

Review

Systematic review of the association between physical activity and burnout

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Abstract: Objective: Burnout constitutes a health risk, and interventions are needed to reduce it. The aim of this study was to synthesize evidence regarding the relationship between physical activity and burnout by conducting a systematic review of longitudinal and intervention studies. **Methods:** A literature search resulted in the identification of a final set of ten studies: four longitudinal and six intervention studies. In separate analyses for each category, evidence was synthesized by extracting the study characteristics and assessing the methodological quality of each study. The strength of evidence was calculated with the standardized index of convergence (SIC). **Results:** In longitudinal studies, we found moderately strong evidence ($SIC(4) = 1$) for a negative relationship between physical activity and the key component of burnout, i.e., exhaustion. We found strong evidence ($SIC(6) = 0.86$) for the effect of physical activity on reducing exhaustion in intervention studies. As only one study could be classified as a high quality study, these results of previous studies need to be interpreted with some caution. **Conclusions:** This systematic review suggests that physical activity constitutes an effective medium for the reduction of burnout. Although consistent evidence was found, there is a lack of high quality longitudinal and intervention studies considering the influence of physical activity on burnout. Therefore, future research should be conducted with the aim to produce high quality studies, to develop a full picture of physical activity as a strategy to reduce burnout.

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Introduction

Burnout, a severe and persistent form of fatigue that occurs after a long period of work stress, has become a common phenomenon in today's organizations. Early conceptualizations of burnout define burnout "as a syndrome of emotional exhaustion, depersonalization, and reduced sense of personal accomplishment, that can occur among individuals who do 'people work' of some kind"¹. Since then, the concept has been broadened from people work to all kinds of occupations. Accordingly, its dimensions were relabeled as "exhaustion," "cynicism," and "professional efficacy." Over time, a consensus has built up that exhaustion is the key component of burnout²⁻⁴. Burnout thus mainly refers to feelings of mental and physical exhaustion (i.e., extreme levels of fatigue), low mood, and lack of energy⁴.

High levels of burnout are associated with substantial losses for employees' health and well-being. Employees with burnout show reduced self-efficacy levels⁵, sleep more poorly⁶, show decreased cognitive functioning^{7,8}, have reduced work ability⁹, and are at higher risk for developing cardiovascular diseases¹⁰. Employers, too, face consequences such as presenteeism and lost productivity time¹¹⁻¹³. Estimations of the annual costs to society caused by burnout vary from 136.4 billion dollars (figures related to the U.S.)¹² to 200 billion euros (figures related to Europe)¹⁴. Given the high prevalence of burnout and its negative consequences, it is valuable to examine potential approaches to reduce it.

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Supplementary materials (Appendices) are available in the online version of this article.

We hypothesized that regular physical activity and exercise may constitute an effective approach to reduce burnout. Physical activity is “any bodily movement produced by skeletal muscles that requires energy expenditure”¹⁵. Exercise is a subcategory of physical activity, and it can be defined as physical activity that is “planned, structured, repetitive and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective”¹⁵. Although there is reason to argue that these two concepts do overlap, yet are not the same, they are often treated interchangeably in the literature. Assets of physical activity for the reduction of burnout might include its accessibility, low costs, and positive “side effects,” such as the reduced risk for cardiovascular diseases¹⁶.

Various pathways have been proposed to explain the relationship between physical activity and burnout; yet, the underlying mechanisms are still uncertain. A combination of psychological and physiological mechanisms may be responsible for the hypothesized positive effects. As to psychological working mechanisms, it has been proposed that regular physical activity facilitates psychological detachment from work, and in this way reduces the risk of prolonged stress responses such as burnout^{17,18}. Regular physical activity may also increase people’s self-efficacy^{19,20} that may “spill over” to the work domain. As a result, employees may feel more competent in coping with their work tasks^{21,22}, and as such experience these tasks as being less demanding. Lower perceived demands may contribute to lower fatigue²³. As regards physiological working mechanisms, it has been suggested that by means of regular physical activity one is better able to handle psychological stress (i.e., the cardiovascular fitness hypothesis)²⁴. This may result in faster bodily recovery after stress exposure, thus reducing the risk of burnout^{25,26}. Exercise may also induce changes in several neurotransmitters and neuromodulators, resulting in better mood and increased energy^{25,27}.

Against this practical and theoretical background, the aim of this study was to synthesize evidence from previous studies on the relationship between physical activity and burnout by conducting a systematic review. Because, compared with cross-sectional studies, intervention studies and longitudinal studies are more appropriate for making causal inferences, we limited our systematic review to intervention and longitudinal studies. In doing so, we tried to answer the question of whether physical activity indeed influences burnout.

Methods

Literature search

A systematic literature search was conducted (February 2016) within three bibliographical online databases: Web of Science, PubMed, and PsycINFO. Search terms con-

sisted of three classes of keywords: i.e., “burnout-related” (burnout, emotional exhaustion, occupation* stress), “physical-activity related” (physic* activ*, exercise), and “work-related” (employ*, work*) keywords. For each search operation, one search term of each class of keywords was combined with the operator *AND*, resulting in 12 different search phrases with three keywords (see Annex 1). This resulted in the identification of 4619 articles: 1657 from the Web of Science, 2285 from PubMed, and 677 from PsycINFO. Crosschecking reference lists revealed two additional articles. The citation details for all of these articles were transferred to EndNote X7.5.

Selection

After removing 2381 duplicate articles automatically via EndNote X7.5 (References Find Duplicates), the first author and second author of this paper independently screened 2240 articles. Three inclusion criteria were used to exclude irrelevant articles. All titles and abstracts were screened for relevance and for participants being adults and employees and not athletes (*inclusion criterion 1*), resulting in 172 remaining records. Another two records were excluded because the articles were not peer-reviewed and/or the full texts were not available (*inclusion criterion 2*). Finally, the 170 remaining articles were read in full, and it was checked whether each study i) utilized burnout as an outcome measure and ii) was a longitudinal or intervention study (*inclusion criterion 3*). Initial substantial agreement between the two authors was reached with Kappa 0.72 and an agreement percentage of 73%²⁸. Results and disagreements were discussed between the two authors and resolved by consensus. This resulted in a final selection of ten studies: four longitudinal and six intervention studies (for a PRISMA flow diagram, see Fig. 1).

Data extraction

The following study characteristics of all ten studies were extracted by the first author: study goal, design (e.g., full-panel design, randomized controlled trial), number and type of participants, measurement method (e.g., questionnaires, objective measures), burnout measure, type of physical activity, measurement points, and results. For longitudinal studies, the physical activity measure was evaluated as well. For intervention studies, besides the conditions and the content of the intervention, the type of prevention was extracted. That is, we indicated for each study whether it concerned primary (i.e., preventing burnout of healthy employees), secondary (i.e., reducing mild burnout symptoms and preventing these from becoming more severe), or tertiary (i.e., reducing serious burnout) prevention^{29,30}. The second author checked all of the extracted study characteristics. Differences were discussed and solved.

