Decreasing screen time of desk workers: a systematic review

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Abstract

Background An increase in screen time goes along with sedentary behaviour in desk workers. Such increased screen time is often accompanied by negative health effects, both physical and psychological. These health effects could be prevented by a decrease in screen time. **Aim** Currently, there is not much known about the state of art of studies decreasing screen time in desk workers. Therefore, the objective of this literature review was to provide an overview of currently available studies as well as specific facilitators and barriers to the reduction of screen time. **Methods** A systematic literature search was conducted with Scopus and PubMed as databases. The found sources were screened with EndNote X9.3.3. Out of the 588 screened records, six were included in this review. Those selected studies were examined in a table in Microsoft Excel, which made further organisation and comparison of the data possible. **Results** The analysis of the six selected studies revealed facilitators to the reduction of screen time, as well as barriers that often hinder the reduction of screen time. The facilitators included a change of the working environment, break prompts, the focus on leisure time screen use, and physical activity. The barriers included a lack of knowledge regarding the negative health effects of prolonged screen time, lack of support within the working environment, and the characteristics of desk work. **Discussion** Due to only a small number of papers fulfilling the criteria of this study, it was concluded that the field of research regarding screen time reduction is not yet far developed. Nonetheless, it was discovered that the found facilitators and barriers are similar within the more developed field of sitting reduction. Moreover, it was discussed why green time studies are not associated with screen time reduction in desk workers. Additionally, the importance of distinguishing between sedentary behaviour and physical inactivity has been demonstrated. Further, the ethical issue of the need to seem productive by staying in front of the screen and the lack of support in working environments were discussed. For future research, it was suggested to explore existing interventions further, and to consider education about health consequences and changes of the working environment for new interventions.

Key words: Screen time, desk workers, facilitators, barriers, systematic literature review

Contents

Introduction

Screen time rates are currently increasing more than ever in the majority of developed countries worldwide (Sultana et al., 2021). As screen time includes the use of different devices, like using a computer or laptop, watching TV, or using a smartphone or tablet, it can be further divided into screen time at work and screen time during leisure time. At work, screen time is most often made up of different computer tasks, for instance working with different programs, writing emails, or attending video conferences (Vizcaino et al., 2019). During leisure time, many people tend to watch television or use their smartphones for several hours a day in addition to their already high screen time at work (Liu et al., 2020). This is problematic because increased screen time brings several negative effects and risks with it that could even increase mortality (LeBlanc et al., 2017; Madhav et al., 2017).

The recent increase in screen time can be attributed to several factors. Chiappetta (2017) states that people's lives are becoming increasingly technological, and Sultana et al. (2021) name the COVID-19 pandemic as one of the causes for this increasing digitalization and use of technology. An example for a group whose screen time has increased especially are desk workers, given the fact that they use a computer, or a different device with a screen, most of the time (Barone Gibbs et al., 2021; LeBlanc et al., 2017). With the onset of the pandemic, numerous companies then started to enable their employees to work from home or do remote work, requiring them to use their screens for even longer periods of time than usually, given the fact that during remote work meetings take place online instead of in person (Barone Gibbs et al., 2021). This possibility of remote work has stayed until now, which is 2022, after the pandemic has already calmed down. An additional reason for people spending more and more time in screen-based sedentary behaviours are for instance the business models of social media companies. Such companies aim at making social media usable in many different ways, for instance for entertainment purposes, bringing people to connect with others while playing online games or watching videos on YouTube and writing comments for example (Mahoney & Tang, 2018; Vizcaino et al., 2020). Additionally, such social media business models bring companies to use social media for their advertisement campaigns to reach a large part of the target population. Thus, the business models of social media companies lead to an increase in screen time both at work and during recreational time. Furthermore, social media is used in large part to simply connect and communicate with others via platforms like WhatsApp, Instagram, Facebook etc., not only regarding private matters, but also on a professional level (Mahoney & Tang, 2018). Thus, people's screen time is increased through desk work both in the office and at home, and it is additionally increased further through screen use during leisure time.

Screen use can be classified as sedentary behaviour. To be more precise, Fox (2012) describes sedentary behaviour as any behaviour with low to no energy consumption. As the majority of people tend to sit down while working on a computer, desk work is most often considered sedentary. The possible negative effects resulting from this can be divided into short-term and long-term effects on both physical and mental health. Examples of short-term effects are a decreased attention span and headaches, as well as sleep disturbances or decreased sleep quality caused by screen exposure in the evening (Goadsby et al., 2021; Montagni et al., 2016; Salfi et al., 2021). Further, the term 'zoom fatigue' has been coined, which describes the physical and psychological fatigue that can be caused by attending video conferences (Fauville et al., 2021). This fatigue and general lack of motivation can furthermore lead to a decreased level of physical activity, which is another negative effect (Fauville et al., 2021). Long-term effects could then be decreased psychological well-being through daily use of digital media, which is also called technostress (Chiappetta, 2017). Symptoms of decreased psychological well-being are common and can possibly develop into a full-blown depression (Madhav et al., 2017; Oswald et al., 2021; Smith et al., 2020; Zhang et al., 2022). Short sightedness, low back pain and even obesity could be additional long-term effects, due to the decrease of physical activity that is caused by sedentary screen-based activities (Chaput et al., 2011; Mahdavi et al., 2021; Spyropoulos et al., 2007; Wong et al., 2021). Generally, increased screen time is accompanied by multiple different negative health effects, and since the reduction of those could be facilitated through interventions, it is needed to understand how people can be persuaded to change their screen use and be encouraged to break it up regularly.

