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PHYSICAL ACTIVITY AS A TOOL TO REDUCE DISEASE-RELATED WORK ABSENTEEISM IN SEDENTARY EMPLOYEES: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Physical Activity (PA) programs have been suggested to lower absenteeism due to illness in sedentary employees. This review examines available scientific literature in order to study PA effects in workplace absenteeism, considering the program design.

Methods: A search through 4 databases (Medline, Sportdiscus, Web of Science and Embase), from inception to December 2017, was conducted to identify control intervention and observational studies about PA and absenteeism published in either English or Spanish language using PRISMA procedures.

Results: A total of 10 published studies between 1981 and 2017 met the inclusion criteria. Evidence from the review suggests that PA is effective in reducing illness-related absence. Likelihood of being off from the workplace reported with sedentary workers reach more probabilities when compared with exercisers.

Conclusions: General PA is considered paramount in order to lower employees' absenteeism, which could be more related to vigorous training. However, there is a lack of rigorous and more specific studies about the issue. More focused on the PA effect on absenteeism, adjusted by intervention variables, research would be desirable.

Key words: Physical activity, Absenteeism, Sick leave, Days off from work, Employees.

RESUMEN

La actividad física como herramienta para reducir el absentismo laboral debido a enfermedad en trabajadores sedentarios: una revisión sistemática

Fundamentos: Se ha sugerido que los programas de actividad física (AF) podrían reducir el absentismo laboral por motivos de enfermedad en trabajadores sedentarios. Esta revisión examina la evidencia científica disponible para estudiar los efectos de la AF sobre el absentismo laboral teniendo en consideración el diseño del programa de AF.

Métodos: Se realizó una búsqueda bibliográfica en 4 bases de datos (Medline, Sportdiscus, Web of Science y Embase) de ensayos clínicos y estudios observacionales publicados sobre AF y absentismo laboral, en inglés y en español, desde el inicio de indización hasta diciembre de 2017, utilizando la metodología PRISMA.

Resultados: Un total de 10 estudios publicados cumplieron con los criterios de elegibilidad establecidos. Las evidencias encontradas en la revisión sugieren que la AF es efectiva como medida para reducir el absentismo laboral por motivos de enfermedad. En general, los estudios observan mayores probabilidades de ausentarse del trabajo en trabajadores sedentarios que en los físicamente activos.

Conclusiones: La AF en general parece disminuir el absentismo laboral. En concreto, la AF vigorosa podría obtener mejores resultados que la realizada a intensidad moderada, aunque faltan estudios de intervención más rigurosos y específicos, con un mayor control sobre las variables de intervención.

Palabras clave: Actividad física, Absentismo laboral, Trabajadores, Absentismo debido a enfermedad.

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INTRODUCTION

The World Health Organization ranks physical inactivity as the fourth mortality risk factor worldwide[1]; a new way of life that is being set inside and outside the workplace[2]. The development of the society, and particularly the labor model in the developed countries, presents a clear trend to reduce physical activity (PA)-related caloric expenditure, which favors the occurrence of diseases related to sedentary lifestyle[3,4] and it has been associated with increased mortality[5]. Therefore, physical inactivity represents a relevant risk factor for public health, having been associated to the major non-communicable diseases such as cardiovascular diseases, type 2 diabetes[6] and 13 types of cancer[7]. Much time lying or sitting, with little caloric expenditure has been linked with obesity, type 2 diabetes, cardiovascular diseases and premature mortality, especially when inactivity is not broken with active pauses[8,9]. Hence, PA promotion, where labor workday takes too much physical inactivity, is paramount for the health of the workers and the sickness absence for the companies.

Several specific studies focused on the results of PA interventions at the workplace have shown that sickness absenteeism is often reduced[10,11,12]. However, other studies do not have confirmed those results[13,14,15] or show moderate evidence[16]. Therefore, a more detailed analysis of sickness absenteeism and its relationship with PA is required. Besides, it also seems necessary to discriminate studies with workers who perform sedentary tasks most of the time from those who do not, and to take into account whether PA is done inside or outside the workplace.