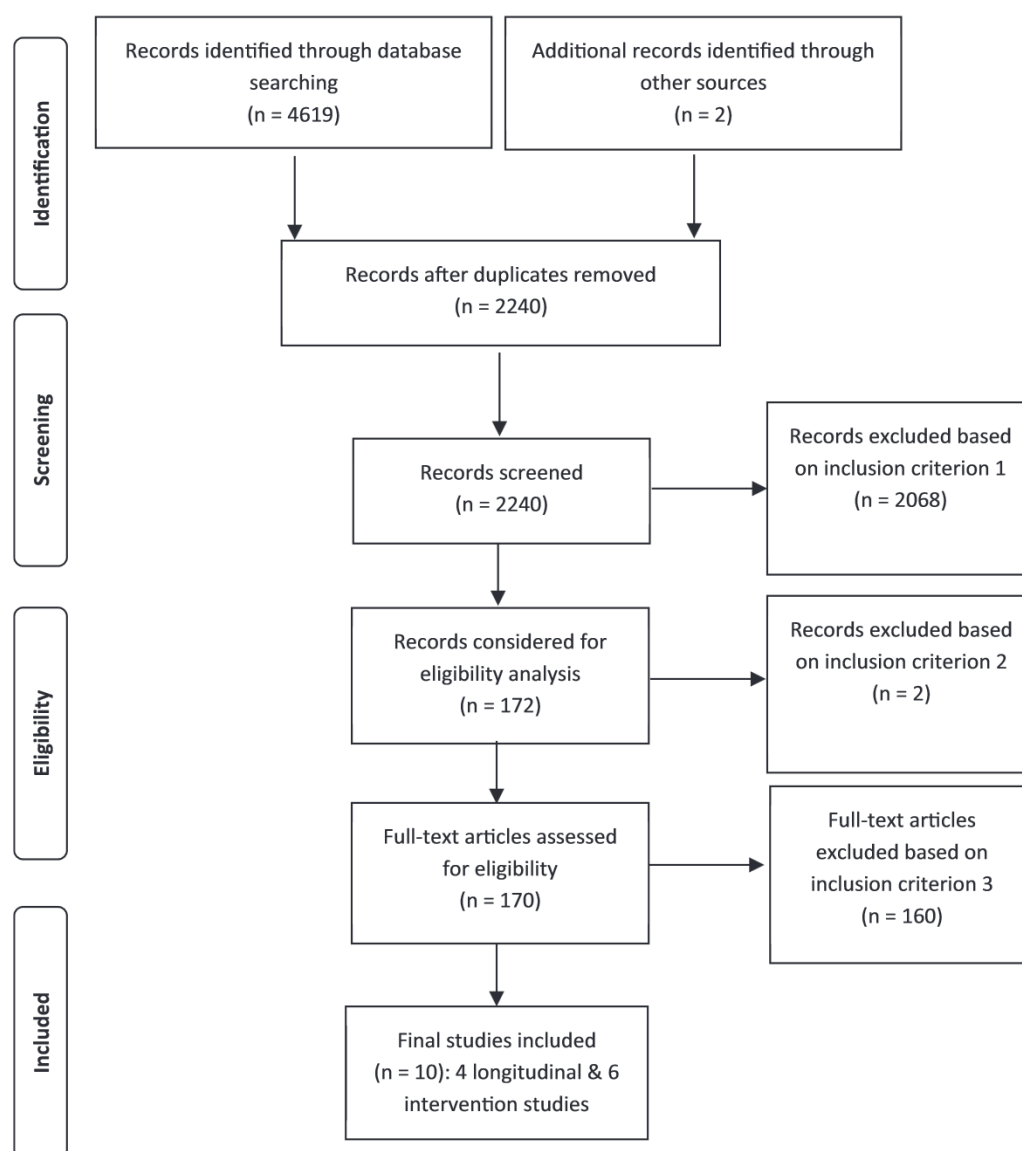


Fig. 1. PRISMA flow diagram for systematic reviews (based on Moher, Liberati, Tezloff, Altman, & The PRISMA Group, 2009⁶⁰).

Study quality evaluation

When drawing conclusions about the relationship between physical activity and burnout, one should rely more strongly on findings from high quality studies. Therefore, we assessed study quality with a criteria list for assessing the methodological quality of each study that was based on the list of Van Laethem, Beckers, Kompier, Dijksterhuis, and Geurts (2013)³¹. We used two different sets of quality criteria, i.e., for longitudinal studies (see Table 1) and for intervention studies (see Table 2). The first author and second author rated the six longitudinal studies for five criteria and the four intervention studies for seven criteria with zero (“insufficient”), two (“sufficient”), or three (“good”) stars. Uncertainties were discussed and consensus was reached between the first two authors. Only when a study had at least two stars (sufficient qual-

ity) for each criterion it was classified as an overall high quality study³¹.

Synthesis of evidence

Due to the variety of measurement methods, timing of measurements, and statistical analyses used in the studies, a meta-analysis was considered inappropriate. To avoid mere “vote-counting” and to quantify the strength of evidence for the relationship between physical activity and burnout, a standardized index of convergence (SIC) value was calculated according to a method of Wielenga-Meijer, Taris, Kompier, and Wigboldus (2010)³². The formula of SIC is

Table 1. Quality evaluation criteria for longitudinal studies

Criteria	0 stars (insufficient)	2 stars (sufficient)	3 stars (good)
1. Applied design	Incomplete panel design (2 TP, ≥ 1 central research variables measured only at 1 TP)	Incomplete panel design (>2 TP, ≥ 1 central research variables measured more than once but not on all TP)	Complete panel design (all variables measured at each TP)
2. Measures: Burnout	Burnout (dimensions) not measured validly (i.e., no correct use of validated [sub]scales of the MBI, MBI-NL, UBOS, SMBQ, C-CBI)		Burnout (dimensions) measured validly (i.e., correct use of validated [sub]scales of the MBI, MBI-NL, UBOS, SMBQ, C-CBI)
3. Measures: PA/exercise	PA/exercise not measured validly (i.e., no correct use of validated scale such as the GPAQ, IPAQ, SGPALS OR no use of objective measures such as accelerometers, pedometers)	PA/exercise measured validly (i.e., correct use of validated scale such as the GPAQ, IPAQ, SGPALS but scale does not take frequency, duration, intensity of PA/exercise into account)	PA/exercise measured validly (i.e., correct use of validated scales such as the GPAQ, IPAQ, SGPALS including the frequency, duration, intensity of PA/exercise, OR use of objective measures such as accelerometers, pedometers)
4. Non-response analysis	No check on selectivity of the sample	Check on selectivity of the sample either at baseline or follow-up	Check on selectivity of the sample at both baseline and follow-up
5. Statistical adjustment	Either no adjustment for: –Potential confounders, and –T1 dependent variables, and –Potential change of independent variables OR adjustment for potential confounders, but no adjustment for: –T1 dependent variables, and –Potential change of independent variables	Adjustment for potential confounders, AND adjustment for: –T1 dependent variables, or –Potential change of some independent variables	Adjustment for potential confounders, AND adjustment for: –T1 dependent variables, and –Potential change of independent variables

TP=Time Point(s); PA=Physical Activity; MBI=Maslach Burnout Inventory; MBI-NL=Maslach Burnout Inventory (Dutch version); UBOS=Utrechtse Burnout Scale; SMBQ=Shirom-Melamed Burnout Questionnaire; C-CBI=Copenhagen Burnout Inventory; GPAQ=Global Physical Activity Questionnaire; IPAQ=International Physical Activity Questionnaire; SGPALS=Saltin-Grimby Physical Activity Scale

$$SIC = \frac{n(positive) - n(negative)}{n(total)}$$

with $n(positive)$ as the number of studies reporting a significant positive relationship, $n(negative)$ as the number of studies reporting a significant negative relationship, and $n(total)$ as the total number of studies examining this relationship. The values can therefore range from

1, with all articles presenting a significant negative relationship, to +1, with all articles presenting a significant positive relationship. A SIC value close to zero means

that the studies either report inconsistent results or did not find a significant relationship at all. By combining the SIC value with the corresponding number of studies assessing this relationship, the strength of evidence can be determined (see Table 3).