Studies that investigated facilitators and barriers for screen time reduction have already been conducted for other target groups, like children and adolescents. For example, Minges et al. (2015) discovered facilitators and barriers to the reduction of screen time in young people (11-18 years). Barriers for the young target group are the routine of using screen-based media in everyday life, easy accessibility to screens, and a lack of opportunities to reduce sedentary behaviour. Facilitators are awareness of the health effects of prolonged screen time, as well as rules and limits to the screen-media usage. It should be noted that the facilitators and barriers for screen time reduction in the case of desk workers are most likely somewhat different. This is due to the fact that working on screens is a main part of the desk job and sufficient support within the working environment to promote screen time reduction is necessary. Therefore, reduction studies are necessary to encourage and support employees in reducing, or at least breaking up, their screen time. An example of a screen time reduction study is the randomized controlled trial by van Wezel et al. (2021). The results showed that overall screen time decreased

from pre-test (M = 274.79; SD = 110.44) to post-test (M = 226.99; SD = 100.96) (van Wezel et al., 2021). Such studies are directed at screen time, which is the source of the negative effects. Other studies include green time as a facilitator for screen time reduction, which includes any type of time spent in nature. If green time is enhanced, screen time will be reduced automatically because desk workers usually must leave their desks to spend time in nature. An example for this are breaks that desk workers spend in front of their screens instead of away from their desks. If they spent their breaks in nature instead, green time would be enhanced while screen time would decrease. Moreover, green time acts as a buffer against the impacts of increased screen time because natural environments have proven to be helpful in restoring attention, reducing stress, and promoting psychological well-being (Calogiuri et al., 2016; Daniels et al., 2022; Perrins et al., 2021; Ulrich et al., 1991; van den Berg et al., 2010). A theory supporting the importance and usefulness of green time is the Attention Restoration Theory, which states that spending time in nature restores cognitive functioning in general (Basu et al., 2018; Kaplan, 1995). Another theory that indirectly backs up the value of green time in screen time reduction is the Stress Reduction Theory by Ulrich et al. (1991), which states that reducing stress leads to a more positive mood. Therefore, it can be said that time spent in nature reduces stress and thus ultimately increases one's mood. Moreover, spending time in nature improves sleep quantity as well as quality (Shin et al., 2020). If the time spent in nature also involves movement, like going for a walk or exercising, then green time also promotes physical health (Han, 2017). In general, green time is thought to aid in screen time reduction and possibly reduce negative effects of screen time by enhancing several different protective factors. Overall, there are various different facilitators and barriers incorporated in current studies.

There already exist various studies targeting the issue of increased screen exposure by means of different methods. Nonetheless, many current studies focus on children and adolescents as the target group, and less on adults, especially not desk workers, who often have an increased screen exposure paired with increased sedentary time (Chiappetta, 2017; Munir et al., 2018). There is a general lack of information on the range and variety of studies for this specific target group, since there are no literature reviews about screen time reduction in desk workers available yet. Moreover, it is currently unknown which facilitators and barriers can be found in the majority of interventions for screen time reduction in desk workers because the focus of available studies has been placed on the sitting aspect only. Therefore, a literature review is necessary to highlight possibilities for desk workers to reduce, or at least break up, their screen time during their working day. The aim of this literature review is to provide an overview of

currently available studies as well as specific facilitators and barriers to the reduction of screen time in desk workers. Therefore, the research question is:

"What are facilitators and barriers in screen time or green time studies that aim to decrease screen time in desk workers?"

Method

Design

A systematic review was employed, which means that the results of selected sources were collected and compiled, but not statistically connected (Gopalakrishnan & Ganeshkumar, 2013). The review was conducted based on the PRISMA Statement by Page et al. (2021). This statement includes a checklist of 27 items and a flow diagram that are used to decrease risk of bias and to ensure clarity and transparency while reporting the systematic literature review.

Data sources

The following two databases were searched for applicable literature: Scopus and Pub-Med. Firstly, Scopus provides an advanced document search, containing sources from across several different fields of research, which makes this an especially rich and extensive database. Secondly, PubMed is the premier database for the biomedical research field, and it thus supplies literature regarding people's physical health in connection to screen time.

Eligibility criteria

The eligible literature from the systematic search was chosen according to specific inclusion criteria, which were formulated as follows. The target group was 18 years old or older, working in a job with a screen-based device, either in an office or remote. Next to this, the reduction of sedentary behaviour including screen time was targeted in the study.

The following exclusion criteria were applied: the publication was not in English, the study focussed on specific disorders like gaming addiction or smartphone addiction, the study focussed on sedentary behaviour but did not explicitly mention screen time, or there was no full-text available.

Study selection

The literature search started with choosing suitable key words. This was done by coming up with key words that could be suitable for the topic of screen time and green time studies for desk workers first, and then testing them by trial-and-error, namely by putting them into one search engine and checking how many possibly useful sources come up. Therefore, the key words could be narrowed down to the most fitting ones. Furthermore, the most suitable key words were then used for the systematic search across selected databases. The search string that

was created included terms based on the variables of green time, screen time, and desk workers. Therefore, the target group was also being included in the terms, and the risk of finding studies that include for instance children or adolescents was decreased. For every term synonyms and related terms were included to ensure an extensive output of studies. The sources were then selected by scanning titles, abstracts, and key words of the articles. In addition to searching the different databases, the reference lists of chosen articles were searched for further useful sources that might have been missed before. Different types of studies were considered in this review. More precisely, interventions, questionnaire and interview studies were of equal importance.

