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Review Article

The impact of coworking spaces on workers' performance, mental and physical health: A scoping review

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Abstract.
BACKGROUND: Utilisation of coworking spaces (CWS) was rising sharply prior to the COVID-19 pandemic. The transition to new work arrangements which involve a hybrid, work and home model, is likely to involve the use of alternative workspaces. Understanding the impacts of CWS on employees is timely to examine the benefits of utilisation and how these might be incorporated into new ways of working. This scoping review aims to explore the relationship between CWS, mental and physical health, and workers' performance, and provide insights into future considerations for design.
OBJECTIVE: The main objective was to map the current literature on CWS, focusing on identification of relevant modifiable factors to improve worker's mental and physical health, and performance.
METHOD: Three databases, Embase, PsycInfo, and Proquest, were systematically reviewed, to identify studies from 2005 onwards. Data was extracted and analysed using diagrammatic mapping. Only studies published in English were included.
RESULTS: Eleven relevant papers were included which covered the three outcomes of interest: worker's performance (5), mental health (4) and physical health (2). Environmental factors influencing the three outcomes were categorised into physical environment (12 factors) and the psychosocial environment (6 factors). Overall, CWS environmental factors had a positive influence on workers (23 positive relationships and 11 negative relationships).
CONCLUSION: Coworking spaces offer potential benefits for tele-workers, including opportunities for collaboration/networking and productivity gains. However, attention to the CWS physical design is important to optimise the experience for workers and mitigate risk of adverse mental and physical health effects.

Keywords: Tele-working, productivity, workplace, physical, psychosocial, hybrid working

1. Introduction

Telework, that is, computer-based employees working away from the employer premises, has increased in recent years, largely due to technological innovations including the uptake of communication and knowledge sharing platforms such as email, video conferencing, and instant messaging software, and cloud-based platforms [1, 2]. In response to the increasing adoption of telework practices, coworking spaces (CWS) evolved to provide an alternative option for remote knowledge-based workers who preferred to work in an office-like environment [3]. A coworking space refers to a shared work environment managed by a third party, that is distinguished

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from other types of office spaces by the patronage of a heterogeneous mix of workers from various organisations, who are provided with the opportunity to interact and collaborate [4, 5]. In addition to providing opportunities to enhance flexibility, networking, collaboration, and creativity, CWS also provide access to relevant infrastructure and workstations [6].

Architecture and design have a fundamental role in the realisation of CWS goals [7]. The traditional office spaces tend to have orderly enclosed offices with private space, monotonous tones, departmental structures, and few recreational areas [7]. The physical design of a traditional office was originally developed to replicate a production line, and contributes to organisational control and accountability functions, forming the basis of employee monitoring and performance management strategies [8]. In CWS, the monitoring or surveillance of workers is removed and design includes open architecture and flexible workstations to facilitate collaboration and interactions between individuals [9–11].

Since the inception of CWS in 2005, utilisation has been increasing rapidly at rates of 250 percent per annum [12]. A diverse range of knowledge-based workers have been identified as users of CWS, including those in paid employment and those who are self-employed, such as entrepreneurs, teleworkers from large organisations, students, and not-for-profit workers [10, 13, 14]. The COVID-19 pandemic and subsequent infection control measures imposed movement restrictions and office density limits which resulted in a significant reduction in the use of CWS [15].

In contrast to the decline in CWS use, the numbers of employees engaged in telework increased exponentially during 2020 [2]. As the COVID-19 pandemic intensity decreased, and people are returning to the traditional offices, a hybrid model of work has emerged as the 'new normal', with a combination of some work days in the office and others at home [8, 16]. Working arrangements are likely to continue to evolve with many businesses embracing telework based on positive results experienced during the mandated telework period and employee expectations of more flexible working arrangements [8, 17–19]. In addition, other workers who were considered traditional users of CWS, such as freelancers and self-employed workers, are now able to return to those spaces to work if they choose.

Telework can be undertaken at home or in a CWS. The role of CWS in post-pandemic work arrangements is uncertain; therefore, improving our understanding of the impacts of CWS on workers' performance, mental and physical health is important to help clarify the benefits of these spaces as alternatives to traditional office environments or working from home. The impact of physical and psychosocial working environments on workers' health is well established [20, 21]. In traditional office environments, a range of work factors have been associated with the development of musculoskeletal pain [22–24] and poor psychological health [25, 26].

In addition, a rapidly increasing body of research is emerging which has examined the impact of working from home on employees' health and performance [27–29]. However, this has not been replicated for those workers who are users of CWS. Therefore, the aim of this scoping review is to explore the relationship between the CWS environment and workers' mental and physical health and performance. The following questions will be addressed:

- What are the impacts of coworking spaces on workers' performance and their mental and physical health?
- What knowledge gaps exist in the use of coworking spaces and the impact on workers' performance and mental and physical health?