SIC calculations were conducted separately for longitudinal and intervention studies. For the intervention studies, the main and most advanced analysis concerning the relationship between physical activity and burnout was used for the calculation of SIC (e.g., no analyses concerning depression or other outcome measures were considered; analyses with statistical adjustments were preferred

Table 2. Quality evaluation criteria for intervention studies

Criteria	0 stars (insufficient)	2 stars (sufficient)	3 stars (good)
1. Control group & randomization	No control group or randomization	One control group, but no randomization	At least one control group and randomization
2. Measuring TP: Burnout	Pre or post intervention only	Pre and post intervention	At least 1 pre and >1 post intervention
3. Intervention content	The initial problem (regarding burnout) is not clear and/or intervention does not fit initial problem	The initial problem (regarding burnout) is insufficiently presented and/or intervention does fit initial problem	The initial problem (regarding burnout) is clear and intervention fits initial problem
4. Intervention process	No information about the implementation process is presented	Information about the implementation process is presented, but insufficient	Information about the implementation process is presented
5. Measures: Burnout	Burnout (dimensions) not measured validly (i.e., no correct use of validated [sub] scales of the MBI, MBI-NL, UBOS, SMBQ, C-CBI)		Burnout (dimensions) measured validly (i.e., correct use of validated [sub] scales of the MBI, MBI-NL, UBOS, SMBQ, C-CBI)
6. Non-response analysis	No check on selectivity of the sample	Check on selectivity of the sample either at baseline or follow-up	Check on selectivity of the sample at both baseline and follow-up
7. Intention-to-treat	No intention-to-treat analysis		Use of intention-to-treat analysis

Note. TP=Time Point(s); MBI=Maslach Burnout Inventory; MBI-NL=Maslach Burnout Inventory (Dutch version); UBOS=Utrechtse Burnout Scale; SMBQ=Shirom-Melamed Burnout Questionnaire; C-CBI=Copenhagen Burnout Inventory

Table 3. Strength of evidence for the relationship between physical activity and burnout based on the number of studies assessing this relationship and its corresponding SIC value

Number of studies	SIC value				
	-1.00 - -.60	-0.59 - -.30	-0.29 - 0.29	0.30 - 0.59	0.60 - 1.00
	Strength of evidence	Strength of evidence	Strength of evidence	Strength of evidence	Strength of evidence
1-2	Insufficient	Insufficient	Insufficient	Insufficient	Insufficient
3-5	--	-	0	+	++
≥6	---	--	0	++	+++

Note. 0=inconsistent evidence; -/+ = limited evidence for negative/positive relationship; - -/+ = moderately strong evidence for negative/positive relationship; - - -/+ = strong evidence for negative/positive relationship

over analyses without statistical adjustments).

Results

Longitudinal studies

We identified four longitudinal studies (see Table 4

A)^{33,36}. Two studies were conducted in the Netherlands^{33,34} and two were conducted in Sweden^{35,36}. Sample sizes ranged from 1747 to 3717 for a heterogeneous group of employees with mixed gender who were employed in business services, public administration, industry, education, health care, and social insurance.

Table 4A. Study characteristics of longitudinal studies

Study	Study goal	Design	Participants	Measurement Methods	Burnout measure	Physical activity measure	Type of physical activity	Measurement times	Results
1. Bernaards et al. (2006) ³³⁾	Investigating the longitudinal relation between strenuous leisure time PA and psychological complaints (depression and emotional exhaustion) in a Dutch working population to find evidence for preventive role of PA	Longitudinal prospective design with 3 times follow up	1747 Dutch employees from 34 companies (blue-, white-collar, caring profession): - mixed gender - ≥1 year work in current job - working hours ≥24h/week	Questionnaires	MBI-NL exhaustion subscale (7 items)	1 item: 'How often within the past four months did you participate in strenuous sports activities or strenuous physical activities that last long enough to become sweaty?'	Strenuous leisure time PA	4 times, in 1994, 1995, 1997 and 1998	Once or twice strenuous leisure time PA a week was associated with lower risk of future exhaustion compared to no or ≥3 times a week. This result was only found in workers with sedentary jobs.
2. De Vries et al. (2016) ³⁴⁾	Examining 'normal', 'reversed' and 'reciprocal' relationships between PA and work-related fatigue (i.e., exhaustion component of burnout); and between PA and task demands	Two-wave longitudinal full panel (with a one-year time interval)	2275 Dutch employees (business services, public administration, industry, education): - mixed gender - full time (36h/week) - no physically demanding jobs	Questionnaires	UBOS exhaustion subscale (5 items)	1 item: 'On how many days a week are you normally physically active during at least 30 mins. a day (only count PA that is equally demanding as brisk walking or biking. Activities shorter than 10 minutes do not count) - during your work and free time together?'	Moderate-intensity PA (i.e., activities that require a moderate amount of effort and noticeably accelerate the heart rate)	2 times, in 2008 and 2009	Support for reciprocal relation between PA and work-related fatigue: - Increase PA associated with decrease work-related fatigue. - Increase work-related fatigue associated with decrease PA

Table 4A. Study characteristics of longitudinal studies (continued)

Study	Study goal	Design	Participants	Measurement Methods	Burnout measure	Physical activity measure	Type of physical activity	Measurement times	Results
3. Jonsdottir et al. (2010) ³⁵⁾	Analyzing longitudinal associations between self-reported leisure-time PA and burnout among working individuals.	Longitudinal prospective design with two year follow up	3114 Swedish employees (mainly health care, social insurance): - mixed gender - ≥1 year work - ≥50% full-time	Questionnaires	SMBQ (22 items), i.e., physical fatigue, emotional exhaustion and cognitive weariness	Adapted 4-level SGPALS PA in the last three months: 1) mostly sedentary; 2) light PA, such as walking for ≥ 2 hours a week; 3) moderate PA, such as swimming for ≥ 2 hours a week; 4) vigorous, high intensity PA ≥5 hours a week	Leisure time PA	2 times, in 2004 and 2006	Workers reporting light PA, moderate, or vigorous PA at baseline are less likely to report burnout at follow-up compared to sedentary workers.
4. Lindwall et al. (2014) ³⁶⁾	Examine whether intra-individual changes in PA are correlated with intra-individual changes in mental health across four measurement time-point over 6 years, both from between- and within-person perspectives.	Longitudinal prospective design with 3 follow up measures	3717 Swedish health care workers: - mixed gender ->/=1 year work ->/=50% full-time	Questionnaires	SMBQ (22 items) i.e., physical fatigue, emotional exhaustion and cognitive weariness	4-level SGPALS, PA in the last three months	Leisure time PA	4 times, in 2004, 2006, 2008 and 2010	Changes in PA were associated with, and travelled together with, changes in burnout across time.

Note. PA=physical activity; MBI=Maslach Burnout Inventory; MBI-NL=Maslach Burnout Inventory (Dutch version); UBOS=Utrecht Burnout Scale; SMBQ=Shirom-Melamed Burnout Questionnaire; C-CBI=Copenhagen Burnout Inventory; GPAQ=Global Physical Activity Questionnaire; IPAQ=International Physical Activity Questionnaire; SGPALS=Saltin-Grimby Physical Activity Scale; mins=minutes

Table 4B. Study characteristics of intervention studies

Study	Study goal	Design	Participants	Conditions	Method of measurement	Burnout measure	Prevention type	Intervention content	Measurement times	Intervention dose	Results
1. Bretland & Thorsteinsson (2015) ⁴⁰⁾	Comparing aerobic with flexibility & strength exercise to assess relative effectiveness against well-being, perceived stress and burnout.	Randomized controlled trial	49 Australian employees (education, government, medical); mixed gender ->18 years old - no medical issues - not hypertensive - no regular exercise	Flexibility & strength exercise ^a (n=9), aerobic exercise ^b (n=20), control (n=20)	Questionnaires, exercise diary	MBI (22 items) i.e., emotional exhaustion, depersonalization and personal accomplishment	Primary prevention	Flexibility & strength exercise ^a (e.g. yoga, pilates & body balance) partly supervised Aerobic exercise ^b : both supervised group fitness classes and individual aerobic exercise	Baseline, after 2 weeks and at post-intervention	4 weeks, 3 times a week, 30 mins	Both types of exercise reduced emotional exhaustion. Flexibility & strength exercise also improved professional efficacy. No change in cynicism.
2. Freitas et al. (2014) ⁴¹⁾	Assessing the effects of a workplace physical activity program on levels of burnout of a nursing team in a palliative care unit.	Pretest-posttest intervention study without control condition. No randomization	21 Brazilian palliative care nursing professionals: - gender not specified - ≥1 year in current job	WPA Program, No control group	Questionnaires	MBI (22 items) i.e., emotional exhaustion, depersonalization and personal accomplishment	Primary prevention	WPA (not further specified)	Baseline, post-intervention	12 weeks, 5 times a week, 10 mins	WPA did not decrease burnout (i.e., emotional exhaustion, depersonalization and personal accomplishment).