Although there is evidence of the positive effects of PA over health and work performance[4,17,18,19,20], a recent report from the National Occupational Safety Institute states that in Spain, unlike other European countries, PA promotion in the workplace is still novel as only 6% of people doing PA do it at the workplace. This fact could be due to several causes, including a lack of information about the return of investment or figures on productivity or sickness absence related to PA promotion strategies[21].

As regards economic impact cost of physical inactivity with employees, the figures of the Adecco report on absenteeism[22], concerning 2014 data on Spain, show first direct days off payment cost of 4,768 million euros to the national health system and 4,503 million euros to the companies.

Also, sedentary lifestyle cost across European Union is estimated in more than annually 80 billion euros adding both direct and indirect cost derived from medical care, medicines, functional limitations, disability and loss of independence, as well as the loss of working hours and low productivity[3].

This study aimed to review the available scientific evidence to analyze the effects of PA over workplace sickness absenteeism, taking into account the PA promotion design.

MATERIAL AND METHODS

A systematic review using PRISMA[23] procedures was conducted, and the whole review process was registered and submitted in PROSPERO systematic reviews database (Ref. Num: CRD42017072073).

Search strategy. The bibliographic search was defined using PICOS strategy (population, intervention, comparator, results and environment). Relevant studies about PA workplace effects over sickness absenteeism (time off from work due to illness) in sedentary workers in comparison to those being active were identified. An independent search through

two authors was carried out in 4 databases; Medline (PubMed), Web of Science, Embase y SportDiscus, including both English and Spanish study up to December 2017.

In order to set the search strategy for the four databases, the terms to search were identified into three categories (table 1). The first group of search terms was related to the PA independent variable (used terms: "physical activity", "physical exercise", "fitness", "sedentary", "sedentarism"). The second group of search terms was related to the sickness absenteeism dependent variable (used terms: "absenteeism", "medical leave", "sick leave", o "sickness absence"). The last search term group was the one related to population (used terms: "worksite", "workplace", "employee"). The final search strategy combined terms from the table 1 relating population with PA and absenteeism with the following limits: field: "title/abstract", language: "English/Spanish", type of article: "clinical trial/observational study". The range of search was extended to the related articles and the bibliography of the recovered articles.

Eligibility criteria:

– Inclusion criteria. Original studies which accomplished the following inclusion criteria were chosen:

i) Subjects of 18 years old or more (working legal age without parental permission in Spain) with sedentary occupational activity.

ii) Including any way of PA assessment as independent variable.

iii) Including company or self-reported sickness absence results in days.

iv) Experimental or clinical and observational studies.

– Exclusion criteria. Articles with subjects diagnosed with diseases or chronic condition were discarded.