2. Method

2.1. Study design

The intention of a scoping review is to map the existing body of literature and identify gaps in the research knowledge, clarify key concepts, and report on types of evidence that might address practice in the field [30, 31]. In recent development of CWS, and limited research in the area, a decision was made to use scoping review for understanding what research has been undertaken and what are the types of evidence currently available in this field. In addition, the intent was not to restrict the review by methodological limitations but support the need of scoping rather than a systematic review [31].

The scoping review followed the methodological framework outlined by Arksey and O'Malley [32]; in five steps which were:

1) Identification of the research question,
2) Identification of relevant articles,
3) Study selection,

4) Charting the data/data extraction,
5) Collation and summation of the results and reporting.

2.2. Search strategy

The final search strategy was developed following refinement of the initial terms to reduce the number of irrelevant articles, e.g., CWS (for coworking space) retrieved many articles related to Child Welfare System and Collision Warning Systems. Only two search term concepts were used in order to maximise search results: coworking gcontext and impacts/outcomes (Appendix 1). PsycInfo, EMBASE, and ProQuest databases were searched on 20 October, 2020, for English language articles published after January 2005 (Appendix 2). The commencement date for the search was from the year 2005 as this year was considered the start of coworking movement [3]. An experienced librarian was consulted regarding the databases for the subject matter of review. Selection was based on the following priorities: coverage of psychosocial research (PsycInfo), a range of the most relevant journals (ProQuest), and business journals (EMBASE). The search of the reference lists included all articles for identifying relevant papers. Hand searching of Google Scholar was conducted between 8th to 23rd October 2020, using 'Co-working' as the key search term.

2.3. Study selection

Results were imported into Covidence (www.covidence.org), an online systematic review platform, and duplicate articles were removed. For inclusion, the following criteria were used: a) the publication was peer reviewed and available in English; b) the study was located in a dedicated CWS; c) participants were adults over the age of 18 years; d) studies that covered physical and/or psychosocial environment factors as related to worker health and/or worker performance outcomes. Exclusion criteria included: a) studies that focused on activity-based working environments; b) if coworking was defined as a working relationship, for example, between different allied health professionals; c) studies that focussed on hot desking; d) opinion papers, reports and dissertations. This scoping review considered quantitative and qualitative study designs to maximise the number of articles retrieved. Grey literature was not searched for the review.

Initial title and abstract screening were undertaken by three members of the research team (JO and NM) and one who is not a listed author. The same three members independently screened the article titles and abstracts to determine compliance with inclusion criteria. The Covidence software program was used to record decisions. Any discrepancies were resolved through discussion. Full text screening was also undertaken by JO and NM. The risk of bias is not routinely assessed in scoping reviews so it was not undertaken here [30].

2.4. Data extraction

The first round of the data extraction process was undertaken manually by one author (NM), using a data extraction form developed by other authors. The following information was extracted: author(s)/date and country of study; study design; participant demographics; measures; results; and outcomes and influences (Table 1). Outcomes were categorised as either physical health, mental health, or workers' performance. The term 'influences' refers to factors in the physical or psychosocial environment which influence the three outcomes of interest. All extracted data was checked by two members team (NK and JO) for accuracy.

2.5. Data analysis

Diagrammatic mapping was undertaken to chart the results. This process involved identifying the influencing factors and outcomes in the data extraction table, and developing these into diagrammatic representations of 1) the range of the evidence, and 2) the relationships between the different factors and outcomes [30]. Outcome measures were heterogeneous. All results were extracted and reported.

3. Results

3.1. Study characteristics

The search identified 219 articles, with further 14 articles located through hand searching of the reference lists from included articles. Following removal of duplicates, initial screening, and full-text evaluation, 11 articles met the inclusion criteria. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews (PRISMA-ScR) was followed. An overview of the study