Table 4B. Study characteristics of intervention studies (continued)

Study	Study goal	Design	Participants	Conditions	Method of measurement	Burnout measure	Prevention type	Intervention content	Measurement times	Intervention dose	Results
3. Gerber et al. (2013) ⁴²⁾	Explore whether a 12-week aerobic exercise ^b training program results in reduced levels of burnout.	Pilot study. Pretest-posttest design without control condition. No randomization	12 Swiss male employees: - male - age 30-65 - non-smoking - good physical health - no regular exercise during last 2 years - high scores on MBI exhaustion or cynicism	Exercise (n=12); No control group	Questionnaires	MBI (22 items) i.e., emotional exhaustion, depersonalization and personal accomplishment	Secondary prevention	Aerobic exercise ^b (e.g., cross trainers, running, bicycle) at a private fitness center, supervised by exercise coaches.	Baseline, and post-intervention	12 weeks, 2/3 times a week, 60 mins	At post-intervention, emotional exhaustion, and depersonalization were significantly reduced No sign. change in personal accomplishment.

Table 4B. Study characteristics of intervention studies (continued)

Study	Study goal	Design	Participants	Conditions	Method of measurement	Burnout measure	Prevention type	Intervention content	Measurement times	Intervention dose	Results
4. Lindegard et al. (2015) ⁴³	Investigating whether initially physically inactive patients diagnosed with exhaustion disorder differ at 6-month, 12-month and 18-month follow-up in burnout levels depending on whether they complied with PA recommendations.	Pretest and posttest design without control condition. No randomization	69 Swedish patients of stress clinic due to stress-related exhaustion: - mixed gender - physically inactive - diagnostic criteria exhaustion disorder	Multimodal treatment (MMT; n=69). No control group.	Questionnaires	SMBQ (22-items) i.e., physical fatigue, emotional exhaustion and cognitive weariness	Tertiary prevention	MMT: program tailored according individual needs; 8-week group stress management program; comprehensive info about PA; <i>self-selection</i> of 18-week participation in coached group-exercise program	Baseline, after 6 months, after 12 months, after 18 months	18 weeks, once a week, 60 mins	All participants reported a decrease in burnout symptoms over time. At 18 months, Participants who complied mildly or strongly with the PA showed larger and more sustained improvements in burnout during the follow-up period than non-compliers.

Table 4B. Study characteristics of intervention studies (continued)

Study	Study goal	Design	Participants	Conditions	Method of measurement	Burnout measure	Prevention type	Intervention content	Measurement times	Intervention dose	Results
5. Tsai et al. (2013) ⁴⁴⁾	Explore the effectiveness of exercise program on burnout and metabolic syndrome components.	Non-randomized quasi-experimental design with control condition	89 Chinese banking and insurance workers: - mixed gender	Control (n=38; no intervention), low (n=36) and high (n=35) intensity exercise	Questionnaires, digital sphigmomanometer, waistlines	C-CBI (10 items) i.e., work-related and personal burnout	Primary prevention	Worksite exercise program, after work, gymnastics, aerobic, stretching to increase muscle strength, with music and trainer	Baseline, post-intervention	12 weeks Low intensity: once a week, 60 mins. High intensity: twice a week, 60 mins.	Personal and work-related burnout was significantly reduced by exercise. High intensity exercise resulted in greater improvements compared to low-intensity.
6. Van Rhenen et al. (2005) ⁴⁵⁾	Investigate the short- and long-term effectiveness of two brief preventive work stress management programs.	Randomized controlled trial	75 Dutch telecommunications company employees: - mixed gender - high rate of distress (4DSQ> .32)	Exercise and relaxation program (FYS; n=71), cognitive intervention (COG; n=59)	Questionnaires	UBOS (16 items), i.e., emotional exhaustion, professional efficacy, cynicism	Secondary prevention	FYS: progressive muscle relaxation ^c & Fitness (aerobic ^b & non-aerobic exercise ^d) during work. Individually conducted. COG: restructuring of irrational beliefs	Baseline, post-intervention, and at 6 months follow-up	FYS: 4 exercise sessions in 8 weeks, 60 mins COG: 4 sessions in 8 weeks, 60 mins.	Both interventions revealed positive impact on burnout (i.e., emotional exhaustion and professional efficacy). No decrease in cynicism.

Note. PA=Physical Activity; MBI=Maslach Burnout Inventory; MBI-NL=Maslach Burnout Inventory (Dutch version); UBOS=Utrecht Burnout Scale; SMBQ=Shirom-Melamed Burnout Questionnaire; C-CBI=Copenhagen Burnout Inventory; GPAQ=Global Physical Activity Questionnaire; IPAQ=International Physical Activity Questionnaire; SGPALS=Saltin-Grimby Physical Activity Scale; mins=minutes

^a Physical activities in which muscles are stretched and strengthened.

^b Physical activities involving large muscle groups that are used for extended periods of time in activities that are rhythmic in nature, such as walking, running, or cycling.

^c Relaxation technique used to learn to monitor and to control the state of muscle tension.

^d Brief intense bursts of physical activity, such as weightlifting.

Table 5. Quality evaluation of longitudinal studies

Study	1	2	3	4	5
	Applied design	Measures: burnout	Measures: PA/exercise	Non-response analysis	Statistical adjustment
1. Bernaards et al. (2006) ³³⁾	**	***	0	***	**
2. De Vries et al. (2016) ³⁴⁾	***	***	0	0	***
3. Jonsdottir et al. (2010) ³⁵⁾	0	***	***	**	**
4. Lindwall et al. (2014) ³⁶⁾	***	***	***	***	**

Note. 0=insufficient; **=sufficient; ***=good; PA=physical activity

All four studies assessed physical activity and burnout with questionnaires. They all measured exhaustion as the main dimension of burnout. These four studies did not measure depersonalization (cynicism) or reduced sense of personal accomplishment (professional efficacy). To measure exhaustion, two studies used the subscale “exhaustion” of Dutch versions of the Maslach Burnout Inventory: the Maslach Burnout Inventory-NL (MBI-NL, seven items)^{33,37)} and the “Utrecht Burnout Scale” (UBOS, five items)^{34,37)}. The other two studies^{35,36)} used the Shirom-Melamed Burnout Questionnaire (SMBQ) with 22 items³⁸⁾. In the two Dutch studies, physical activity was investigated with one item, whereas the two Swedish studies used the Saltin-Grimby Physical Activity Scale (SGPALS)³⁹⁾ to assess participants’ frequency, duration, and intensity of physical activity. Burnout (exhaustion) and physical activity were measured at four^{33,36)}, or at two, different measurement points^{34,35)}. The time between the measurements points lasted 1 year^{33,34)} or 2 years^{35,36)}.