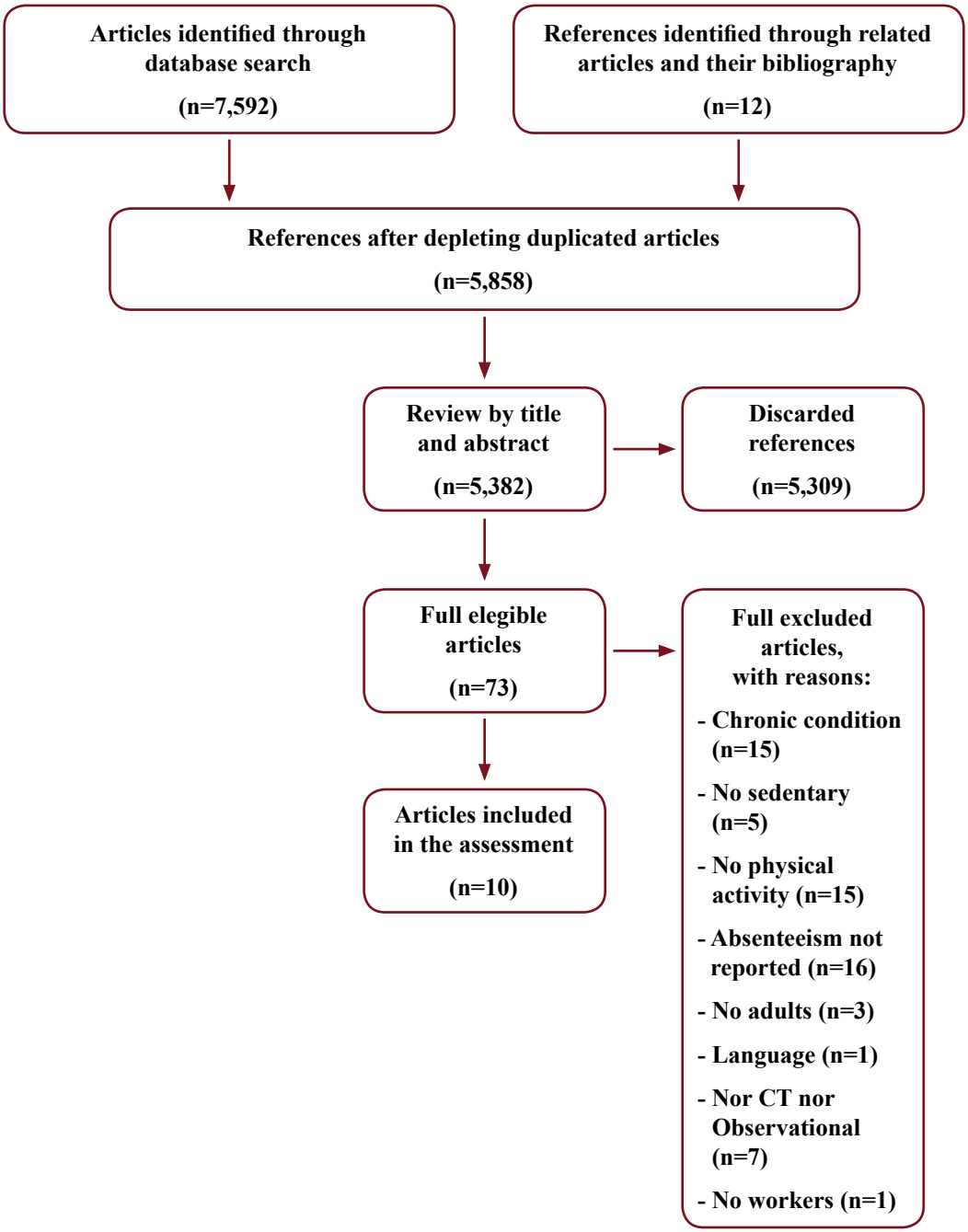
There was no disagreement about whether including articles between the two authors and, therefore, a third opinion was not necessary. There was a complete agreement between the two authors, and the kappa index[24] was 1.

Figure 1 shows the PRISMA flow chart on selected articles. A total of 7,592 original articles were identified using the defined search strategy. Twelve articles were identified as "related articles" and the cited bibliography of those. After depleting duplicated registers, it remained 5,858 original studies. Five thousand

Table 1
Search strategy used in the different databases.

Independent variable (physical activity)	Dependent variable (absenteeism)	Population
Physical activity	Absenteeism	Worksite
Physical exercise	Medical leave	Workplace
Fitness	Sick leave	Employee
Sedentary	Sickness absence	-
Sedentarism	-	-

Figure 1
Flow PRISMA chart for bibliography search.



three hundred nine articles were rejected by the reading of the title or the abstract. Of the 73 eligible studies, 63 were discarded for several reasons (figure 1).

Data extraction and quality analyses. Of the eligible articles, there were extracted, among others, the following information:

i) The principal author and the year of publication.

ii) The study design.

iii) The geographic origin of the sample.

iv) Characteristics and size sample.

v) Details about the PA intervention.

vi) The final outcome.

Concerning quality analyses of the clinical trials, the PEDro guidelines were followed [25], which gets a maximum punctuation of 11 points, whereas the STROBE[26] scale, with a maximum of 22 points, was used for observational studies.

RESULTS

Of those recovered articles (tables 2 and 3), 10 reached the eligibility criteria: 5 of which are clinical trials[27,28,29,30,31] and other 5 are observational studies[32,33,34,35,36]. The clinical trials included 4,512 participants in the intervention group and 6,483 participants as a control group. In the case of the observational studies, there were included, 20,242 participants. In general, the included studies in the review suggest an inverse association between PA and sickness absenteeism.

