Systems Supporting Occupational Health Behavior Change: A Systematic Literature Review

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Abstract. Occupational health interventions for behavior change have potential to reduce or prevent health risks, such as influencing absenteeism. This systematic literature review concentrates on searching for and presenting interventions in occupational health settings with the focus on targeting behavior change. Lack of descriptions of the actual intervention features and implementations, lack of results, and coercive (rather than persuasive) elements led to the exclusion of several studies from the analysis. Persuasive software feature examples were identified from the included studies with the help of Persuasive Systems Design Model. The recognized software features can be utilized in the planning and development of occupational health support systems for behavior change.

Keywords: Occupational healthcare, occupational health interventions, behavior change support systems, Persuasive Systems Design, information systems, web, mobile

1 Introduction

Health issue related work absence has a negative impact on productivity in a workplace. With many places of employment relying on various degrees of training and education these days, enabling the workforce to maintain good health and able to remain at work is in the best interests for employers – and naturally for the employees themselves in the form of improved personal health.

Occupational health is strongly focused on primary prevention of hazards and deals with all aspects of health and safety in the occupational environments [1]. Risk factors at the workplace can, for example, lead to cancers, accidents, musculoskeletal diseases, respiratory diseases, hearing loss and stress related disorders (ibid.).

Large enterprises have better resources to solve problems relating to occupational health and safety, compared to small enterprises [2]. The situation in relation to absenteeism due to health issues might be dire in small companies, in case an employee is absent from work and a replacement is hard to come by. The aforementioned situation might be unbearable in a one-man business, where the absence from work due to a health issue is reflected directly to the productivity and earning capacity of the business. Lifestyle related problems might cause absences from work (and loss of productivity),

which brings high costs to the society, therefore emphasizing the importance of self-motivation (for healthy behavior) as there is no possibility to support everyone individually with the current healthcare resources [3]. Thou again, the argument could be rephrased that with the advancement of technology, everyone can be supported with the current healthcare resources by improving the self-motivation of individuals for healthy behavior. Workplaces often provide excellent settings and infrastructure to support health-related interventions, therefore making occupational environments interesting for health promotions [4].

A study by Bolier et al. [5] shows that web-based preventive workers' health surveillance program (online screening, personalized feedback and a personalized offer of online self-help interventions) can enhance positive mental health and can have a significant impact on occupational mental health. Monitoring and analyzing the workers' health is required for planning improvements to working conditions [6].

Occupational health interventions could make a difference in changing the behavior and attitude of workers towards healthier direction. In order to establish the present situation in research regarding occupational health interventions and behavior change, we conducted a systematic literature review on *what scientific studies have been conducted of interventions in occupational health settings with the focus on targeting behavior change*. The review covers native mobile information systems, web information systems (whether used via mobile or other technological platforms) and traditional information systems (systems which are not native mobile or web information systems), while taking persuasion and persuasive system features into account.

The basic assumption was that there is not a large amount of scientific studies conducted about occupational health interventions for behavior change relating to traditional information systems, web information systems or native mobile information systems. The assumption was somewhat correct, but the amount of studies included for the systematic literature review is suitable (18 studies). Most fitting persuasive software feature examples were identified with the help of the Persuasive Systems Design (PSD) model [7], and are presented as practical implications to be taken into consideration for planning and developing an occupational health support system targeting behavior change.

The outline for this paper (after introduction) is the following: background information, research methods (including the complete search process), results (including examples for practical implications), discussion and conclusion.

2 Background

There is potential for information and communication technology (ICT) to provide personalized (and motivational) tools for health management [8]. Interventions for managing health risks can be individual or group interventions, or target changing the environment (ibid.).

Healthcare information systems in general are under-represented in leading information system journals, despite the importance of such systems, but the tide on pre-

senting healthcare information systems has been turning and the interest has been increasing [9]. In the past, information systems for general healthcare were mainly used for patient records or for aiding health professionals, but the systems can be used to tailor health information for individual patients [10].