Table 1

Search String Key Words

Variable	Key words
GT	("green time" OR "green space" OR natur* OR "green exercise" OR outdoor OR park*)
ST	("screen time" OR "digital media use" OR "digital media" OR "screen use" OR "sedentary behaviour" OR "sedentary time" OR "screen-based" OR "social media" OR "social media use")
Target group	("desk work*" OR "office work*" OR "remote work*" OR employee* OR worker*)
Full search string	("green time" OR "green space" OR natur* OR "green exercise" OR outdoor OR park*) AND ("screen time" OR "digital media use" OR "digital media" OR "screen use" OR "sedentary behaviour" OR "sedentary time" OR "screen-based" OR "social media" OR "social media use") AND ("desk work*" OR "office work*" OR "remote work*" OR employee* OR worker*)

Data management and outcomes looked for

The screening of the literature took place in September 2022 and EndNote X9.3.3 was used to extract the studies from the search engines. All found effects of studies on the sedentary behaviour of desk workers, including their screen time, were reported in this systematic review. A reduction in screen time that can be attributed to the facilitators used in the studies was equally as important as study outcomes that did not entail a decrease in screen time, as barriers might have been present there. Barriers and facilitators to the reduction of workplace sedentary behaviour and screen time were identified from within the selected studies. For each study, the authors, publication year, country, percentage of female participants, age range of the participants, study design, sample size, and research type were reported, as well as the aims, instruments, and findings.

Results

Included articles

In total, 588 studies were identified from scientific databases. 79 duplicates were excluded, and 509 studies were included in the title screening. In this phase, 457 studies were excluded, and the 52 remaining studies were examined in the abstract screening. Another 34 studies were not deemed feasible for this review, and thus the remaining 18 studies were examined closely in the full-text screening. One of the available full texts was not in English, one did not include data collection, and another ten full texts did either not explicitly mention screen time or displayed false outcome measures irrelevant to this review. In the end, six studies met the eligibility criteria. Figure 1 displays the study identification process by means of a PRISMA flow-diagram.

Figure 1

PRISMA Flow-Diagram
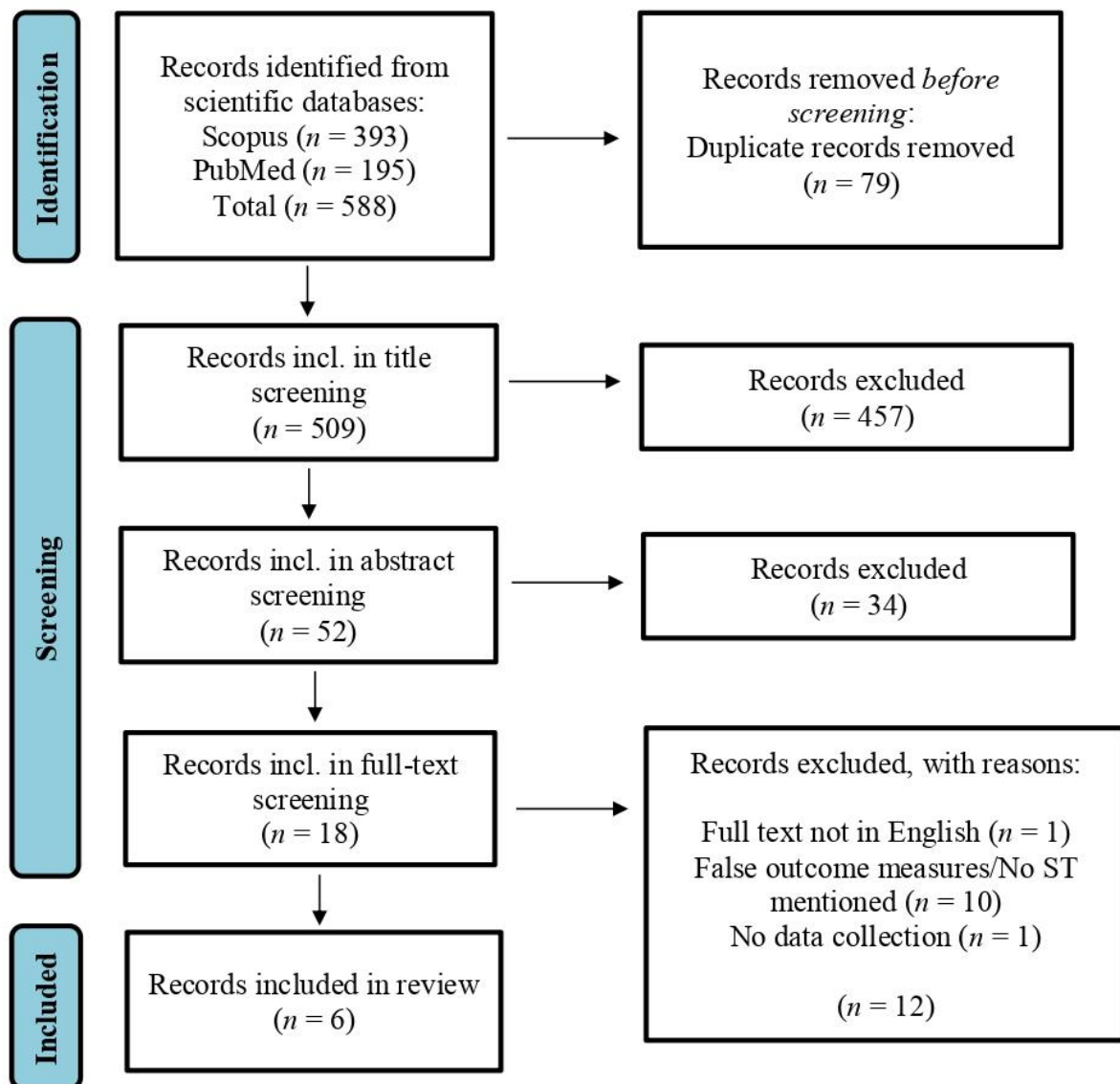
Study Range and Characteristics