Study quality evaluation

Two studies used a complete panel design with physical activity and burnout measured at each time point (see Table 5, *criterion 1*)^{34,36)}. An incomplete panel design was used by Bernaards et al. (2006)³³⁾, who measured burnout at four measurement points but physical activity only at baseline. Jonsdottir et al. (2010)³⁵⁾ also used an incomplete panel design with two time points, measuring burnout at both time points but physical activity only at baseline. In all four studies, burnout was defined as “exhaustion only.” All four studies used validated (sub) scales to measure exhaustion (*criterion 2*). In two studies, a full questionnaire was used (i.e., SMBQ)^{35,36)}, and the remaining two studies used one subscale (i.e., MBI)^{33,35)}. In two studies, physical activity was measured with a validated scale, including the frequency, duration, and intensity of physical activity (*criterion 3*)^{35,36)}, while in the other two studies physical activity was measured with a single item (see Table 4A^{33,34)}). A non-response analysis (*criterion 4*)

was applied in three studies. Two studies checked the selectivity of the sample at baseline and follow-up^{33,36)}. Jonsdottir et al. (2010)³⁵⁾ did so only at follow-up, and De Vries et al. (2016)³⁴⁾ did not do so at all. One study adjusted for potential confounders (*criterion 5*) (e.g., gender, age, education, working overtime, and working irregular hours), time point one (T1) -dependent variables, and the potential change of independent variables³⁵⁾. Bernaards et al. (2006)³³⁾ also adjusted for potential confounders and a potential change of independent variables, but adjustments for T1 measurements were conducted for exhaustion only and not for physical activity, as physical activity was measured at baseline and not at follow-up. Lindwall et al. (2014)³⁶⁾ and Jonsdottir et al. (2010)³⁵⁾ adjusted only for age, gender, and T1 physical activity and exhaustion but not for potential changes of independent variables.

Altogether, the study by Lindwall et al. (2014)³⁶⁾ could be classified as a high quality study (two or three stars on each quality criterion). The other three studies can be considered as studies of moderate quality.

Synthesis of evidence

All four studies demonstrated a significant negative relationship between physical activity and the key burnout component, i.e., exhaustion. Three of these studies investigated only a “normal” relationship (i.e., physical activity exhaustion)^{33,35,36)}, whereas one study examined a “normal” but also a “reversed” relationship between physical activity and exhaustion (i.e., also exhaustion physical activity)³⁴⁾.

Specifically, it was shown that participants who engaged in strenuous physical activity once or twice a week were at significantly lower risk for (future) exhaustion than participants who were physically active more than twice a week or between one and three times a month. This association was stronger for workers with sedentary rather than non-sedentary jobs³³⁾. Furthermore, participants who became more physically active over a 6-year

Table 6. Quality evaluation of intervention studies

Study	1 Control group & randomiza- tion	2 Measuring TP: burnout	3 Intervention content	4 Intervention process	5 Measures: burnout	6 Non- response analysis	7 Intention- to-treat
1. Bretland & Thorsteinsson (2015) ⁴⁰⁾	***	***	***	***	***	0	0
2. Freitas et al. (2014) ⁴¹⁾	0	**	**	**	***	0	0
3. Gerber et al. (2013) ⁴²⁾	0	**	***	***	***	0	0
4. Lindegard et al. (2015) ⁴³⁾	0	***	***	***	***	**	0
5. Tsai et al. (2013) ⁴⁴⁾	**	**	***	***	***	0	0
6. Van Rhenen et al. (2005) ⁴⁵⁾	***	***	***	***	***	**	0

Note. 0=insufficient; **=sufficient; ***=good; TP=time points

^a The aim of this study was to test the hypothesis that a newly developed, combined physical intervention is more effective in reducing psychological complaints than a cognitive intervention. The cognitive intervention can be considered as control condition.

period showed a larger decrease in exhaustion than participants who did not become more active. Lindwall et al. (2014) ³⁶⁾ showed that exhaustion and physical activity changed together over time, from both a between-person and a within-person perspective (i.e., increasing physical activity levels were associated with decreasing exhaustion levels). Jonsdottir et al. (2010) ³⁵⁾ found participants reporting performance of light, moderate, or vigorous physical activity to be less likely to report exhaustion at follow-up compared with participants with a sedentary lifestyle. Only De Vries et al. (2016) ³⁴⁾ investigated, and found supportive evidence for, a reciprocal relationship between physical activity and exhaustion. An increase in physical activity was related to a decrease in exhaustion at follow-up, and an increase in exhaustion was associated with a decrease in physical activity at follow-up.

Based on the four longitudinal studies reviewed in this paper, the SIC value was: $SIC(4) = (0 - 4)/4 = -1$. This indicates moderately strong evidence for a negative relationship between physical activity and the key component of burnout, i.e., exhaustion (see Table 3).

Intervention studies

The main study characteristics of the six identified intervention studies ⁴⁰⁻⁴⁵⁾ are presented in Table 4B. These studies were conducted in Australia, Brazil, Switzerland, Sweden, China, and the Netherlands. Two studies had a randomized controlled trial design ^{40,45)}. Three other studies had a non-randomized quasi-experimental design ^{41,43,45)}.

One study was conducted as a one-condition pilot study ⁴²⁾. Sample sizes ranged from 12 to 89 in a heterogeneous group of participants who were employed in education, government, medicine, telecommunications, banking, and insurance. Five studies used a sample of mixed gender, whereas one study examined only male employees ⁴²⁾. Two studies selected subclinical samples of participants with high burnout or stress symptoms ^{42,45)}, which therefore were considered as secondary prevention studies ^{29,30)}. In one study, patients attending a stress clinic and who were diagnosed with stress-related exhaustion were investigated ⁴³⁾, and this study was accordingly considered as concerning tertiary prevention ^{29,30)}. Three studies selected healthy employees ^{40,41,44)} and were considered to cover primary prevention ^{29,30)}. Three studies selected participants who were not physically active ^{40,42,43)}.

All six studies measured exhaustion, i.e., the main burnout dimension. Lindegard et al. (2015) ⁴³⁾ and Tsai et al. (2013) ⁴⁴⁾ measured exhaustion only. Lindegard and co-workers used the SMBQ, whereas Tsai et al. used the Copenhagen Burnout Inventory (C-CBI). The four other studies ^{40-42,45)} additionally included measures of cynicism and professional efficacy, using the MBI. Internal consistency was good in all studies, except for the MBI in the study of Freitas et al. (2014) ⁴¹⁾. Participants were asked to fill out the questionnaire at baseline and at one follow-up point in three studies ^{41,42,44)}. Two intervention studies used three time points ^{40,45)} whereas one study had four time points ⁴³⁾. Intervals between time points ranged from 2

weeks to 6 months. Most interventions comprised instructed group fitness sessions, during or after work, sometimes combined with individual workouts. All studies operationalized physical activity as aerobic exercise, to which two studies also added flexibility, strength, and relaxation exercises, i.e., yoga and pilates⁴⁴, and progressive muscle relaxation⁴⁵. Intervention program durations ranged from 4 to 18 weeks, with two to five weekly physical activity sessions, and a duration of 10–60 min per session. The most frequently applied duration was 12 weeks, twice each week, for 60 min. Two studies adjusted the level of physical activity based on individual skills and fitness of the participants^{43,45}.

Study quality evaluation

As to *criterion 1*, i.e., applied design (Table 6), two intervention studies had at least one control condition and applied randomization for the different conditions^{40,45}. Tsai et al. (2013)⁴⁴ used a control condition but did not randomize the participants. The three remaining studies had neither a control condition nor randomization^{41–43}. In three studies, burnout was measured (*criterion 2*) at baseline and at several follow-up points^{40,43,45}, whereas in the remaining three studies burnout was measured at two time points only, i.e., pre- and post-intervention^{41,42,44}. As to *criterion 3* (intervention content), the initial problem regarding burnout was well-explained, and the intervention fitted the initial problem in five studies^{40,42–45}. Only Freitas et al. (2014)⁴¹ presented the problem insufficiently, with very little research evidence to argue for their intervention content. Five studies provided information on the implementation process (*criterion 4*), but Freitas et al. (2014)⁴¹ did not mention in detail how the intervention was implemented. As regards the measurement of burnout (*criterion 5*), in all studies burnout was measured with a validated instrument^{40–45}. A non-response analysis (*criterion 6*) was applied in two studies but only at baseline and not at follow-up^{43,45}. Furthermore, none of the six studies performed an intention-to-treat analysis to examine external validity of the intervention (*criterion 7*).