ICT (internet, mobile phones and wireless applications), combined with an interest in creating a culture of health, has the ability to reach high volume of people for enhancing health and to lower the costs (of healthcare) [11]. Personalized prevention intervention can reduce health risks, but the individuals must be proactive about their health, which can be achieved by technology and interactive web-based tools (ibid.).

Getting individuals to participate in web-based physical activity intervention is associated with smaller increases in healthcare costs, when compared to those of nonparticipant individuals and therefore it is important to encourage participation [12]. The level of participation increases by implementing online intervention modules, as the participants can complete them at convenient moments [13]. Internet-based interventions are most cost-effective as well (ibid.). There is evidence that web-based interventions can be more effective in achieving the desired outcome and behavioral change [14]. However, there is also evidence that web-based interventions can have only limited or no better effectiveness over non-web-based interventions [15].

Mobile applications are the next step from web-based approaches, as they can similarly reach people for interventions, but the adherence rate for engaging with the application appears to be better than with web-based approaches [16]. The evolution of wireless technologies and connectivity has enabled health services to be used in mobile devices (mHealth), with improved mobility and reduced location dependency, when compared to other branches of eHealth [17]. In addition, mobile browsers now enable the use of web-based health interventions on the mobile devices. Even though mHealth applications are the third fastest-growing category of applications after games and utilities, one of the downsides is the lack of security – a serious problem, considering how mHealth applications gather information to be compiled and analyzed [18].

2.1 Behavior Change and Persuasive System Features

Persuasion is a planned attempt to change attitudes or behaviors (or both) without using coercion or deception, as persuasion is voluntary [19]. Persuasion is based on the intentions, not the outcomes; therefore, unintended outcomes are side effects, as persuasion is focused on intended design of behavior or attitude change (ibid.).

Persuasive systems enable affecting users' behavior, even in situations where their attitude is not favorable towards the behavior, as attitudes do not necessarily predict or determine behavior [7]. When analyzing the persuasion event, both use context and user context should be taken into consideration, and the goal of the users should be understood, including past performance and current progress (ibid.). Persuasion and convincing are two different things, but separating them from each other may be difficult (ibid.).

3 Research Methods

Systematic literature review was used as the research method, following the recommendations and guidance described in Webster and Watson [20]. The following databases were searched for records: ACM Digital Library (The ACM Guide to Computing Literature extended search), IEEE Xplore (IEEE/IEE Electronic Library), Medic (Finnish database), Medline (Ovid) and Scopus. There were no further limitations on the language of the results (Medic was searched with Finnish words/terms, the other databases with English words/terms) or on the dates and years. The coverage of the databases was compared against each other in order to gain a variety of sources, with making sure that the current Senior Scholars' Basket of Journals [21] was included.

3.1 Search Process

The search process of the databases was done by combining main search terms with all of the specified search terms (see table 1 for the terms), and in case the records found exceeded 400, specific limitation terms were used to restrict the records found to be below 400 per main search term and search term pair.

Table 1. Search terms

Main	Specified	Main (Medic)	Specified (Medic)
occupational well-being	mobile	työterveys	matkapuhelin
occupational health	smartphone	työhyvinvointi	älypuhelin
occupational health care	smart phone	työterveydenhuolto	puhelinpohjainen
occupational healthcare	mobile phone	työntekijöiden terveys	web*
welfare at work	mobile-based		net*
workers' health	mhealth		internet
industrial health	web		nettipohjainen
	web-based		webbipohjainen
	internet		e-health
	e-health		ohjelmisto
	software		informaatiojärjestelmä*
	information system*		datajärjestelmä*
	data system*		käytöksen muutos
	data processing system*		käyttäytymisen muutos
	behavio* change		tietojenkäsittely
	persuas*		

To ensure the reliability of the search process, the usage of "health care" and "healthcare" in separate searches was intentional, as the spelling may differ between countries. Likewise, to ensure the reliability of the search process, the usage of "smartphone" and "smart phone" in separate searches was intentional as the spelling may differ between countries and between dates of the publications. The asterisk (*) in the terms denotes a wildcard. English words such as web and e-health have been adopted into the Finnish language as loanwords and the possible problems in the search relating to case suffixes were solved with using wildcards when appropriate.