Table 1
Data extraction table

Author (Date) Country of study	Study design	Participants	Measures	Results	Outcomes & influences
Qualitative Houtbeckers (2017) (Finland)	Ethnographic (Qualitative)	Software developers, photographers, unspecified professionals (age and gender not specified)	15 interviews; 33 visits for observations and participation	Increased self-confidence, hope and personal development through cooperation with other coworking space users, compared to previous dysfunctional workplace.	Mental health outcome Psychosocial influence
Orel & del Mar Alonso Almeida (2019) (Germany (Latvia (and the Czech Republic (Prague)	Ethnographic study (Qualitative)	Managers of coworking spaces	Observation of CWS users, 6 unstructured interviews with CWS operators (average time per CWS 35 h)	CWS furniture placement that created open space and flexibility, contributed to increased communication between users and collaboration. Bright lighting and situating worktables near windows increased satisfaction, communication and collaboration. Office plants increased motivation, productivity, wellbeing and satisfaction. Inability to customise temperature control may lead to reduced openness to interact with other users. A community/mediation manager of the CWS increased interaction between users.	Mental health outcome Work outcome Psychosocial influence Physical influence
Servaty et al. (2018) (Germany)	Interviews (Qualitative)	14 CWS users (5 F) (36%) (9M) (64%) Age 36.64 yrs (SD 7.24) Information technology consultants, graphic designers, journalists, marketing professionals	Coworker interviews covered demographics working conditions (physical and psychosocial) communication, health impacts and rating of satisfaction with CWS	Motives for working in a CWS were community and for some, an alternative to home office. Increased productivity compared to home office due to workstation flexibility, working atmo-sphere/infrastructure. Flexible task arrangement resulting in increased autonomy & influence at work leading to positive mental health, job satisfaction & well-being. Use of laptops,	Mental health outcome Physical outcome Work outcome Psychosocial influence Physical influence

(*Continued*)

Table 1
(*Continued*)

Author (Date) Country of study	Study design	Participants	Measures	Results	Outcomes & influences
				non-adjustable office chairs/desks, insufficient light & sub-optimal temperature resulted in negative effect on general health (details not specified), with adjustable furniture, optimal light & temperature, and noise dampeners having a positive effect on general health (details not specified). Mental exhaustion/high stress related to high noise levels & lack of privacy compared to single office. Physical proximity & community aspect of coworking facilitated collaboration/networking & beneficial for mental health.	
Spinuzzi et al. (2019) (USA, Italy & Serbia)	Case studies (Qualitative)	6 CWS in USA, Italy and Serbia (one franchised and non-franchised per country). CWS managers, mid career professionals, creative industry professionals, entrepreneur start-ups, (age and gender not specified)	Semi-structured interviews; participant observations and artefact analysis (documents, photos and web site screen captures)	3 CWS had managers that set institutional rules or membership selection (with an emphasis on community/collaboration) so that users had a shared interest and greater potential to network/collaborate. However, the relationship between coworkers was characterised as providing each other with camaraderie and emotional support but not intensely collaborating on work— for the most part, "working alone, together". The remaining 3 locations had Geselleschaft communities with little collaboration on common projects.	Work outcome Physical influence Psychosocial influence
Walden (2019) (USA)	Grounded theory informed ethnographic (Qualitative)	22 CWS members Marketers, community developers,	Interview topics covered use of the office, sharing accomplishments,	Physical proximity provided an opportunity for collaboration and	Mental health outcome Work outcome Psychosocial

(*Continued*)

Table 1
(*Continued*)

Author (Date) Country of study	Study design	Participants	Measures	Results	Outcomes & influences
		entrepreneurs, pastors, office managers, finance professionals, artists, food co-op managers, author, baker (8 F) (36%) (14 M) (64%) Age 31.7 yrs (24-67)	seeking feedback on projects and interactions. Observations of online and in person interactions	career enhancement/opportunities, social support, and knowledge sharing/expertise input. Disrupted work & stress/pressure due to other co-workers requesting knowledge/expertise – use of headphones to minimise disruptions (as a signal that they are focussing and do not wish to be disturbed).	influence
Quantitative Bouncken et al. (2020) (26 cities across USA, Germany, and China)	Cross sectional survey (Quantitative)	Interviews: with 5 CWS managers and 9 users (coach, freelancer, consultant, entrepreneurs, unspecified professional) Surveys: 328 respondents: 50% entrepreneurs, China (77.7%), Germany (21.6%) USA (0.7%) (119 F) (36%) (209 M) (64%) Age 27.7 yrs (SD 6.3)	14 interviews Standardised questionnaire using a 5 pt Likert scale, participation, autonomy, linkage multiplicity, sense of community, mutual knowledge creation and work satisfaction	Interview results: Sense of community in CWS contributes to work satisfaction. Open architecture facilitates social exchanges, open participation, and mutual knowledge creation that leads to high work satisfaction and increased motivation. Autonomy might improve work satisfaction & empowerment. Survey results: individual work satisfaction caused by 1) sense of community in the absence of participation, 2) participation with multiple linkages, or 3) in absence of autonomy with linkage multiplicity and mutual knowledge creation. Negative work satisfaction caused by absence of participation, autonomy, linkage multiplicity or mutual knowledge creation.	Mental health outcome Work outcome Psychosocial factor Physical factor

(*Continued*)

Table 1
(*Continued*)