According to the PEDro scale, the quality of the studies for the clinical trials was ranged between 4 and 6 points (11 maximum) (table 4), whereas the range for observational studies, according to the STROBE scale, was between 11 and 19 points (22 maximum) (table 5). Sickness absenteeism was self-reported in 4 studies[31,32,34,35] and reported by the company in 6[27,28,29,30,33,36]. Concerning PA measurement, those were self-reported by the workers using different questionnaires in 9 of the studies[27,28,29,30,31,32,33,35,36] and 1 study used accelerometers[34].

Regarding the intervention control, only 1 of the studies presented an exhaustive monitoring over the participants and described PA program parameters such as contents (calisthenics, jogging, ball games), frequency (3 weekly sessions of 30 minutes long) or intensity (17 minutes over 65% of maximum heart rate)[27].

Of the five clinical trials, none of them scored in the items 3,5,6 and 7 of the PEDro scale, referred to participants allocation (Num. 3) and the study masking (Num. 5 and 6). In other cases, there were problems related to the presentation of the results[27,31], as those were not reported with group means without adjusted variability measurements.

The five clinical trials[27,28,29,30,31] show a positive effect of the PA programs over sickness absenteeism when the results between the interventions groups and the control groups are compared, either in a higher reduction of the percentage of days off from work or the overall time, measured in hours or days. There were significant differences between the pre-test and the post-test of the intervention group in 2 of them[27,29]. The study by Cox et al[27] detected statistical significant differences of 25.4% in favor of the intervention group when lowering absenteeism after the intervention term, whereas the study by Lynch et al[29] found significant differences favors to a higher days off from work reduction in both men (-0.42 ± 0.20 days), and

Table 2
Characteristics of the clinical trials included in the review.

N.	First author	Country of the sample	Design	Sample	Intervention	Results
1	Cox (1981)	Canada	CT	Employees from an insurance company (I:1,281, C:577)	30 min 3 times a week for six months Calisthenics, jogging and ball games. More 17 min over 65% of MHR	Company reported I:↓48.8% days off from work(**) C:↓23.4% days off from work
2	Baun (1986)	USA	RCT	Employees from an air conditioning cleaning company (I:221, C:296)	Self-managed training in a fitness center for one year	Company reported (absence hours) I:36.15 ± 41 C:45.02 ± 79
3	Lynch (1990)	USA	CT	Employees from a health care center (I:2,232, C:5,837)	Self-managed for 11 months, during their leisure time in the company facilities	Company reported days off from work MI:-0.42 ± 0.20(*) MC:-0.18 ± 0.19 WI:-0.99 ± 0.37(*) WC:-0.01 ± 0.27
4	Steinhardt (1991)	USA	CT	Judicial police (NPA:68, OPA:360 , RPA:306)	3 years to progress from 30% to 50% population percentile Self-managed training in the institution wellness/fitness facilities	Department reported days off from work NPA:12.46 ± 9.58 OPA:7.58 ± 6.57 RPA:7.45 ± 6.7
5	Von Thiele (2011)	Sweden	CT	Employees from a dental medical center (PA:61, RWH:51, C:65)	During 12 months 2.5 hours a week Free-chosen activity 55% to 89% MHR	Employee reported days off from work (8-29 days) PA:13% RWH:19% C:29%

(*) p<0,05; (**) p<0,001; PA=Physical activity; OPA=Occasional PA; RPA=Regular PA; C= Control group; MC=Men control; WC=Women control; CT=Controlled trial; RCT=Randomized controlled trial; MHR=Maximum heart rate; I= Intervention group; MI=Men intervention; WI=Women intervention; NPA=No PA; RWH=Reduction of working hours.

women (-0.99 ± 0.37 days) post-intervention in the intervention group.

Concerning the observational studies quality (table 5), 4 out of 5 studies[33,34,35,36] show a high score on the STROBE scale. The weakest points of these studies were the items number 1 and 4, regarding the study design, the item number 9 related to the risk of bias and its possible effect and, last, the item number 21, given its little or null discussion over results generalization. The study by Bowne et al[32] also showed more methodology gaps related to the study design, the intervention characteristics and the description of the possible origin of the risk of bias.

Table 3
Characteristics of the observational studies included in the review.