All in all, no intervention study scored “sufficient” (or higher) for all of the seven criteria. This means that none of these six studies can be classified as a high quality study. The Van Rhenen et al. (2005)⁴⁵ study scored “good” for most criteria but also has one shortcoming, whereas the study by Freitas et al. (2014)⁴¹ was of poorer quality with three methodological shortcomings. The most frequent insufficiencies constitute the absence of non-response analysis (four out of six studies) and intention-to-treat analysis (all six studies).

Synthesis of evidence

Five out of six studies demonstrated a significant influence of the physical activity intervention on the key component of burnout, i.e., exhaustion^{40,42–45}. We note that in the Freitas-study (2014)⁴¹, in which no reduction in exhaustion was found, the internal consistency of the MBI

was insufficient. The corresponding SIC value for exhaustion is as follows: $SIC(6) = (0 - 5)/6 = -0.83$. This indicates that there is strong consistent evidence for a negative relationship between physical activity and exhaustion (see Table 3). Two^{40,45} out of four studies that investigated the burnout component “professional efficacy” (or personal accomplishment), found a significant effect on this outcome. The SIC value for professional efficacy is as follows: $SIC(4) = (2 - 0)/4 = 0.50$, indicating limited evidence for a positive relationship between physical activity and professional efficacy. One⁴² out of four studies that studied “cynicism” (or depersonalization) showed a significant effect on this outcome. Hence, the corresponding SIC value for cynicism is as follows: $SIC(4) = (0 - 1)/4 = -0.25$. This means that there is inconsistent evidence for a negative relationship between physical activity and cynicism.

Discussion

Burnout constitutes a serious risk to sustainable health of employees of today’s organizations. Accordingly, interventions are needed that may reduce burnout. We hypothesized that regular physical activity may constitute an instrument that may be used for the reduction of burnout. Therefore, this study systematically reviewed longitudinal and intervention studies that investigated the strength of the relationship between physical activity and burnout. Ten studies, four longitudinal and six intervention studies, were identified. The consistency of the evidence for a negative relationship between physical activity and the key component of burnout (i.e., exhaustion) in longitudinal studies was moderate, while the consistency of this evidence in intervention studies was strong.

Moreover, for intervention studies, we found limited evidence for a positive relationship between physical activity and professional efficacy, and inconsistent evidence for a negative relationship between physical activity and cynicism.

Methodological quality of the studies

The SIC values that we calculated for longitudinal and intervention studies suggest that physical activity is related to a reduction of exhaustion at a later point in time. It should also be acknowledged, though, that research into the causal relation between physical activity and burnout is still in its infancy. This conclusion follows from the assessment of the methodological quality of the included studies, as investigated by means of well-established criteria regarding design, measurement quality, and appropriateness of analyses. More trust can be put in those published studies with design, measurements, and statistical analyses of sufficient or good quality, as these are less likely to suffer from biases that may reduce the validity of the findings^{46,31}. However, in our systematic review, only

one of the longitudinal studies, and none of the intervention studies, was qualified as a high quality study. This sheer absence of high quality studies prevented us from conducting a second set of separate analyses of “high quality studies only,” as advocated by De Lange et al. (2003)⁴⁶.

In the longitudinal studies, poorer report marks (“insufficient”) related to the measurement of physical exercise, the absence of non-response analysis, and the applied design. Several methodological flaws can also be noted in the aforementioned intervention studies, such as lack of control conditions, no (described) randomization procedure, a combination of exercise and other intervention ingredients, and lack of intention-to-treat analyses. Control conditions are important for internal validity⁴⁷. Sound randomization procedures minimize systematic differences between conditions of known and unknown factors that may affect intervention effects⁴⁷. When intervention ingredients are combined, such as in the study of Van Rhenen and colleagues (2005)⁴⁵, it is unknown to what extent beneficial effects were due to physical activity or to other intervention components⁴⁸. As none of the intervention studies analyzed the results according to the intention-to-treat principle⁴⁹, it is possible that some of the estimates of intervention efficacy were overoptimistic.

Dose and type of physical activity

A large variety in the “dose” and type of physical activity was applied in the selected studies. It was found that engagement in physical activity once or twice a week for 4 weeks⁴⁰ to 18 weeks⁴³ has promising effects on preventing³³ and reducing⁴⁵ burnout symptoms. This effect might be especially visible in initially inactive employees³³ and in clinical populations who show considerable compliance to the physical activity intervention⁴³. On the other hand, more exhausted employees may also have greater difficulties and less motivation to initiate and continue exercise³⁴, as has also been suggested in previous cross-sectional research^{50,56}.

Although physical activity seems effective to reduce exhaustion, it is still unclear which type, intensity, duration, or frequency of physical activity might be most effective. In one study, it was concluded that higher-intensity physical activity (not more than twice a week) is effective to prevent burnout³³, whereas others found that low-intensity physical activity yields positive results³⁵. In Bretland and Thorsteinsson’s (2015)⁴⁰ study, 4 weeks of exercise three times a week for 30 min already reduced symptoms of burnout.

In most studies, physical activity was defined as aerobic exercise. It also became clear, though, that flexibility and strength exercise (e.g., yoga, pilates, resistance training) was able to reduce burnout symptoms^{40,44}, which is in accordance with prior work that found non-aerobic exercise to be beneficial for depression⁵¹.

More research concerning the intensity, frequency, duration, and type of physical activity should be conducted in order to specify which physical activity “dose” is best to reduce burnout. With respect to the measurement of physical activity, future longitudinal studies could apply validated scales, such as the Global Physical Activity Questionnaire (GPAQ)⁵² and the International Physical Activity Questionnaire (IPAQ)⁵³, or use objective measures, such as accelerometers and pedometers, to validly measure different physical activity characteristics. In intervention studies, one may consider the comparison of different physical activity doses.

Conceptualization of burnout

All four longitudinal studies examined only exhaustion as the key burnout component, whereas most intervention studies (four out of six) examined burnout conceptualized from a three dimensional perspective. Nine out of ten studies found a significant result in reference to “exhaustion.”

Results concerning “professional efficacy” and “cynicism” were less frequent and consistent; they were only looked into in four intervention studies. Some of these studies found positive effects of physical activity on these dimensions (cynicism⁴²; professional efficacy^{40,45}), while others did not find such an association (cynicism^{40,45}; professional efficacy⁴²).

These findings seem theoretically plausible. Several psychological and physiological mechanisms underlying the relationship between physical activity and exhaustion have been proposed (e.g., psychological detachment^{17,18}; the cardiovascular fitness hypothesis²⁴), while the theoretical foundation for the association between physical activity and professional efficacy, and, in particular, cynicism, is weaker. As regards professional efficacy, it is possible that mastery experiences obtained through physical activity spill over to the work domain^{21,22}. While it thus may be theoretically plausible that physical activity improves one’s sense of personal accomplishment, a plausible theoretical mechanism that relates physical activity to cynicism seems more difficult to construe.

Strengths and limitations of this systematic review

We believe that one strength of this systematic review is that the literature search and synthesis of evidence were extensive and well-structured. The application of two sets of quality criteria to assess the quality of longitudinal and intervention research on this topic may be considered an asset as well.

This study also has limitations. As studies with significant results are more often accepted and published, we cannot exclude the possibility of publication bias. Another limitation follows from the “moderate,” not high, quality of the studies that we identified. Such poorer study designs increase the chances of biased findings and

force researchers to be cautious in making firm claims about both internal and external validity.

Future research

First, we recommend future research on the relationship between physical activity and burnout to aim to be of a high methodological quality, which can be achieved, for example, by relying on the quality criteria used in this study.