Author (Date) Country of study	Study design	Participants	Measures	Results	Outcomes & influences
Bueno et al. (2018) (Nth America, Sth America, Europe, Turkey, Egypt, Morocco, Russia and Australia)	Cross sectional survey (Quantitative)	193 CWS users (job role not specified) (73 M) (37.8%) (120 F) (62.2%) 113 CWS users < 34 years old (58.03%)	Survey covered demographics, and rating satisfaction with the coworking space environment, social interactions and productivity	CWS environment (office layout) (0.336, $p < .01$)) and social interaction (0.846, $p < .001$) significantly impact CWS user productivity.	Work outcome Psychosocial factor Physical factor
Cheah et al. (2019) (Singapore)	Cross sectional survey (Quantitative)	101 CWS users (young professionals from same firm) (41 F) (41%) (60 M) (59%) Age 28.77 yrs (SD 6.28)	Twice daily questionnaire for ten consecutive workdays covering mutual support, role breadth self efficacy (RBSE) and sustainable job performance. Peer survey (to assess the validity of participants self-reported responses on their job performance)	Daily mutual support received by a worker in a coworking space was positively related to the worker's daily sustainable job performance (after controlling for daily sleep quality, daily job requirements and daily workload stress) (B0.08, $p < 0.01$) A worker's daily RBSE (self-confidence about their abilities to perform a broader, more proactive role) was a significant positive moderator between daily mutual support the worker receives and the work's daily sustainable job performance (B0.05, p<0.05).	Work outcome Psychosocial factor
Houghton et al. (2018) (Australia)	Cohort (Quantitative)	47 CWS users from 10 different Government departments at 2 CWS (37 trial participants and 10 supervisors) M (44%) F (56%). Age 26-30 yrs = 13%, 31-35 = 9%, 36-40 = 9%, 41-45 = 13%, 46-50 = 35%, 51-55 = 4%, 56-60 = 4%, 61^{+}=4%	Online quarterly survey with multi-choice and open-ended questions covering perceptions and experiences of participants and supervisors, plus diary of experiences and interactions	Physical discomfort from chairs. Negative impacts on productivity included ICT issues (lack of network access/slow system), lack of face-face discussions with colleagues, late office opening times. Geographic location of CWS close to home meant less commute time & improved work-life balance, resulting in decreased stress and high productivity.	Mental health outcome Work outcome Physical outcome Physical factor
Robelski et al. (2019) (Germany)	Cross sectional survey (Quantitative)	112 CWS users, self-employed information technology specialists,	Survey covered demographics sociodemo-graphic, characteristics of	CWS promoted perceived productivity, ability to concentrate & self organise, & job	Mental health outcome Physical outcome Work outcome Psychosocial

(*Continued*)

Table 1
(*Continued*)

Author (Date) Country of study	Study design	Participants	Measures	Results	Outcomes & influences
		consultants, graphic designers, photographers, journalists, marketers M (61.6%) F (38.4%) Age 38.09 yrs (SD 9.55)	the CWS, job stressors, comparison of CWS and home office, general health status (single item from COPSOQ), psychosomatic complaints and satisfaction with the CWS	satisfaction, and provided increased social interactions. Work environment (noise, dust, temperature, equipment) significantly associated with CWS satisfaction but no statistically significant association with physical/mental health.	factor Physical factor
Mixed Methods Gerdenitsch et al. (2016) (Europe)	Study 1 – Cross sectional survey (qualitative) Study 2 - Cross sectional (quantitative) (employees versus coworkers)	Study 1 – 69 CWS users (job not specified) (45 M) (65.22%) (24 F) (34.78%) Age 32.02 yrs (SD 5.99) Study 2 – 609 office employees, (279 M) (45.81%) (330 F) (54.19%) Age 29 yrs (SD 3.9). 154 CWS users (roles in software/web development, consultancy, journalism/media, science research, marketing, design/creative, architecture, social entrepreneurship, tourism/gastronomy (102 M) (66.23%) (52 F) (33.77%) Age 39 yrs (SD 8.45)	Study 1 - Survey included sociodemographic information and questions on social interactions with other coworkers. Study 2 – Survey covered demographics, social support, time pressure, self-efficacy and performance satisfaction	Study 1 – Coworkers describe most of the situations as informal social interactions which enable the creation of a social network. Instrumental support and exchange of information are examples of direct social support. Study 2 – For CWS, social support on performance satisfaction was positive and significant ($B = 0.21$, $p = 0.01$) and remained significant when self-efficacy was included as a mediator ($B = 0.19$, $p = 0.017$). For the employee sample, the effects of social support on self-efficacy (path a; β 0.25, $p < 0.001$) and of self-efficacy on satisfaction with performance (path b; β 0.26, $p < 0.001$) were significant. The total effect from social support to performance satisfaction was significant (path c: β=0.24, $p < 0.001$) and remained significant although weaker with the mediator included (path c': β=0.18, $p < 0.001$).	Work outcome Psychosocial factor