In case the pairing of main search terms and specified search terms gave an output of more than 400 records, additional limitation terms were used: intervention, randomi*ed controlled trial. The asterisk (*) denotes a wildcard. The first limitation term used was "intervention" and if the output was still more than 400 records, the second limitation term, "randomi*ed controlled trial", was used. For example, Scopus had an output of 5089 records with the combination of "occupational health" and "information system*", with added limitation term, "intervention", the output was 601 records and after the second limitation term, "randomi*ed controlled trial", the output was 81 records.

The output of records (below 400) was scanned through by reading the title of the record and by reading the abstract if it was unclear should the record be included or not. Duplicates were excluded during the search process. The search process and scanning of the records founded lasted from 1st of September to 15th of October (year 2016). Additional searches of the databases in the last week of the search process were also done in order to gain such records that might have been added since 1st of September (year 2016).

Inclusion Criteria. The record had to be related to an occupational health setting, the record had to be related to either traditional information systems, native mobile information systems or web information systems, and the record had to be related to health behavior interventions. Behavior change and persuasiveness had their own additional search round, and randomized controlled trials were preferred overall, but were not compulsory for a record to be included.

Exclusion Criteria. Information communication technology was used in the study only indirectly, occupational health setting was not included, intervention was not mentioned or described, the record was about an altogether different subject matter.

Studies Found. 403 records were identified from a total of 23155 records found by searching the databases. 193 duplicates were removed from the 403 records identified, leaving total of 210 records for the scanning round, at which point the records were referred to as studies. The remaining 210 studies were scanned through (title and abstract) and a total of 47 were included in the next round (screening). The scanning of

the 210 studies also included reading through those that showed potential for background information. The screening round consisted of reading through the studies carefully.

Backward Search. All the studies (47) included in the systematic literature review after the scanning process were searched "backwards" as instructed by Webster and Watson [20], meaning that all the references of the studies were scanned through and all the relevant studies were included. All the studies found in the backward search were given a backward search of their own. An amount of seven studies was included into the screening round of the systematic literature review.

Forward Search. All the studies included in the systematic literature review were searched "forward" as instructed by Webster and Watson [20], meaning that all those studies that had cited the included studies were scanned through and relevant studies were added into the systematic review. All the studies included in the forward search were given a forward search of their own, as well as backward searches. Therefore, all the studies included into the screening round were searched backwards and forwards for relevant studies. An amount of two studies was included into the screening round of the systematic literature review.

Final Search Process. The interventions in the included studies (18 out of 56) of the screening round did not have coercive elements, they had results, and the actual interventions were described. Interventions with limited description of software features could be included if there was a screenshot present.