N.	First author	Country of the sample	Design	Sample	Exposition	Results
6	Bowne (1984)	USA	Cohort	Employees from an insurance company (I:184, C:121)	Self-managed, at least 20 min / 3 times a week within 70-80% MHR for 3-5 years during their leisure time in the company facilities	Average annual absenteeism reported by employees (days) I:3.35 C:7.30
7	Bernaards (2006)	Netherlands	Cohort	Office and technician workers <1 day a month 1-3 days a month 1-2 days a month ≥Three days a week (n=1,747)	Four months with a self-managed frequency by the employee	Annual absenteeism reported by the company (21 days or more) /gender adjusted <1 day a month OR: ref.1-3 days a month OR: 0.55 (0.25 -1.40) 1-2 days a week OR: 0.4 (0.20-0.90)(*) ≥Three days a week OR: 0.3 (0.10-1.20)
8	Proper (2006)	Netherlands	Cross-sectional	Representative sample of two national surveys with Holland workers (OBIN n=5,070, POLS n=8,893) OBIN-NPA:27.1% OBIN-MPA:44.8% OBIN-VPA:28.1% POLS-NPA:32.3% POLS-MPA:50.2% POLS-VPA:17.5%	Employee reported through questionnaire	Two last months absenteeism reported by the employee (days) OBIN-NMPA: 2.18 ± 7.88 OBIN-MPA: 2.34 ± 8.48 OBIN-NVPA: 2.43 ± 8.58 OBIN-VPA: 1.85 ± 7.11 POLS-NMPA: 2.21 ± 7.81 POLS-MPA: 2.40 ± 8.15 POLS-NVPA: 2.31 ± 7.98 POLS-VPA: 1.89 ± 7.19 OBIN VPA frecuency: 0 days/week: 2.74 ± 9.27 1 day/week: 2.30 ± 8.27 2 days/week 2.01 ± 7.56(*) 3 days/week 1.72 ± 6.54(**) 4 days/week or more: 1.96 ± 7.53(*) POLS VPA frecuency: 0 day/week: 2.45 ± 8.13 1 day/week: 2.05 ± 7.81 2 days/week: 1.92 ± 7.43 3 days/week: 1.55 ± 6.06(**) 4 days/week or more: 2.08 ± 7.77
9	Tolonen (2016)	Finland	Cohort	Helsinki council city servants NPA:842 MPA:1,849 VPA:1,244	Employee reported through questionnaire	Absenteeism got from the employer for 3 years (1 to 14 days) NPA:20.3 ± 24.90 days MPA:18.6 ± 20.90 days VPA: 15.5 ± 19.40 days(***)
10	Losina (2017)	USA	Cohort	Medical center workers 0-74 min week:148 75-149 min week:83 ≤150 min week:61	6 months PA hours registered through accelerometers	Absenteeism reported by the employee 0-74 min week: RR 4,106 (2.00-8.40) 75-149 min week: RR 2.72 (1.42-5.19) ≥150 min week: ref.

(*) p<0,05; (**) p<0,01; (***) p=0,0001; MPA=Moderate PA; VPA=Vigorous PA; C= Control group; MHR=Maximum heart rate; I= Intervention group; NPA=No PA; NMPA=No moderate PA; NVPA=No vigorous PA; OBIN= Injures and PA in Holland; OR=Odds Ratio; POLS=Permanent study of life conditions; RR=Relative risk.

Table 4
PEDro scale for experimental studies quality assessment.

Studies	Eligibility	Randomization	Allocation	Homogeneity of the groups	Blinding of the subjects	Blinding of the therapists	Blinding of the assessors	Key outcome measurement	Display of the results	Statistical comparison	Measurement and variability	Total
	1	2	3	4	5	6	7	8	9	10	11	
Baun (1986)	x	x	-	-	-	-	-	x	x	x	x	6
Cox (1981)	x	-	-	x	-	-	-	-	x	x	-	4
Lynch (1990)	x	-	-	-	-	-	-	x	x	x	x	5
Steindhardt (1991)	x	-	-	-	-	-	-	x	x	x	x	5
Von Thiele (2011)	x	x	-	-	-	-	-	x	-	x	x	5

Table 4
PEDro scale for experimental studies quality assessment.