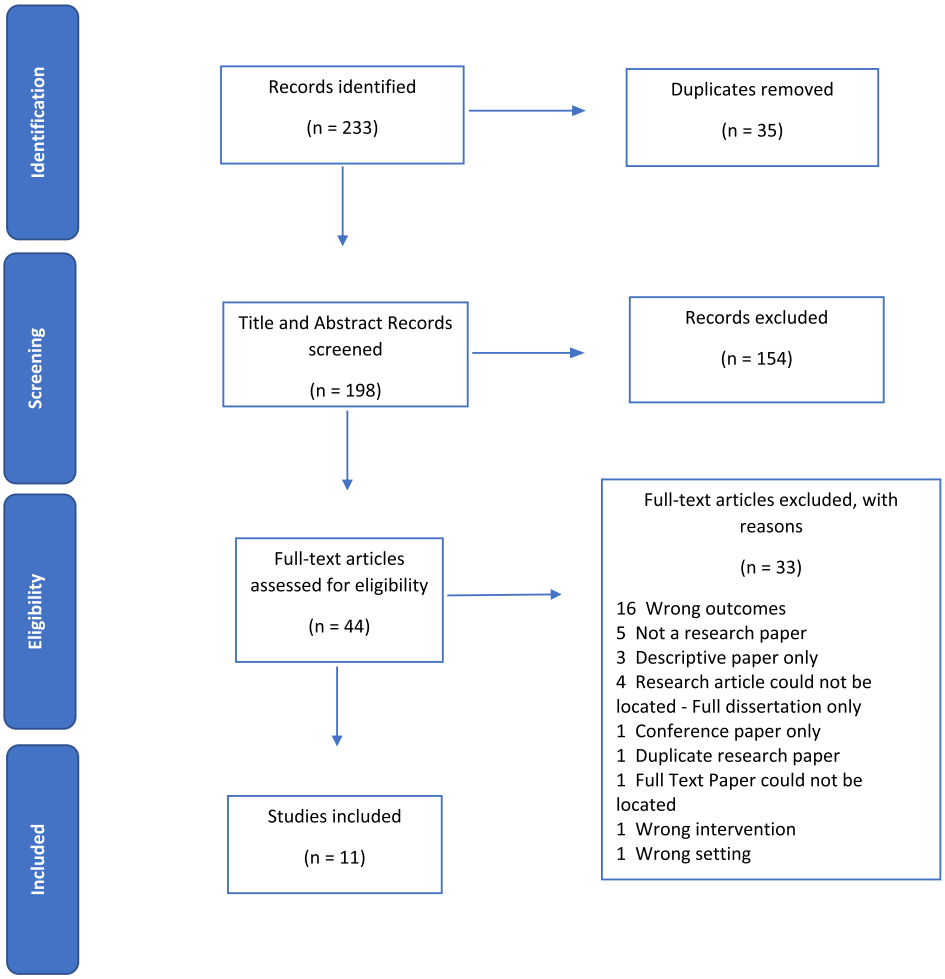

Fig. 1. PRISMA (ScR) flow diagram.

selection process is show in Fig. 1. The most common reason for article exclusion was that the outcome of interest was not included ($n = 16$).

Study designs of included articles were as follows: qualitative ($n = 5$), quantitative ($n = 5$), and mixed methods ($n = 1$). Across all studies the mean age of CWS users were less than 39 years (range 27.7 – 39 years), with 57.6% male and 42.4% female. Articles represented 14 countries (USA, Germany, China, Turkey, Egypt, Morocco, Russia, Australia, Singapore, Finland, Latvia, Czech Republic, Italy and Serbia) - five articles represented multiple countries (refer Table 1). All 11 included articles were published between 2016 and 2020, with nine articles being published in 2018 and 2019.

3.2. *Environmental influencing factors (physical and psychosocial)*

Twelve physical and six psychosocial environmental factors were identified in the literature (see Table 2). These environmental factors were discussed in the context of their impact on work-related outcomes (See Fig. 2). Figure 3 shows the outcomes related to CWS, and the number of articles which reported on each outcome.

3.3. *Workers' performance*

In the text references, either productivity, work performance satisfaction, or daily sustainable work

Table 2
Coworking space influencing factors and outcomes (n = number of articles)