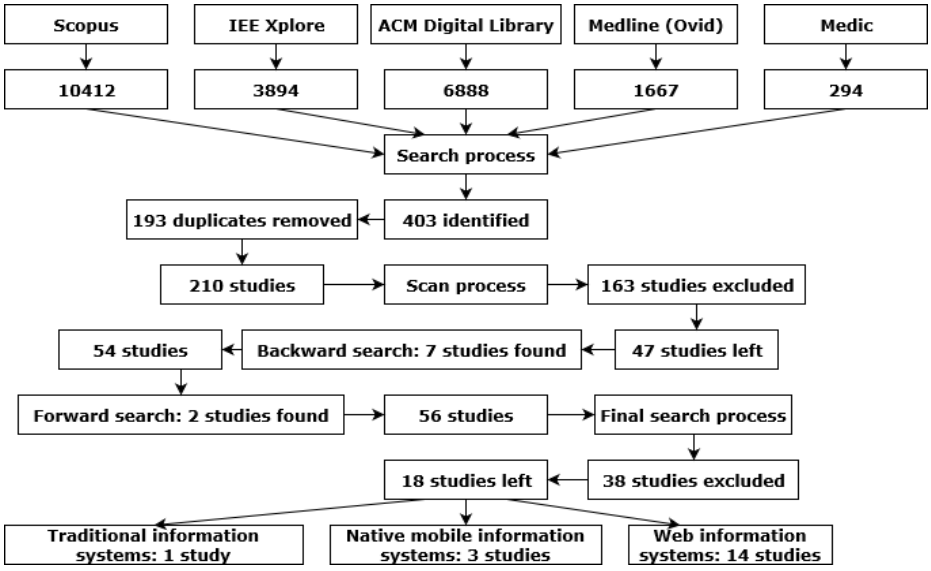

Fig. 1. Descriptive flowchart diagram of the search process.

4 Results

As the subject area is relatively wide with three different system platforms for the interventions, and with several types of problem domains (stress, physical activity, depression, et cetera), it was difficult to find a single unifying theme between the intervention studies. In order to form a big picture of the intervention studies, the successfulness of the interventions was addressed, as well as the change in health behavior. Examples of PSD principle implementations are provided as practical implications to be considered when developing behavior change support systems. Additionally, 'goal setting' examples found from the studies are also introduced as practical implications.

4.1 Excluded Studies

Some issues emerged, while reading through all (56) the studies, which led to the exclusion of 38 studies. The exclusion of studies in the screening round was 67.85% (38 out of 56), with the main reason being that the description of the intervention was insufficient for analysis (25 out of 38), while the other reasons being the lack of results or issues with the results (9 out of 38) and coercion (4 out of 38). More often than not, the actual intervention was not described from the viewpoint of traditional information systems, native mobile information systems or web information systems. For example, only the content matter was provided [22] or a link to an external web page of the intervention was provided, but the page was in other language than English [23], or password protected [24]. Additionally excluded full studies were for example study protocols [25] or design papers [26] without results from the interventions. As a rule, if screen captures of the intervention were provided in the studies, in addition to description (even if just content matter), the studies were included. One study was excluded because there was only a screen capture of the intervention, but no proper content matter or description [27].

4.2 Recognized Application Domains

A total of 18 studies are included in this systematic literature review (see table 2) after the exclusion in the final search process. Fourteen studies had web information systems as platform, whereas three had native mobile information systems and only one had traditional information systems (systems which are not native mobile or web information systems).

Two interventions [28-29] compared a web-based approach to traditional print and in the case of the *Active Living* [28], which was dealing with physical activity, there was no difference between the two approaches (both increased the physical activity slightly). The same phenomenon could also be seen in the *Health Connection* [29], which was dealing with stress, physical activity, and dietary practices. The exception here was dietary practice measurement, where web-based intervention approach was significantly better than the traditional print (ibid.). Both studies are over a decade old, calling to question how the results have withstood the developments with the Web and its role in people's everyday life