Studies	Design	Background	Objectives	Design II	Setting	Participants	Variables	Data sources	Bias	Study size	Variables II	Statistics	Results I	Results II	Results III	Results IV	Other analyses	Key results	Limitations	Interpretation	Generalizability	Funding	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Bowne (1984)	x	x	x	-	x	x	-	x	-	x	-	-	x	x	-	-	-	-	x	-	-	x	11
Bernaards (2006)	x	x	x	-	x	x	x	x	-	-	x	x	x	x	x	x	x	x	x	x	-	x	18
Proper (2006)	x	x	x	x	x	x	x	x	-	-	x	x	x	x	x	x	x	x	x	x	-	-	18
Tolonen (2016)	-	x	x	x	x	x	x	x	-	-	x	x	x	x	x	x	x	x	x	x	x	x	19
Losina (2017)	-	x	x	x	x	x	x	x	-	-	x	-	x	x	x	x	x	x	x	x	-	x	17

The five observational studies reported an inversed relationship between PA levels and the sick leave days[32,33,34,35,36]. That inverse association was informed as statistically significant in two of them[33,36].

Four studies show a dose-response association between the PA parameters such as volume or intensity and the sickness absenteeism of the workers when groups are stratified by the PA variable[33,34,35,36]. The direction of the association of these studies shows that, when measured PA, either measured in minutes, days or intensity, increases, the days of sickness absenteeism decreases. An odds ratio (OR) in favor of the sickness absenteeism reduction (OR 0.4; 95% CI 0.20-0.90), was detected with those participants exercising 1 or 2 times a week in the study by Bernaards et al[33]. Whereas the study by Losina et al[34] pointed that the relative risk (RR) of being off from work due to illness multiplied by more than 4 with the least PA quantity group (RR=4,106; 95% CI 2.00-8.40).

When PA was stratified by level of intensity, both the study by Proper et al[35] (1.85 ± 7.11 days) (1.89 ± 7.19 days) and the study by Tolonen et al[36] (15.50 ± 19.40 days) found less days of sickness absenteeism with the groups declaring do vigorous PA. In the case of the study by Proper et al[35], the number of days off from work due to illness was lower when training at vigorous intensity three days a week (1.72 ± 6.54 days) (1.55 ± 6.06 days).

DISCUSSION

The effect of the results varies depending on the studies, being difficult to compare among them because the data on absenteeism are reported in different ways or are adjusted by other variables such as sex or age. Steindhart et al[30] show a remarkable dose-response regarding PA volume, with less number of days a year off from work for those groups doing PA. That group doing more PA was the one which absents five days a year less from work than the control group.

In the study by Losina et al., PA is measured by accelerometry[34], whereas in the rest of the studies, PA is self-reported. The objective measurement of PA through accelerometry, instead of being taken by questionnaires, has been suggested by several authors as a necessity to improve quality research on this field[12,37]. Regarding absenteeism, only two studies include company reports[33,36] and the rest self-report this variable through not validated questionnaires, which points to a possible measurement risk of bias of sickness absenteeism.

It is remarkable the dose-response relationship in the study by Tolonen et al., with a difference of 5 fewer days off from work and minus 663 euros of estimated cost per worker in favor to the vigorous PA group when compared to the group which did not reach the recommended minimum levels[36]. However, it is in the study developed with Holland workers[35] in which the strongest dose-response associations take place, resulting in an appropriate weekly training level of 3 days of vigorous PA to get the highest reduction of absenteeism.

In brief, there have been found studies that report four times higher relative risk of being off from work due to illness when comparing workers doing with workers not doing PA[34], and a 5 annual days of difference between intervention and control groups showing less levels of absenteeism in the first ones[30,36]. Dose-response associations related to PA volume[33,34,35] and PA intensity[35,36] have already been detected.

It is possible to suggest a reinforcement of the association between PA and a sickness absenteeism decrease owing to the dose-response found in one of the clinical trials[30]

and four observational studies[33,34,35,36], which occurs with both short term sick leaves[36] and long term sick leaves[33,34]. However, not all the scientific literature on the issue has found that association[38]. That lack of agreement in the results could be due to the fact sedentarism have not been used as a feature of the subjects when stablishing eligibility criteria, which could result in determinant as the less active subjects could be the ones who benefit more from PA as a way to improve their health and diminish the absenteeism[21].