Physical environment influences ($n = 8$)	Psychosocial influences ($n = 11$)	Worker performance outcomes ($n = 10$)	Mental outcomes ($n = 7$)	Physical outcomes ($n = 3$)
Temperature • Noise • Lighting • Dust • Workstation flexibility • Furniture adjustability/use of laptop • Office plants • Presence of coworking space mediation manager • Open architecture/physical proximity of users • ICT infrastructure • Coworking space opening hours • Geographic location (proximity to home)	Social interactions/cooperation/mutual support/sense of community • Working atmosphere • Flexible task arrangement/autonomy • Lack of privacy • Knowledge sharing • Lack of face-to-face discussions with colleagues	Productivity (including measures of performance satisfaction) • Collaboration/networking • Disrupted work • Job satisfaction • Career enhancement	Stress/pressure/mental exhaustion • Wellbeing/mental health • Self-confidence /empowerment • Motivation	Physical comfort • General health

performance, were considered as proxy measures *of productivity* [33–39]. Productivity was positively associated with social support/interactions [35, 38, 39] and negatively associated with lack of visage to face contact with colleagues [34]. Some articles in the review, linked productivity to physical aspects of the coworking space, open architecture, and workstation flexibility which facilitated social interaction between users [36, 37, 40, 41]. Additional physical environmental factors related to productivity benefits were: the location of CWS being close to the users home (thus reducing commute time and stress) [34], and office plants which contributed to positive comfort ability of a coworking space [37]. Two physical factors were associated with reduced productivity: inadequate ICT infrastructure, and the opening times of the CWS (i.e., CWS not opening until late in the morning) [34]. Overall, the CWS environment was reported as having a positive impact on productivity [33, 35].

Collaboration/networking between CWS users was positively associated with social interactions/mutual support [38, 40], facilitated by physical proximity [36, 41]. However, in contrast one study found that camaraderie and social support was not associated with collaboration, describing the relationship as 'working alone, together' pg. 131 [42]. Positive physical environment influences on collaboration and networking included bright lighting and when worktables were located near a window [37].

Disrupted work was experienced by some users at a CWS – the source of the disruption was through other users requesting knowledge or expert input [41]. In general, social interaction was regarded positively but, conversely, negative impacts on productivity were also identified as a potential issue.

Job satisfaction was positively associated with the general CWS environment [33]. More specifically, job satisfaction was positively associated with: social interactions and the sense of community created by CWS open architecture [40]; flexible task arrangements that increased autonomy and influence at work [36]; and, bright lighting and office plants [37].

Career enhancement opportunities were reported as a benefit of working in a CWS, through networking opportunities created by the CWS open architecture [40].

3.4. Mental health outcomes

Stress/mental exhaustion was reported as an outcome associated with two psychosocial aspects of the CWS: disruption by co-users seeking knowledge or expertise [41], and lack of privacy [36]. Only one physical environment factor i.e. high noise levels, was