The six included studies were published in a range of five years, between 2015 and 2020 (Cole et al., 2015; Genin et al., 2018; Hadgraft et al., 2016; Liu et al., 2020; Luo et al., 2018; Wang et al., 2020). Two studies did not report the country in which the study took place (Genin et al., 2018; Luo et al., 2018), the remaining four studies took place in the United Kingdom, Australia, Taiwan and Singapore (Cole et al., 2015; Hadgraft et al., 2016; Liu et al., 2020; Wang et al., 2020). With regards to the sample size, the studies varied remarkably, ranging from $n = 14 - 938$ (Cole et al., 2015; Wang et al., 2020). The age of the participants of all included studies ranged from $m = 23 - 62$ (Hadgraft et al., 2016). Regarding the gender,

it can be said that most participants in the included studies were female (Table 2). Only Genin et al. (2018) and Luo et al. (2018) mentioned the overall duration of the study, those being five months and three weeks respectively. Different study designs were applied, with two quantitative (Genin et al., 2018; Liu et al., 2020), two qualitative (Cole et al., 2015; Hadgraft et al., 2016) and two mixed method approaches (Luo et al., 2018; Wang et al., 2020). The characteristics and range of the selected studies are displayed in Table 2.

Table 2

Overview of Study Characteristics

Author(s)	Publication Year	Country	Age Range, % Female	Study Type	Sample Size n	Research Type
Cole et al.	2015	United Kingdom	Not reported	Qualitative study: semi-structured interviews, questionnaires, feasibility test of mobile app	14	Fundamental
Genin et al.	2018	Not reported	44.2 ± 9.8 years, 43% female	Quantitative study (quasi-experimental design): self-reported questionnaire, workplace PA intervention	193	Applied
Hadgraft et al.	2016	Melbourne, Australia	23-62 years, 50% female	Qualitative study: semi-structured interviews, questionnaire	20	Applied
Liu et al.	2020	Taiwan	37.4 ± 7.2 years, 43.3% female	Quantitative study (cross-sectional design): questionnaire study	363	Fundamental
Luo et al.	2018	Not reported	24-60 years, 72% female	Mixed method study (exploratory field study): intervention,	25	Applied

				questionnaire before and after, semi-structured interview (optional)		
Wang et al.	2020	Singapore	Quantitative part: 58.7% <40 years, 83.8% females Qualitative part: 75% <40 years, 92.9% females	Mixed method study (cross-sectional design): survey, environmental audit, and focus group discussions (FGDs)	Quantitative part (survey): $n = 938$ Qualitative part (FGDs): $n = 28$	Applied

Study Background and Development

With regards to their development and background the selected studies shared similarities but also showed differences within certain aspects. Similarities could be seen in the background of the studies, while differences became evident in the development of the studies and their study components. When examining the development of the different study components, it can be seen that five out of the six studies included at least one newly developed component in addition to already existing questionnaires. Such new components were for example the mobile application to track one's activities by Cole et al. (2015), or the break prompting system 'Time for Break' by Luo et al. (2018). Genin et al. (2018) did not develop a new component, as they focussed on the regular participation in a physical activity program which was being offered to the study participants by their employer. Due to the fact that they used the existing program as an intervention, their study can be considered as applied research. Altogether, four of the six studies are applied research (Genin et al., 2018; Hadgraft et al., 2016; Luo et al., 2018; Wang et al., 2020), while two are fundamental research (Cole et al., 2015; Liu et al., 2020).