Table 2. Included studies

Study	Problem domain	User context	Use and technology context
[3]	Wellness, activity, relaxation	Technology group of the Nuadu trial (119 recruited)	Wellness diary, training plans, personal relaxation
[30]	Stress reduction	Employees of a major technology company (309)	Web-based health promotion
[29]	Diet, stress, activity	Employees of a human resources company (419)	Multimedia health promotion
[31]	Continued sitting	University and environmental agency (213)	Web-based intervention with tailored feedback
[32]	Musculoskeletal discomfort	Ohio drug and poison call center employees (37)	Software reminder prompt monitoring activity
[33]	High-risk drinking	18- to 24-year-old employees (196)	Web-based survey program with feedback
[34]	Depressive symptoms	6 international companies in Netherlands (231)	Web-based problem-solving and therapy
[35]	Workplace walking	Academic and administrative staff at 5 campus (390)	Web-based workplace walking program
[36]	Stress and health	4 ICT and 2 media companies (303)	Web-based health promotion and stress management
[37]	Stress	General population with symptoms of stress (264)	Web-based health and problem-solving
[38]	Physical activity	IBM employees (126,372 eligible, 67,324 participated)	Online behavior change tool
[39]	Depressive symptoms	Employees of 2 Japanese IT companies (762)	Web-based Manga stories with feedback
[40]	Stress management	Middle managers of Swedish companies (73)	Smartphone behavioral stress intervention application
[28]	Physical activity	Members of an Australian university staff (655)	Interactive website with feedback and goal-setting
[41]	Mental health well-being	2 Finnish ICT companies (25 included in analysis)	Smartphone and web application for stress management
[42]	Absenteeism	Financial service company (3826 enrolled)	Web-based health promotion program
[43]	Weight management	IBM employees (7743)	Interactive weight management tool
[44]	Weight loss	Overweight or obese employees (75)	Internet-based multimedia intervention program

Excessive Sitting. The sole traditional information systems (see Fig 1) intervention study included [32] utilized a prompt on desktop computer, a similar technology used in three excluded interventions [45-47], with the exception that the included intervention had an active prompt, which could be ignored (persuasion instead of coercion). The included intervention was successful, as both sit-stand workstations and the software produced similar effect in relation to musculoskeletal discomfort. The *Start to Stand* [31], another intervention targeting excessive sitting, managed to decrease self-reported total workday sitting, leisure time sitting and increased objectively measured breaks at work.

Stress. The *Health Connection* [29] was successful in reducing stress, increasing physical activity and affecting dietary practices, even though the print approach had a similar effect. The *Stress and Mood Management* [30] showed significant positive effects on stress, in addition to related behavioral health problems of anxiety, depression and substance abuse. The intervention for stress management and health promotion [36] was also successful with beneficial (6-month) effects from the stress management part, in addition to improvement of mental health and psychological indicators for the participants. The *GET.ON Stress* [37] is the newest of the interventions that had stress as a problem domain, and is highly efficient in reducing perceived stress. There seems to be no single similar feature in the four interventions that would seem to be the key factor for reducing or managing stress, except for the fact that they are all web-based. It might be because only the *GET.ON Stress* (ibid.) is purely for stress management, while the others have other problem domains included. Nevertheless, based on these four interventions from 2005 to 2016, web-based occupational health interventions for behavior change can have a positive effect on stress, with the newest intervention being the most efficient.

The native mobile information system intervention for stress management [40] was moderately successful, as it had a moderate effect on stress. Another mobile intervention [41] had a different problem domain (mental health), but had stress management and mental well-being as the focus of the intervention. The intervention for mental health (ibid.) was not successful, as there were no significant changes observed in well-being, even though some participants reported relief in stressful situations.

Physical Activity. The *Health Connection* [29] also managed to increase physical activity. The *Walk@Work* [35] was successful in increasing walking of all participants, with the most active group increasing the least and the least active group increasing the most. The *Virtual Fitness Center* [38] managed to increase the participation rate from 13% (previous year) to 53% with a cash incentive, and those of the participants who were active enough to earn cash rebate reduced their physical inactivity risk and high-risk status significantly. The *Active Living* [28] was not highly successful: the intervention increased physical activity of the participants only slightly. All four interventions had a wide content matter, but when comparing the oldest (2003) to the newest (2013), the difference between the results affecting physical activity might be explained by the differences in technological solutions (which have evolved in a decade), and people

having become accustomed to web-based solutions within the decade separating the studies. In the case of the *Virtual Fitness Center* (ibid.), the success of the intervention might be explained by the cash incentive: the total participation rate quadrupled from the previous year, following the implementation of the incentive. The *Mobile Coach* [3] had a positive influence on motivating participants who used the application the whole intervention period, as their exercising became regular during the intervention.