Second, we believe that this area can also be moved forward by paying more attention to the process evaluation of intervention studies. Process evaluation opens the “black box” to see what happened during the intervention period. It explores the implementation (i.e., the way a program is put into practice), receipt (i.e., the dose and views of participants), and setting (i.e., the general intervention and implementation context) and thus helps in interpreting intervention outcomes, designing future effective exercise interventions for burnout, and successfully implementing the intervention(s) in practice⁵⁴⁻⁵⁷.

Third, we recommend that future research pays more attention to bi-directional relationships between physical activity and burnout. The “reverse” relationship, with burnout having an impact on physical activity, may also be theoretically plausible. Generally, fatigue is seen as a stop emotion to protect against an excessive depletion of energy stocks^{58,59}. When fatigued, people have a lower tendency to start or complete a task, especially when this task requires large effort²³. As physical activity requires (high) effort, one may assume that high fatigue levels negatively affect employees’ physical activity levels.

Fourth, the results of this systematic review seem to indicate that physical activity may be effective for the primary, the secondary, and the tertiary prevention of burnout. However, given the small number of studies included in our study, future research is needed to shed more light on this issue.

Conclusion

Our systematic review suggests that physical activity is effective to reduce burnout. However, more high quality longitudinal and intervention studies are required to firmly establish this relationship.

Conflicts of interest: The authors declare that there are no conflicts of interest.

References

- 1) Maslach C, Jackson SE. Maslach burnout inventory: second edition. Palo Alto, CA: Consulting Psychologists Press; 1986.
- 2) Breninkmeijer V, Van Yperen N. How to conduct research on burnout: advantages and disadvantages of a unidimensional approach to burnout. *Occup Environ Med* 2003; 60: 16-21. (doi: 10.1136/oem.60.suppl_1.i16).
- 3) Kristensen MB, Borritz M, Villadsen E, Christensen KB. The Copenhagen burnout inventory: a new tool for the assessment of burnout. *Work & Stress* 2005; 19: 192-207. (doi: 10.1080/02678370500297720).
- 4) Schaufeli WB, Leiter MP, Maslach C. Burnout: 35 years of research and practice. *Career Development International* 2009; 14: 204-220. (doi: 10.1108/13620430910966406).
- 5) Alarcon G, Eschleman KJ, Bowling NA. Relationships between personality variables and burnout: a meta-analysis. *Work & Stress* 2009; 23: 244-263. (doi: 10.1080/02678370903282600).
- 6) Ekstedt M, Söderström M, Åkerstedt T, Nilsson J, Söndergaard H-P, Aleksander P. Disturbed sleep and fatigue in occupational burnout. *Scand J Work Environ Health* 2006; 32: 121-131. (doi: 10.5271/sjweh.987).
- 7) Deligkaris P, Panagopoulou E, Montgomery AJ, Masoura E. Job burnout and cognitive functioning: a systematic review. *Work & Stress* 2014; 28: 107-123. (doi: 10.1080/02678373.2014.909545).
- 8) Oosterholt BG, Van der Linden D, Maes JH, Verbraak MJ, Kompier MA. Burned out cognition: cognitive functioning of burnout patients before and after a period with psychological treatment. *Scand J Work Environ Health* 2012; 38: 358-369. (doi: 10.5271/sjweh.3256).
- 9) Arvidson E, Börjesson M, Ahlborg G, Lindegård A, Jonsdottir IH. The level of leisure time physical activity is associated with work ability - a cross sectional and prospective study of health care workers. *BMC Public Health* 2013; 13: 855. (doi: 10.1186/1471-2458-13-855).
- 10) Melamed S, Shirom A, Toker S, Berliner S, Shapira I. Burnout and risk of cardiovascular disease: evidence, possible causal paths, and promising research directions. *Psychol Bull* 2006; 132: 327-353. (doi: 10.1037/0033-2909.132.3.327).
- 11) Demerouti E, Le Blanc PM, Bakker AB, Schaufeli WB, Hox J. Present but sick: a three-wave study on job demands, presenteeism and burnout. *Career Dev Int* 2009; 14: 50-68. (doi: 10.1108/13620430910933574).
- 12) Ricci JA, Chee E, Lorandean AL, Berger J. Fatigue in the U.S. workforce: prevalence and implications for lost productive work time. *J Occup Environ Med* 2007; 49: 1-10. (doi: 10.1097/01.jom.0000249782.60321.2a).
- 13) Toppinen-Tanner S, Ojajarvi A, Väänänen A, Kalimo R, Jäppinen P. Burnout as a predictor of medically certified sick-leave absences and their diagnosed causes. *Behav Med* 2005; 31: 18-27. (doi: 10.3200/BMED.31.1.18-32).
- 14) Eurofound. Fifth European working conditions survey [EWCS]. Luxembourg: Publications Office of the European Union. [Online]. 2012. Available from: URL: <https://www.eurofound.europa.eu/nl/publications/report/2012/working-conditions/fifth-european-working-conditions-survey-overview-report>
- 15) Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep* 1985; 100: 126-131 (PMCID: PMC1424733).