Aims & Instruments

Table 3

Overview of Study Aims, Instruments & Findings

Study	Aim	Instruments	Findings
Cole et al. (2015)	Explore desk-based workers perceptions of factors that influenced sedentary behaviour at work and explore the feasibility of a novel mobile phone application to track their behaviours.	Semi-structured interview, accelerometer, questionnaire about physical activity behaviour (GPAQ), mobile app to track activities	Barriers to reducing sedentary behaviour: characteristics of desk work, facilities within the work environment. Facilitators for reducing sedentary behaviour: peer support. Mobile app: reduced sedentary behaviour, increased awareness of time spent in various activities, participants report a negative view on the app's usefulness, they want to be able to tailor the app to their own preferences.
Genin et al. (2018)	Compare health indicators between active and inactive tertiary employees with similar high levels of sedentariness. Secondly, we questioned the	Questionnaire, workplace physical activity (PA) intervention	The PA intervention has beneficial health effects on both initially inactive and active employees. Nevertheless, some health and fitness indicators in active employees did not show improvements, which might be attributed to their prolonged sedentary and screen time.

	effects of a 5-month workplace physical activity program on overall health indicators among initially active and inactive tertiary employees.		
Hadgraft et al. (2016)	Explore barriers to reducing office workplace sitting, and the feasibility and acceptability of strategies targeting prolonged sitting in this context.	Semi-structured interview, questionnaire including the Occupational Sitting and Physical Activity Questionnaire (OSPAQ)	On average, participants reported sitting at work for 7.2 h per day (min, max: 4.0, 9.5 h). Barriers to reducing sedentary behaviour: characteristics of desk work, organizational social norms. Strategies to reduce workplace sedentary behaviour: promoting and optimizing existing opportunities to reduce sitting, workplace interventions with additional strategies – not just height-adjustable desks. Perceptions around addressing workplace sedentary behaviour: perceived individual responsibility or motivation, workplace priorities.

Liu et al. (2020)	Examine the associations of overall and domain-specific (i.e., occupational, transport, and leisure-time) sedentary behaviours with cardiovascular disease (CVD) risk factors among high-tech company employees in Taiwan.	Questionnaire based on the Sedentary Behaviour Questionnaire for the Elderly of Taiwan	More than 2 h per day of leisure-time computer use entails a greater likelihood of having more than one CVD risk factor. No significant associations were observed for total sedentary time, occupational sitting, transport-related sitting, and TV-viewing.
Luo et al. (2018)	Understand information workers' intentions and practices around standing or moving breaks. Goal: inform the design of systems for promoting long-term healthy work routines.	Prompt-based system "Time for Break"	1) Actual breaks were mainly driven by physiological needs, instead of by wanting to relax or stay healthy. 2) Stronger pre-study habit strength in taking moving breaks = responding "yes" to the prompt more often 3) Self-regulation significantly increased over the study period, which means that participants became better at developing and managing their plan to take moving breaks.

Wang et al. (2020)	Assess sedentary behaviour (SB) and its determinants, as well as potential strategies to reduce SB among employees in a tertiary hospital in Singapore, using a mixed-methods approach grounded in the socioecological framework.	Survey, environmental audit, focus group discussions (FGDs)	Survey: employees in desk-based professions engage in more SB at work than other occupations; sex, BMI, and work schedule are significant factors affecting occupational SB. Environmental audit: the working environment was reasonably supportive for PA but inadequate to reduce SB. FGDs: the median sitting time at work was 480 minutes/day; confirmed the lack of a supportive physical environment to facilitate reductions in SB. Barriers to reducing sedentary behaviour: characteristics of desk work, lack of knowledge on health risks associated with sedentary behaviour.

Study Main Components

The studies provided findings regarding various facilitators and barriers (Table 3). It should be mentioned that none of the studies included the concept of green time. In the following, the findings are described.

Facilitators

Certain facilitators that helped decrease screen time were found. Those were the change of the working environment, the break prompts, the focus on leisure time screen use, and physical activity.

Change of Working Environment. Changing the working environment in companies supports the reduction of screen time. Such a change can be arranged in multiple different ways. As Hadgraft et al. (2016) describe, the working environment not only comprises the physical surroundings, but also the working climate and the organisational social norms within a company. For instance, if it is the norm to stay seated at the desk most of the day because this signifies productivity, employees will not be motivated to leave their desks. Therefore, Hadgraft et al. (2016) suggest that a change in such organisational social norms by encouraging employees to take regular breaks away from their desks facilitates the reduction of screen time. Participants in an interview study ($n = 14$) by Cole et al. (2015) also stated that peer support would help. This means that seeing co-workers leave their desks more often would change the perception that leaving one's desk signifies unproductivity. It would thus lead to a normalization of taking breaks away from the desk and breaking up screen time. In addition to that, Wang et al. (2020) also found support for the change of working environments. By means of environmental audits in four companies and focus group discussions ($n = 28$), they uncovered that a change in the information environment is necessary to raise awareness of the health risks of sedentary behaviour and screen time, and that a change in the physical environment is essential to provide more opportunities to break up sedentary time including screen time. An example for such an opportunity would be face-to-face communication within the company, like having meetings instead of chatting or emailing (Wang et al., 2020). Thus, changes within working environments can be undertaken in many different ways and are considered as facilitators to reduce screen time.

Break Prompts. Another type of facilitator are break prompts that are regularly shown to employees to remind them to take breaks away from their screens. The prompt-based system 'Time for Break' developed by Luo et al. (2018) uses this method, as it nudges employees to leave their desks by means of desktop pop-up messages. The study participants ($n = 25$) that tested the system were encouraged to take moving breaks from their work after certain amounts

of time that they chose themselves. It was revealed that participants' self-regulation increased significantly from pre- to post-test [(M = 4.26, SD = 0.60; M = 3.75, SD = 0.77), t(24) = -3.64, p = .010, d = .728], meaning that it became easier for them to adhere to their intended work and break duration (Luo et al., 2018). In conclusion, break prompts are facilitators to screen time reduction because the system 'Time for Break' enabled participants to work and break up their screen time in more regular intervals.