Depression. Depression, depressive symptoms and anxiety as problem domains were present in three interventions. The *Stress and Mood Management* [30] managed to increase the awareness and understanding of signs and symptoms of depression and anxiety, but was not intended to treat those. The *Happy@Work* [34] compared the outcome of depressive symptoms between the intervention and control groups (post-treatment), and no difference between the groups was found as both groups showed significant improvements in depressive symptoms, with a significant but small effect in favor of the web-based approach in anxiety. The *Internet CBT program* [39] differed from all the other interventions, by using a Manga (Japanese comic) story of a psychologist and a client worker to motivate the participants and facilitate easy learning. The intervention showed a significant positive effect on depression (ibid.).

Weight Management. The *Virtual Food Pro* [43] managed to improve the eating habits of the participants, and some participants reduced their weight. The other intervention dealing with weight loss [44] managed to produce significant clinical weight losses. Both interventions had a strong emphasis on self-monitoring as one of the core functions.

Substance Abuse. The *Stress and Mood Management* [30] concentrated mainly on stress management, with substance abuse prevention as a part of the stress management techniques. The intervention managed to reduce binge drinking (ibid.). The *CheckYourDrinking* [33] decreased weekend drinking significantly when compared to the control group. In the *CheckYourDrinking* (ibid.), when comparing the standalone web-based intervention and web-based intervention (combined with motivational interview), the study shows that, the standalone web-based intervention could be used as such (without a motivational interview).

Absenteeism. A web-based health promotion program, The *Prevention Compass* [42] had an immediate effect on reducing absenteeism with total reduction of 20.3%. The intervention (ibid.) addressed several health problems with a personal health plan, which might explain the substantial change in the absenteeism level.

4.3 Persuasive Software Features and Implementation Considerations

The Persuasive Systems Design model [7] was used to identify exemplary persuasive software features from the included studies. The examples can be utilized as practical guidance material for designing occupational health behavior change support systems.

Primary Task Support. The *Virtual Food Pro* [43], a successful intervention, provides the users a four-step framework that was designed to help the users to progress through the program in order to reach the goal. Therefore, the effort to perform the target behavior is 'reduced' to help the users [7].

A moderately successful intervention [40] from the included studies provides tailored content for a user group (middle managers), thus making the system more persuasive [7]. A successful intervention with significant positive effect on the problem domain, the *Stress and Mood Management* [30], provides an assessment instrument for the users in order to offer personalized content, which can increase the capability for persuasion [7]. In case developers would see 'personalization' challenging from the viewpoint of programming, 'tailoring' could be used instead.

The users should be offered a way to keep track of their own performance or status by a system in order to help the users to achieve goals [7], and as goal setting is one of the key issues for persuasion, 'self-monitoring' should be taken into consideration. A successful intervention [36] from the included studies provides the users real-time monitoring of perceived current health and stress status, in addition to a diary. Supporting and motivating the users to reach a set goal by 'self-monitoring' should not be a cumbersome obstacle from the viewpoint of programming, as a simple diary may be sufficient (depending on the problem domain). The *Wellness Diary* for example showed the users' progression towards their goals, thus increasing motivation [3]. If the users are allowed to set the goals themselves, it could enhance the participation rate, as the users could set goals that are reasonable. The *Mobile Coach* generated training plans, based on the personal goals of the users, which were seen as persuading and motivating by the users [3]. An occupational health support system should therefore let users set the goals themselves, monitor the progression towards the goals, and allow 'self-monitoring' for the users.

Dialogue Support. The highly efficient intervention, *GET.ON Stress* [37], provided the users the possibility to receive automatic text messages (e.g. short relaxation exercises) on their mobile phones either every other day or several a day. 'Reminders' can help the users to perform a target behavior [7], but the amount and frequency of possible 'reminders' should be consider carefully while giving the users a chance to choose between options.