- 16) Warburton DER, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. *CMAJ* 2006; 174: 801-809. (doi: 10.1503/cmaj.051351).
- 17) Geurts SA, Sonnentag S. Recovery as an explanatory mechanism in the relation between acute stress reactions and chronic health impairment. *Scand J Work Environ Health* 2006; 32: 482-492. (doi: 10.5271/sjweh.1053).
- 18) Sonnentag S. Psychological detachment from work during leisure time: the benefits of mentally disengaging from work. *Current Directions in Psychological Science* 2012; 22: 114-118. (doi: 10.1177/0963721411434979).
- 19) Craft LL. Exercise and clinical depression: examining two psychological mechanisms. *Psychol Sport Exerc* 2005; 6: 151-171. (doi: 10.1016/j.psychsport.2003.11.003).
- 20) Joseph RP, Royse KE, Benitez TJ, Pekmezi DW. Physical activity and quality of life among university students: exploring self-efficacy, self-esteem, and affect as potential mediators. *Qual Life Res* 2014; 23: 659-667. (doi: 10.1007/s11136-013-0492-8).
- 21) Feuerhahn N, Sonnentag S, Woll A. Exercise after work, psychological mediators, and affect: a day-level study. *Eur J Work Organ Psy* 2014; 23: 62-79. (doi: 10.1080/1359432X.2012.709965).
- 22) Rook JW, Zijlstra FR. The contribution of various types of activities to recovery. *Eur J Work Organ Psy* 2006; 15: 218-240. (doi: 10.1080/13594320500513962).
- 23) Hockey RV. The psychology of fatigue: work, effort and control. Cambridge: Cambridge University Press; 2013.
- 24) Colcombe S, Kramer AF. Fitness effects on the cognitive function of older adults: a meta-analytic study. *Psychol Sci* 2003; 14: 125-130 (PMID: 12661673).
- 25) Jackson EM, Dishman RK. Cardiorespiratory fitness and laboratory stress: a meta-regression analysis. *Psychophysiology* 2006; 43: 57-72. (doi: 10.1111/j.1469-8986.2006.00373.x).
- 26) Klaperski S, Von Dawans B, Heinrichs M, Fuchs R. Effects of a 12-week endurance training program on the physiological response to psychosocial stress in men: a randomized controlled trial. *J Behav Med* 2014; 37: 1118-1133. (doi: 10.1007/s10865-014-9562-9).
- 27) Schuch FB, Vancampfort D, Richards J, Rosenbaum S, Ward PB, Stubbs B. Exercise as a treatment for depression: a meta-analysis adjusting for publication bias. *J Psychiatr Res* 2016; 77: 42-51. (doi: 10.1016/j.jpsychires.2016.02.023).
- 28) Chang Un P, Hyun Jung K. Measurement of inter-rater reliability in systematic review. *Hanyang Medical Reviews* 2015; 35: 44-49. (doi: 10.7599/hmr.2015.35.1.44).
- 29) Kompier MAJ, Kristensen TS. Organizational work stress interventions in a theoretical, methodological and practical context. In: Dunham J, editor. *Stress in the workplace: past, present and future*. London: Whurr Publishers; 2000. p. 164-190.
- 30) Tetrick LE, Quick JC. Prevention at work: public health in occupational settings. In: Quick JC, Tetrick LE, editors. *Handbook of occupational health psychology*. Washington DC (US): American Psychological Association; 2003. p. 3-17.
- 31) Van Laethem M, Beckers DG, Kompier MA, Dijksterhuis A, Geurts SA. Psychosocial work characteristics and sleep quality: a systematic review of longitudinal and intervention research. *Scand J Work Environ Health* 2013; 39: 535-549. (doi: 10.5271/sjweh.3376).
- 32) Wielenga-Meijer EG, Taris TW, Kompier MA, Wigboldus DH. From task characteristics to learning: a systematic review. *Scand J Psychol* 2010; 51: 363-375. (doi: 10.1111/j.1467-9450.2009.00768.x).
- 33) Bernaards CM, Jans MP, Van den Heuvel SG, Hendriksen IJ, Houtman IL, Bongers PM. Can strenuous leisure time physical activity prevent psychological complaints in a working population? *Occup Environ Med* 2006; 63: 10-16. (doi: 10.1136/oem.2004.017541).
- 34) De Vries JD, Claessens BJ, Van Hooff ML, Geurts SA, Van den Bossche SN, Kompier MA. Disentangling longitudinal relations between physical activity, work-related fatigue, and task demands. *Int Arch Occup Environ Health* 2016; 89: 89-101. (doi: 10.1007/s00420-015-1054).
- 35) Jonsdottir IH, Rödger L, Hadzibajramovic E, Börjesson M, Ahlberg Jr G. A prospective study of leisure-time physical activity and mental health in Swedish health care workers and social insurance officers. *Prev Med* 2010; 51: 373-377. (doi: 10.1016/j.ypmed.2010.07.019).
- 36) Lindwall M, Gerber M, Jonsdottir IH, Börjesson M. The relationship of change in physical activity with change in depression, anxiety, and burnout: a longitudinal study of Swedish healthcare workers. *Health Psychol* 2014; 33: 1309-1318. (doi: 10.1037/a0034402).
- 37) Schaufeli WB, Van Dierendonck D. The construct validity of two burnout measures. *J Organ Behav* 1993; 14: 631-647. (doi: 10.1002/job.4030140703).
- 38) Melamed S, Kushnir T, Shirom A. Burnout and risk factors for cardiovascular diseases. *Beh Med* 1992; 18: 53-60. (doi: 10.1080/08964289.1992.9935172).
- 39) Grimby G, Börjesson M, Jonsdottir IH, Schnohr P, Thelle DS, Saltin B. The "Saltin-Grimby Physical Activity Scale" and its application to health research. *Scand J Med Sci Sports* 2015; 25: 119-125. (doi: 10.1111/sms.12611).
- 40) Bretland RJ, Thorsteinsson EB. Reducing workplace burnout: the relative benefits of cardiovascular and resistance exercise. *Peer J* 2015; 9: e891. (doi: 10.7717/peerj.891).
- 41) Freitas AR, Carnesecca EC, Paiva CE, Paiva BS. Impact of a physical activity program on the anxiety, depression, occupational stress and burnout syndrome of nursing professionals. *Rev Latino-Am Enfermagem* 2014; 22: 332-336. (doi: 10.1590/0104-1169.3307.2420).
- 42) Gerber M, Brand S, Elliot C, Holsboer-Trachsler E, Pühse U, Becl J. Aerobic exercise training and burnout: a pilot study with male participants suffering from burnout. *BMC Res Notes* 2013; 6: 78. (doi: 10.1186/1756-0500-6-78).
- 43) Lindegard A, Jonsdottir IH, Börjesson M, Lindwall M, Gerber M. Changes in mental health in compliers and non-compliers with physical activity recommendations in patients with stress-related exhaustion. *BMC Psychiatry* 2015; 15: 272. (doi: 10.1186/s12888-015-0642-3).

- 44) Tsai HH, Yeah CY, Su CT, Chen CJ, Peng SM, Chen RY. The effects of exercise program on burnout and metabolic syndrome components in banking and insurance workers. *Ind Health* 2013; 51: 3. (doi: 10.2486/indhealth.2012-0188).
- 45) Van Rhenen W, Blonk RW, Van der Klink JJ, Van Dijk RJ, Schaufeli WB. The effect of a cognitive and a physical stress-reducing programme on psychological complaints. *Int Arch Occup Environ Health* 2005; 78: 139-148. (doi: 10.1007/s00420-004-0566-6).
- 46) De Lange AH, Taris TW, Kompier MA, Houtman IL, Bongers PM. "The very best of the millennium": longitudinal research and the demand-control-(support) model. *J Occup Health Psychol* 2003; 8: 282-305. (doi: 10.1037/1076-8998.8.4.282).
- 47) Mohr DC, Spring B, Freedland KE, et al. The selection and design of control conditions for randomized controlled trials of psychological interventions. *Psychother Psychosom* 2009; 78: 275-284. (doi: 10.1159/000228248).
- 48) Ekkekakis P. Honey, I shrunk the pooled SMD! Guide to critical appraisal of systematic reviews and meta-analyses using the Cochrane review on exercise for depression as example. *Ment Health Phys Act* 2015; 8: 21-36. (doi: 10.1016/j.mhpa.2014.12.001).
- 49) Gupta SK. Intention-to-treat concept : a review. *Perspect Clin Res* 2011; 2: 109-112. (doi: 10.4103/2229-3485.83221).
- 50) Ahola K, Pulkki-Raback L, Kouvonen A, Rossi H, Aromaa A, Lonnqvist J. Burnout and behaviour-related health risk factors results from the population-based Finnish health 2000 study. *J Occup Environ Med* 2012; 54: 17-22. (doi: 10.1097/JOM.0b013e31823ea9d9).
- 51) Krogh J, Nordentoft M, Sterne JA, Lawlor DA. The effect of exercise in clinically depressed adults: systematic review and meta-analysis of randomized controlled trials. *J Clin Psychiatry* 2011; 72: 529-538. (doi: 10.4088/JCP.08r04913blu).
- 52) Armstrong T, Bull F. Development of the World Health Organization Global Physical Activity Questionnaire (GPAQ). *J Public Health* 2006; 14: 66. (doi: 10.1007/s10389-006-0024-x).
- 53) Craig CL, Marshall AL, Sjoström M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003; 35: 1381-1395. (doi: 10.1249/01.MSS.0000078924.61453.FB).
- 54) Steckler AB, Linnan L. *Process evaluation for public health interventions and research*. San Francisco: Jossey Bass; 2002.
- 55) Durlak JA. What everyone should now about implementation. In: Durlak JA, Domitrovich CE, Weissberg RP, Gullotta TP, editors. *Handbook of social and emotional learning: Research and practice*. New York: Guilford; 2015.
- 56) Kompier M, Aust B. Organizational stress management interventions: is it the singer not the song? *Scand J Work Environ Health* 2016; 42: 355-358. (doi: 10.5271/sjweh.3578).
- 57) Murta SG, Sanderson K, Oldenburg B. Process evaluation in occupational stress management programs: a systematic review. *Am J Health Prom* 2005; 21: 248-254. (doi: 10.4278/0890-1171-21.4.248).
- 58) Ament W, Verkerke GJ. Exercise and fatigue. *Sports Med* 2009; 39: 389-422. (doi: 10.2165/00007256-200939050-00005).
- 59) Meijman TF. The theory of the stop-emotion: on the functionality of fatigue. In: Pogorski D, Karwowski W, editors. *ergonomics and safety for Global Business Quality and Production*. Warsaw: CIOP; 2000.
- 60) Moher D, Liberati A, Tezlaiff J, Altman DG, The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med* 2009; 151: 264-269. (doi: 10.7326/0003-4819-151-4200908180-00135).

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