Focus on Leisure Time Screen Use. One study suggested that screen time during leisure time might be a better target for interventions than screen time at work (Liu et al., 2020). The reason for this is their finding that out of different sedentary behaviours, especially leisure time screen use increases the likelihood of being at risk for cardiovascular disease (CVD). Liu et al. (2020) state that this includes general internet, computer, and smartphone use, but surprisingly not TV viewing. Due to modern technology, these behaviours might simply have become more prevalent in the population of participants (n = 363), with an average leisure time screen use of 925.21 minutes per week, while the average weekly time of TV viewing was at 406.60 minutes (Liu et al., 2020). Limiting this behaviour would then decrease the likelihood of having CVD risk factors, more than the limitation of occupational screen use possibly could (Liu et al., 2020). Furthermore, the reduction of total screen time would be facilitated since leisure time screen use is easier to target due to the voluntariness of using screens after work (Liu et al., 2020). Therefore, focussing on leisure time screen use reduction instead of screen time reduction at work is another facilitator.

Physical Activity. Increasing physical activity has proven to facilitate the reduction of screen time as well. Genin et al. (2018) showed that physical activity can be a useful intervention to reduce screen time indirectly. The applied intervention contained both muscle-strength and cardiorespiratory exercises and took place two to three times per week for 45 minutes respectively (Genin et al., 2018). It did not matter if participants were active before taking part in the intervention or not. The increase in physical activity worked indirectly as a facilitator in this intervention since it caused employees to leave their screens while being physically active. In addition to that it ameliorates people's overall health status.

Another intervention that also used the increase in physical activity as an indirect facilitator was the activity tracking app by Cole et al. (2015). This app enabled employees to track their activities throughout the day, which increased their awareness about their prolonged sedentary screen time. The findings showed that implementing the app decreased the participants' mean minutes of daily sedentary behaviour significantly from pre- to post-test [baseline (n = 5) 401.90; follow-up (n = 11) 384.19]. Moreover, the participants stated in the exit questionnaire

(n = 8) that their awareness about their amount of sedentary time increased throughout the study (Cole et al., 2015). These results show that the implementation of an activity tracking app increased awareness about one's behaviour, which in turn increased physical activity and indirectly decreased screen time. Lastly, Luo et al.'s (2018) suggestion to incorporate synchronized moving breaks into a workday also includes an increase in physical activity as a facilitator. These types of breaks help to break up screen time by motivating employees to go outside together with their co-workers. The social aspect increases the motivation to leave one's desk even further.

Barriers

Several barriers that hinder the reduction of screen time were found. Those were a lack of knowledge regarding the health risks of prolonged sedentary behaviour, the lack of support within working environments, and the characteristics of desk work.

Lack of Knowledge. Wang et al.'s (2020) findings state that there are health risks associated with sedentary behaviour and screen time that are independent from the amount of physical activity someone engages in. This means that a physically active person is still at risk of suffering from the negative health effects of prolonged screen time and sedentary behaviour. Focus group discussions (n = 28) showed that there is a general lack of knowledge regarding this fact, as the participants did not differentiate clearly between physical inactivity and sedentary behaviour when talking about it (Wang et al., 2020). Such a lack of knowledge poses a barrier in a way that people might not deem it necessary to decrease or break up their sedentary behaviour and screen time. They might think that compensating this behaviour with physical activity is enough, even though it is not. Of course, physical activity is a facilitator, but directly decreasing or breaking up screen time in addition to that is more effective (Wang et al., 2020). Thus, the lack of knowledge is a barrier that people should be made aware of, and information about the importance of breaking up screen time should be offered.

Lack of Support within the Working Environment. Environmental audits in four different companies revealed that all of the employers provided a working environment that facilitated physical activity but did not aid in reducing sedentary behaviour and screen time (Wang et al., 2020). An example for this is the fact that there were reminder signs in the companies to use the stairs instead of the elevator, while there were no reminders to leave one's desk more often and reduce screen time. This is a common barrier to the reduction of screen time, which is also backed up by other studies (Cole et al., 2015; Hadgraft et al., 2016; Wang et al., 2020). Those also found that organisational social norms and workplace priorities often hinder employees from decreasing their sedentary behaviour because they make employees feel obligated

to stay in front of their desks for long amounts of time to seem as productive as possible (Cole et al., 2015; Hadgraft et al., 2016; Wang et al., 2020).

Characteristics of Desk Work. A barrier that is shared by multiple studies are the screen-based characteristics of desk work. More precisely, desk workers spend the majority of their time in front of a screen due to their tasks being mostly done online (Cole et al., 2015; Genin et al., 2018; Hadgraft et al., 2016; Wang et al., 2020). To give some examples, Hadgraft et al. (2016) found that the total number of hours spent in front of a screen per day ranged from 4.0 to 9.5 ($M = 7.2$). Moreover, Wang et al. (2020) found that their participants had a median sitting time of 480 minutes per day at work. A remedy against prolonged sitting are height-adjustable desks, but screen time does not decrease through this (Hadgraft et al., 2016). These findings show that the characteristics of desk work pose a strong barrier to the reduction of screen time that has to be circumvented by incorporating screen time reduction into work tasks. One example are walking meetings instead of online meetings.