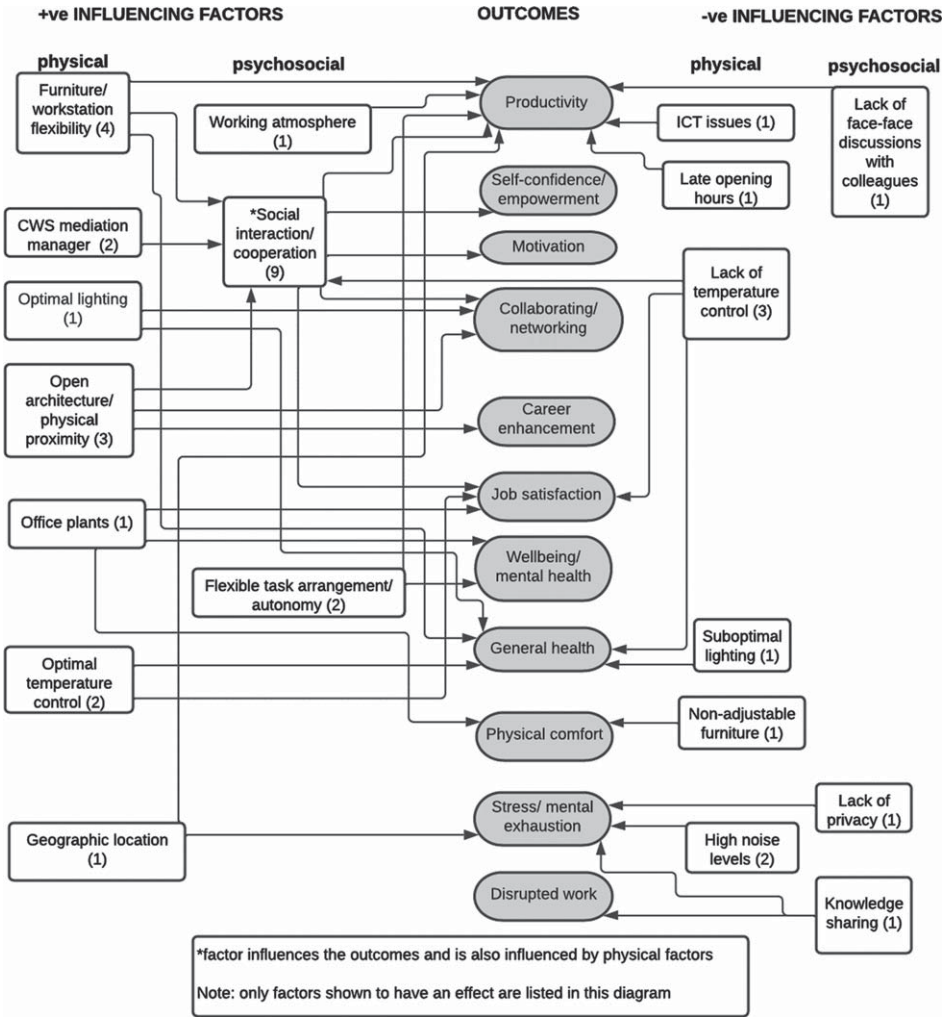

Fig. 2. Relationships between influencing factors and outcomes (n = number of articles).

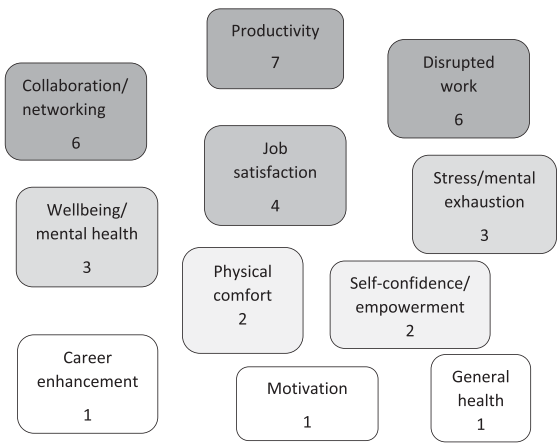

Fig. 3. Map of outcomes related to CWS, as measured by number of articles reporting those outcomes.

associated with increased stress [36], whilst CWS geographic location close to home was associated with decreased stress (due to lesser commuting time and improved work-life balance) [34].

Wellbeing/mental health was reported to be improved by the presence of office plants [37]. However, no significant association was identified with other physical environment factors such as noise, dust, temperature, rooms, and facilities [33]. Although temperature was not reported as having a direct impact on wellbeing/mental health, one study found that the inability of CWS to cater for individual temperature preferences, could reduce the social interactions between users if they become dissatisfied with other users who set temperature controls [37]. As social interaction is a psychosocial factor that reportedly improved wellbeing/mental health [36],

the lack of temperature optimisation could negatively impact wellbeing/mental health. A further psychosocial factor that improved wellbeing/mental health was an individual's ability to undertake flexible task arrangements with freedom to organise their schedule, leading to increased autonomy and influence over work [36].

Self-confidence/empowerment was enhanced for CWS users through social interactions and cooperation with other users [43], as well as having autonomy in their work role [40].

Motivation was reported to be increased through social interactions and collaboration with other users [40].

3.5. Physical health outcomes

Physical comfort was negatively associated with office furniture that could not be adjusted to suit an individual's needs [34] and positively associated with office plants [37]. Use of laptops (poor neck posture), insufficient lighting, and sub-optimal temperature were negatively associated with *general health* [36]. There was no statistically significant relationship between the general work environment (noise, dust, temperature, equipment)and self-reported physical health [33].

4. Discussion

Prior to the COVID-19 pandemic, CWS were increasingly utilised by knowledge-based workers as an alternative to their office or working from home. CWS were also used as hubs for independent workers to come together to work separately and also to collaborate and innovate [44]. The current review sought to explore the impact of CWS environmental conditions on worker performance, and their mental and physical health. All studies included in the review explored psychosocial influencing factors and eight studies included some physical influencing factors. However, when considering the outcomes related to the CWS environment, most of the studies examined worker performance outcomes and mental health outcomes, and only a very small number included physical outcomes. Overall, the CWS environment appears to have a positive impact on workers' health and worker performance outcomes.

There has been an increasing emergence of a range of different CWSs but the impacts on the users of these spaces is not well understood [45]. The rapid change to working conditions over the past few years due to the pandemic offers reconsideration of how these spaces are used and by whom i.e. CWS may offer an alternative location for use by those workers who do not attend their normal organisation's central office due to a change in working models or its geographical location.

Geographical location is a physical aspect of CWS positively influence worker performance if the location results in reduced commute time [34]. Other physical factors in the CWS environment is positive influence on productivity with the open architecture, flexible workstations and presence of a mediation manager. These factors can facilitate enhanced social interactions (a psychosocial environment factor) which can contribute to increased productivity. The level of social interaction is often reduced for those working from home, and thus CWS can offer a more beneficial work environment to some workers [46].

Physical aspects of the CWS environment (adjustable furniture, optimal light and temperature) also had a positive effect on the general health of workers [36]. These aspects of the work environment are often not easily optimised when working from home [29], which may further increase the appeal of a CWS for some workers who engage in hybrid work arrangements.