A system should have a look and feel that appeals to the users, in other words a system should be visually attractive [7]. The *Internet CBT program; Useful mental health solutions series for business* [39], an effective intervention, provided training along a Japanese Manga comic story, which could be seen as appealing for the target users (Japanese people).

Social Support. The *CheckYourDrinking* [33], a successful intervention, provided normative data about drinking alcohol and the risks associated with drinking alcohol. 'Normative influence' can be used to help and motivate the users as leverage to adopt a target behavior [7].

5 Discussion

Black-box thinking [48], lack of providing specific details of the system described, was present in the majority (25 out of 38) of excluded papers, which could be because of the limited space. Another reason for leaving out support system details could be that researchers are possibly unfamiliar with the field of computer science [49].

The results of the interventions were overall successful in all system platforms, from slight to significant effect into the problem domains addressed. The only exception, with a distinct failure as a result was the intervention, in which the participants were not allowed to use the system in an occupational environment [41]. In *Health Connection* [29], the authors discuss how the improvements in all the health topics of the intervention might be attributable partly because of the Hawthorne effect [50].

Traditional intervention approaches (printed material et cetera) are not the only ones that employers should consider, as both the *Active Living* [28] and the *Health Connection* [29] proved out to be equivalent to traditional print as interventions. Additionally, the *WorkPace* [32] produced similar effect as sit-stand workstations for discomfort in shoulders, upper back, and lower back.

When looking for similarities between the interventions, no single unifying software feature was found, possibly because the interventions were handling problem domains varying from each other (and some had several domains). All the interventions had persuasive features, for example 'personalization' [31] and 'self-monitoring' [44]. All the interventions included into this systematic literature review were targeting a health behavior change, while having traditional information systems, native mobile information systems or web information systems as platforms. The composition and amount of participants in the interventions were also differing when compared against each other, so there were no single unifying factor between the participants either, with the exception that they all were employees.

When considering improving the working conditions of workers by monitoring their health [6], there might be some ethical and/or legal issues. In worst-case scenario, an employer might dismiss an employee with health issues, even though it could be resolved by a health intervention or the health problem does not have an influence on the productivity of the employee. In the European Union, the General Data Protection Regulation will be applied starting 25th of April 2018, which will be completed and clarified by national regulation, thus having strict rules (at least in Finland) on how and to what purposes collected data can be used [51]. The legal (and ethical) grounds for dismissing employees might be less strict in some countries in the world, thus monitoring employees might lead into a situation where the aim is not to improve the working conditions.

The amount of excluded studies because of insufficient intervention description (25) was large when compared to the amount of included studies (18), thus giving evidence

that black-box thinking described by Oinas-Kukkonen [48] is a common phenomenon in research papers relating to occupational health interventions for behavior change.

6 Conclusion

Employees might face different health problems, thus occupational health interventions might target several health problem domains at the same time. Modern technology can provide recommendable alternatives (e.g. behavior change support systems) for traditional intervention approaches. Although monitoring and analyzing employees' health might be beneficial for both the employer and employee, the legal and ethical aspects of monitoring could be problematic in the end. Absenteeism originating from stress for example or from unhealthy behavior of employees might be reduced by promoting health in worksites, which could both increase the productivity of the employees, as well as improve their general well-being. Participating in a worksite health promotion program (intervention) could have a significant impact on absenteeism by improving the health of employees, which alone should be motivation enough for employers to spend resources on health support systems for behavior change. Employees already familiar with the organization and production procedures are valuable assets, therefore further research on how to improve health of employees could be beneficial for the employers as well. It would help if the researchers would add proper descriptions of support systems used in the interventions into the published studies, which should not be an insurmountable effort, even though space on papers might be scarce at times.

Acknowledgements. This research has been funded by the Strategic Research Council at the Academy of Finland, contract no. 303430 (Finnish Institute of Occupational Health), contract no. 303431 (University of Oulu, OASIS), as well as Finnish Cultural Foundation.

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