Discussion

The aim of this systematic review was to provide an overview of currently available studies as well as specific facilitators and barriers to the reduction of screen time in desk workers. Overall, 588 studies were screened and examined, ranging from questionnaires to interviews and focus group discussions. Only six eligible studies were identified in this systematic review. The findings are discussed below.

Discussion points

Overall, four facilitators and three barriers were identified in this review. The facilitators are the change of the working environment, break prompts, the focus on leisure time screen use, and lastly, physical activity. The barriers were the lack of knowledge regarding the health risks of screen-based sedentary behaviour, a lack of support within working environments, and the screen-based characteristics of the desk job.

The first main point is that these findings can also, in great part, be applied to the research field of sitting reduction in desk workers, and vice versa the findings of sitting reduction research can frequently be applied to screen time reduction. To be more precise, even though screen time is often not explicitly included in the research field of sitting reduction, the facilitators and barriers are similar because desk work combines screen use with sitting most of the time. To give examples for shared facilitators, De Cocker et al. (2015) name the change of the working environment, and Hadgraft et al. (2018) state that support from both co-workers and managers is a key facilitator, which can also be connected to the change of the social working

environment. A method that could also be used to decrease screen time and that includes the shared facilitator of physical activity are walking meetings (Damen et al., 2020). Another facilitator that influences sitting time reduction are desktop prompts that remind employees to stand (O'Dolan et al., 2018). The desktop prompts for standing are similar to the prompts for breaking up screen time and can ideally be combined. Regarding barriers, there were also similarities between the two research fields. Examples of barriers for sitting reduction were the awkwardness of standing, social norms, as well as a potential decrease of productivity and thus negative views from employers (De Cocker et al., 2015; Gilson et al., 2011; Hadgraft et al., 2018). These points can be summed up as a lack of support within the working environment, which is a shared barrier within both research fields. In general, there is considerable overlap between the facilitators and barriers of sitting and screen time reduction, which signifies that some reduction methods are useful for both.

The second main point is the fact that no green time study aiming at decreasing screen time was found in this literature review. This was unexpected, given the fact that many studies already included green time to buffer the negative effects of increased screen time and sedentary behaviour in different target groups (Calogiuri et al., 2016; Daniels et al., 2022; Gladwell & Brown, 2016; Perrins et al., 2021; Ulrich et al., 1991; van den Berg et al., 2010). The target group of children has also already been studied thoroughly in connection with screen time and green time (Camerini et al., 2022; Oswald et al., 2021; Oswald et al., 2020). It could be that the combination of screen time and green time does not exist yet for the target group of desk workers. One reason for this could be that many businesses do not have access to green space in close proximity, which makes it difficult for them to use green time as a facilitator. This lack of green space availability can be attributed to various possible reasons. For example, cities with a higher population density have less green space, and ethnic minorities and people of low socioeconomic status (SES) have less access to green space than White and high SES people (Richards et al., 2017; Rigolon et al., 2018). Another reason for the missing connection could be that green time has mainly been applied as a facilitator in sitting reduction in desk workers, considering that this research field is more advanced than screen time reduction and that many sedentary reduction studies do not include screen time reduction explicitly (Brown et al., 2014; Carr et al., 2016; De Cocker et al., 2015; Gladwell & Brown, 2016; O'Dolan et al., 2018). The fact that no green time study was found that was aimed at reducing screen time in desk workers shows that there still might be potential to expand the body of research, but it also shows that green space availability varies greatly between cities and countries, which must be considered when wanting to apply green time as a facilitator for screen time reduction.

A third main point that stood out was that physical activity is often employed as a facilitator to reduce both sitting and screen time (Cole et al., 2015; Genin et al., 2018). Nonetheless, when designing interventions aimed at screen time reduction, the distinction between physical inactivity and sedentary behaviour is important to be aware of, as there are independent health risks of sedentary behaviour that should be known. This means that even if a person is physically active, the health effects of sedentary behaviour are still present. Nonetheless, increasing physical activity has been found to be an indirect facilitator for screen time reduction if it involves getting the employees away from their desk and screen. Moreover, the probability of improving one's physical health by regularly increasing physical activity is high (Nguyen et al., 2020). Interventions that decrease both sitting and screen time, and additionally improve physical health include for example walking meetings (Damen et al., 2020; Kling et al., 2021). They even improve the employees' mood and productivity (Kling et al., 2021). Next to this, there are also interventions that do not decrease screen time, but still improve physical health. An example are height-adjustable sit-stand desks, which have become a popular device, given the fact that they have proven to be effective in decreasing sitting time on the long-term (Carr et al., 2016; Chau et al., 2014). Nonetheless, it is not enough to use a height-adjustable desk if one wants to reduce screen time because only the sitting aspect is targeted. These types of desks employ the facilitator of increased physical activity, but they do not get employees to leave their screens. In comparison to the desks, walking meetings are a more promising solution for the future of screen time reduction. In sum, there are different types of interventions that employ the facilitator of increased physical activity, with some that indirectly decrease screen time and some that do not. If this facilitator is employed but screen time is not decreased, the negative health effects of screen time are not reduced.