The second question in this scoping review was to identify the knowledge gaps in the use of CWS and the impact on workers' performance and mental and physical health. The limited number of articles retrieved through the systematic search process utilised in the review, supports the rationale for using a scoping review, given the limited nature of the research evidence identified despite utilisation of a rigorous process. Accordingly, taking into account the findings for this scoping review, further research opportunities exist. The limited coverage of the impact of CWS on workers' physical outcomes are musculoskeletal pain were further studies are necessary to evaluate outcome. To expand the usage of CWS, understanding the motivations of those who could choose to use these spaces but do not currently do so, could be explored. Finally, the longitudinal studies examine the impacts of CWS on workers' health and performance over time, will help to enable examination of causal relationships rather than the identification of patterns and associations between the different variables of interest.

4.1. Limitations

This narrative analysis may be considered a subjective process and alternative methods to extract and map the information resulted in different findings. A quality assessment of the articles retrieved was not undertaken for this scoping review. It is consistent with proposed approach outlined by Arksey and O'Malley [32] and other scoping review approaches [31]. Whilst study design was not restricted or assessed in the current review, most of the studies included were cross sectional, limiting inferences of causality on the impacts of the coworking environment on worker performance, and mental and physical health. Opportunities exist for more extensive longitudinal studies which examine the impact of coworking spaces over time, incorporating both quantitative and qualitative methodologies. Improved understanding of the motivations for CWS will be particularly important in a post pandemic environment to ensure the continuation of this type of working.

5. Conclusion

This review found that the coworking space environment can positively impact worker health and performance outcomes, particularly in relation to productivity and collaboration/networking opportunities. However, some aspects of the coworking space environment (particularly noise control, privacy, and extent of knowledge sharing) require attention to mitigate the risk of negative mental health outcomes too. Further research is needed to address the knowledge gap in relation to physical health outcomes, which received limited attention in the articles reviewed. In the 'new normal' work environment during the COVID-19 pandemic, there is rapid uptake of hybrid working arrangements. CWS may provide a positive alternative workspace of working from home.

Ethical approval

Not applicable.

Informed consent

Not applicable.

Conflict of interest

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Appendix 1: List of search terms

Context	Concept
Coworking	*Impacts and outcomes*
• coworking	• health*
• co-working	• wellbeing*
• "co working"	• physical*
• "non-territorial work*"	• injur*
• "multi-tenant workplace*"	• psychosocial*
• "multi-tenant workspace*"	stress*
• "collaborative office*"	• fatigue*
	• isolati*
	• mental*
	• "mental health"
	• performance
	• productiv*
	• "job strain"
	• "job satisfaction"
	• workload
	• "work variety"
	• "job insecurit*"
	• "job opportunit*"
	• "work demand*"
	• "social support*"
	• "work control"
	• "musculoskeletal"

Appendix 2 Full electronic search strategy

PsycINFO

1. (coworking or co-working or "co working' or "non-territorial work*" or "multi-tenant workplace*" or "multi-tenant workspace*" or "collaborative office*").mp.[mp = title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh]

2. limit 1 to (English language and yr="2005-current")

3. (health* or wellbeing* or physical* or injur* or psychosocial* or stress* or fatigue* or mental* or "mental health" or performance or productiv* or "job strain" or "job satisfaction" or workload or "work variety" or "job insecurity*" or "job opportunity*" or "work demand" or "social support" or "work control" or musculoskeletal).mp.[mp = title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh]

4. limit 3 to (English language and yr="2005-current"

5. 2 and 4

Embase

1. (coworking or co-working or "co working' or "non-territorial work*" or "multi-tenant workplace*" or "multi-tenant workspace*" or "collaborative office*").mp.[mp = title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate team word, mesh]

2. limit 1 to (English language and yr="2005-current")

3. (health* or wellbeing* or physical* or injur* or psychosocial* or stress* or fatigue* or mental* or "mental health" or performance or productiv* or "job strain" or "job satisfaction" or workload or "work variety" or "job insecurity*" or "job opportunity*" or "work demand" or "social support" or "work control" or musculoskeletal).mp.[mp = title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate team word, mesh]

4. limit 3 to (English language and yr="2005-current"

ProQuest

Noft(coworking OR co-working OR "co working" OR "non-territorial work*" OR "multi-tenant workplace*" OR "multi-tenant workspace*" OR "collaborative office*") AND noft((health* OR wellbeing* OR physical* OR injur* OR psychosocial* OR stress* OR fatigue* OR mental* OR "mental health" OR performance OR productiv* OR "job strain" OR "job satisfaction" OR workload OR "work variety" OR "job insecurity*" OR "job opportunity*" OR "work demand" OR "social support" OR "work control" OR musculoskeletal) AND stype.exact("Scholarly Journals") AND la.exact("English") and pd(>20050101).