease in performance. This fact may be influenced by gender rules, what depends on behavioral and cultural aspects, since the patriarchal society, for example, may impose woman to domestic responsibilities and child care. Also, differences in the reporting of pain in men and woman may be due to gender-specific socialization patters concerning expectations, beliefs and subsequent behaviors, where male role are expected to underreport pain and in other hand, female role would allow woman to verbalize their pain reports.[68] Marital status was found as WRMSD risk factor in one study from this review in office workers.[25] Although in other studies there was no significant relationship between marital status and WRMSD.[35,69]

Another relevant risk factors for WRMSD described in some of the studies of this review were related to the low frequency of physical activities (PA) in both office workers and teleworkers. In a study with office workers there were significant relationship between the prevalence of WRMSD among participants with not having a regular exercise status, besides educational status and age.[70] Although many studies have reported on the associations between PA and various health conditions, for Putsa et al.[57] in a cross-sectional study, the effect of PA on WRMSD among office workers remains inconclusive. Physical activity (PA) was modified in relation with habits during pandemic, frequently allowing the increasing strength and stretching exercises, and it was observed a reduction in the type and frequency of painful symptomatology of the population.[18] Nevertheless, in a scoping review study with teleworkers, it was found that less carrying out physical activities was associated with the increased risk of musculoskeletal disorders during pandemic.[45]

Low educational level was found associated with WRMSD in one study from this review with office workers.[7] Kibret et al.[71] in a study carried out with bankers, found a significantly association between the developing of WRMSD and the educational status. Those who had low educational status were 4.2 times more likely to develop WRMSD than those who had masteŕs degree. Older age was also found as a WRMSD risk factor in two articles from this review related to office workers.[6,33] The results of a study with office workers show the prevalence of WRMSD had an increase from youngest to oldest population.[72] Kibret et al.[71] found age as a significant predictor among workers who were respondents above 40 years old with 5.7 times more likely to have WRMSD compared to those aged 20 to 29 years. Some aged-related changes affect adults' abilities that affect functional abilities with time, and older office workers might encounter challenges due to these changes, which can lead to an increase in WRMSD.[72] Although in others studies it was not found significant association between the workers age and WRMSD.[35,51] We found in this review in office workers, as a risk factor for WRMSD, longer office work years.[6,25] Other study agrees with this risk factor, since it was showed that the WRMSD occurrence was related to workeŕs years of computer use,[73] occupational risks factors have cumulative effects with increasing years of work.

History of injury was also associated with WRMSD in office workers.[25,26] For Johnston et al.[26] the history of neck injury in office workers was strongly associated to neck pain. And Ye et al.,[25] reported in office workers a history of low back pain as a significant risk for low back pain. History of pain can be related to frequency and refer the question of being acute or chronic. Patients with chronic musculoskeletal pain of any etiology may experience excessive emotional, cognitive and behavior responses to chronic pain,[74] which can influence the mental health risk and also WRMSD. The fact of pain being acute or chronic was not explored in the articles from this review.

Limitations of this study were identified, and some selected studies used a diversity of collection instruments, considering that even though the central theme has remained, the different objectives refer to the use of different protocols, and this constitutes a limiting factor for generalizations. Also, the diversity of work sectors and participants occupations, besides the differences in the professionals tasks requirements that were not deeply investigated, even though some positions were reported, were limitations to analysed papers. How telework was implemented and the socioeconomic status of the participants was also not explored and may influence whether or not is easy to acquire adequate equipment or furniture to work, if company does not provide it. Most studies adopted a cross sectional design, that can lead to differential reporting of outcome. This systematic review examined the differences in between office workers and teleworkers, but some possible comparisons were not always possible, because of the methodological diversity of the studies selected. Although, this systematic review evidence the necessity to continue investigating the WRMSD risk factors impact in teleworkers health and safety.

Conclusions

Both office and teleworkers can be at risk of musculoskeletal symptoms/pain. Telework working conditions differences with office work that are related with the presence of risk factors for WRMSD symptoms, were mainly the lack of workspace at home, the inadequate table, chair and furniture, working frequently with laptops without external keyboards and ergonomics mouses, and the environmental differences, considering the absence of thermal comfort. The work at home exposure to this risk factors increased teleworkers WRMSD symptoms and pain. Nevertheless, ergonomic risk factors presence was evident

in both office work and telework, besides organizational, psychosocial, and individual factors. Results suggest that teleworkers in the working at home environment face (i) challenges related to improperly set up home office, (ii) high demands, (iii) difficulty in managing work and domestic routine, and (iv) increased working time without breaks, that increased WRMSD symptoms. It is necessary to continue to systematize telework working conditions through regulation, greater provision of companies with adequate worker's conditions at home and establishing an ergonomic action plan that result in benefits for teleworkers health and safety, allowing the increase in satisfaction and productivity. This systematic review brought the necessity of further research in health and safety at work (occupational health) to better understand and prevent WRMSD risk in teleworkers.

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