A fourth main point that needs to be addressed is the ethical issue of screen time reduction. Due to barriers like the screen-based characteristics of their job and the lack of support in the working environment, desk workers might be driven to give the impression of being productive and then disregard the fact that this could have negative effects on their health (Hadgraft et al., 2016). In addition to that, many businesses also seem to either disregard, or not know about the fact that increased screen time is detrimental to their employees' health, which shows in the workload pressures that many employees endure (Griffiths et al., 2007). This sparks the question if it is ethically justifiable that employees are being driven to appear productive at any cost. It could be difficult for companies to justify why health protection is not given first priority. To be more precise, putting productivity and revenue first means that basic human rights are disregarded, which finally signifies exploitation (Collins et al., 2019).

Therefore, it is the responsibility of the companies to make sure that their employees work under circumstances that do not threaten their health, not on a short-term and also not on a long-term basis (Collins et al., 2019). Working without screens is basically impossible during this technological era, but there are still possibilities to prevent negative health effects of prolonged screen time, like regularly breaking up screen time with the help of facilitators. Therefore, this ethical issue must be resolved, and employers should be obligated to preserve their employees' health by enabling them to break up their screen time regularly and educate them about the importance of this. Providing opportunities to break up screen time would retain or even improve their employees' health, and thus logically also their job performance, which would be a win-win situation (Zivnuska et al., 2019). Thus, employers are responsible for the facilitation of screen time reduction and prevention of negative health effects in order to circumvent the ethical issue as much as possible.

Strengths and Limitations

This systematic review has several strengths. The first strength is that this review focussed specifically on sedentary behaviour including screen time in desk workers, while all other available reviews for the target group of desk workers focussed on sedentary behaviour excluding screen time, meaning that the physical sitting aspect was in the focus in those other reviews. The difference in findings compared to other reviews is that the studies in this review target additional negative health effects that are solely caused by screen-based activities, no matter if they are carried out sedentarily or not. Such additional effects are zoom fatigue as well as sleep disturbances. Next to the differences, similarities between the other available reviews and this review are indeed the similarities between the facilitators and barriers of screen time and sitting reduction. This is another strength since these similarities have not been pointed out before. Furthermore, the fact that facilitators and barriers were collected and summarised is another strength of this review. Both of these variables have not been considered in screen time reduction research with desk workers yet, only in sitting reduction research and in research with youth (Minges et al., 2015). This new, shifted focus towards facilitators and barriers is relevant to future research, as studies or interventions should target the enhancement of facilitators or the minimisation of barriers to effectively tackle the reduction of screen time in desk workers.

There are several limitations to this study. One important limitation was that the results of this study are not applicable to all desk workers worldwide, due to the difference of opportunities that people have based on their SES, ethnicity, and their countries' development status (Richards et al., 2017; Rigolon et al., 2018). Another limitation was that only one researcher screened the literature and handled the data, meaning that there was no possibility to establish

interrater reliability. Other researchers could have worked in a different manner and could have found more sources or would have excluded others for example. A last limitation is the heterogeneity of the selected studies, which hindered the assessment for risk of bias. To be more precise, many of the studies included both questionnaires and interviews, while two of them were intervention studies. Thus, no assessment tool was found that would have been able to assess all of the studies correctly.

Suggestions for Future Research & Practice

With regards to future research into the field of screen time reduction, various recommendations can be given. Since barriers to the reduction of screen time were identified, it would be useful for intervention designers to focus on the lack of knowledge and change of the working environment, as these factors seem to be the best factors to target. The change of the working environment was mentioned several times, both in screen time and sitting reduction studies, including multiple possibilities for adjustment. Generally, a supportive and informative environment that enables and motivates employees to regularly take moving breaks should be built (Luo et al., 2018). As a first step, employers and employees have to be informed about the health risks of prolonged screen time in order to create awareness and set a solid foundation for behavioural change (Wang et al., 2020). Education about health consequences has proven to be effective in various different contexts, especially in connection with environmental changes, with examples being oral health and decreasing alcohol consumption (Kelly-Weeder et al., 2011; Nakre & Harikiran, 2013). An additional step is the preparation of the physical working environment to make it supportive. This could include the prompt-based system 'Time for Break', joined moving breaks, as well as face-to-face communication instead of online communication whenever possible (Hargreaves et al., 2020; Luo et al., 2018). To ensure that there are long-term effects, walking meetings could be made obligatory (Damen et al., 2020; Kling et al., 2021). Moreover, green time could be included in future interventions, e.g., if the suggested walking meetings took place in natural environments outside the companies. Generally, people should be nudged to break up screen time and leave their desks regularly. In this way, both physical and mental health effects could be targeted and improved.

Conclusion

By collecting and comparing different studies, this systematic review uncovered different facilitators and barriers to decrease screen time in desk workers. It was found that these variables are similar in the domain of sitting reduction in desk workers and that certain reduction methods are useful in both fields. Furthermore, the fact that screen time and green time

have not been connected shows that potential for future research was uncovered, but that there are also differences in opportunities for screen time reduction between population groups. Moreover, the importance of distinguishing between sedentary behaviour and physical inactivity has been demonstrated because increasing physical activity alone does not necessarily reduce screen time. Next, it was revealed that the need to seem productive by staying in front of the screen and the lack of support within working environments pose an ethical issue that needs to be circumvented by employers. Overall, this review illustrated the current state of art and showed that it is still in its infancy. Future research should therefore focus on further exploration of existing interventions, and new interventions should include education about health consequences of increased screen time, as well as changes within working environments. In conclusion, this systematic review highlighted possibilities for desk workers and their employers to reduce, or at least break up, prolonged screen time during their working day.

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