The present review has considered each PA intervention or PA exposition, either inside or outside the workplace. There have been found studies of the two mentioned types and the place or the time have not being considered not to diminish the number of the eligible articles. In any case, there seems to be a wide margin of improvement regarding intervention control and the quality of the studies in both cases; inside and outside the workplace[11,13,19,20,37,38].

The limitations of the selected studies are related to the fact that most of them, present self-reported PA; only one study[34] measured daily PA of the subjects objectively with accelerometers. That issue could represent a clear risk for the internal validity of most of the studies included in the present review. On the other hand, the description of the PA characteristics is a point to improve in most of the experimental studies. Another limitation is the fact that some of the reviewed studies have been carried out during the decades of the 1980 and 1990, which could point out a possible limitation in the generalization of the results as the habits of the societies from those times could have changed in comparison with the current ones. The option of including the oldest studies allowed the inclusion of higher number of studies in the review, although the risk of bias could increase when comparing studies with each other, as there are possible changes in the criteria and evidences.

In conclusion, less sickness absence is observed when comparing workers who usually do with those who do not do PA. It mainly occurs with vigorous intensity PA characterized by training of 1 to 3 weekly sessions. In order to generalize these results, research with more control over training variables and greater precision in the PA program definitions (length, intensity, content and frequency) in order to accurately define the more effective and rigorous PA strategies to reduce sickness absenteeism.

REFERENCES

1. World Health Organization. Global recommendations on physical activity for health. Geneva: WHO; 2010.

2. Crespo-Salgado JJ, Delgado-Martín JL, Blanco-Iglesias O, Aldecoa-Landesa S. Basic guidelines for detecting sedentarism and recommendations for physical activity in primary care. Aten Primaria. 2015;47:175-83.

3. Centre for Economics and Business Research. The economic cost of physical inactivity in Europe. London: ISCA / Cebr report; 2015.

4. Odeen M, Magnussen LH, Maeland S, Larun L, Eriksen HR, Tveito TH. Systematic review of active workplace interventions to reduce sickness absence. Occup Med (Lond). 2013;63:7-16.

5. Arem H, Moore SC, Patel A, Hartge P, Berrington de Gonzalez A, Visvanathan K et al. Leisure time physical activity and mortality: a detailed pooled analysis of the dose-response relationship. JAMA Intern Med. 2015;175:959-67.

6. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. 2012;380:219-29.

7. Moore SC, Lee IM, Weiderpass E, Campbell PT, Sampson JN, Kitahara CM et al. Association of Leisure-Time Physical Activity With Risk of 26 Types of Cancer in 1.44 Million Adults. JAMA Intern Med. 2016;176:816-25.

8. Healy GN, Dunstan DW, Salmon J, Cerin E, Shaw JE, Zimmet PZ, et al. Breaks in sedentary time: beneficial associations with metabolic risk. Diabetes Care. 2008;31:661-6.

9. Wilmot EG, Edwardson CL, Achana FA, Davies MJ, Gorely T, Gray LJ et al. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. Diabetologia. 2012;55:2895-905.

10. van den Heuvel SG, Boshuizen HC, Hildebrandt VH, Blatter BM, Ariens GA, Bongers PM. Effect of sporting activity on absenteeism in a working population. Br J Sports Med. 2005;39:e-15.

11. Conn VS, Hafdahl AR, Cooper PS, Brown LM, Lusk SL. Meta-analysis of workplace physical activity interventions. Am J Prev Med. 2009;37:330-9.

12. Amlani NM, Munir F. Does physical activity have an impact on sickness absence? A review. Sports Med. 2014;44:887-907.

13. Proper KI, Staal BJ, Hildebrandt VH, van der Beek AJ, van Mechelen W. Effectiveness of physical activity programs at worksites with respect to work-related outcomes. Scand J Work Environ Health. 2002;28:75-84.

14. Aldana SG, Pronk NP. Health promotion programs, modifiable health risks, and employee absenteeism. J Occup Environ Med. 2001;43:36-46.

15. Hendriksen IJM, Bernaards CM, Steijn WMP, Hildebrandt VH. Longitudinal Relationship Between Sitting Time on a Working Day and Vitality, Work Performance, Presenteeism, and Sickness Absence. J Occup Environ Med. 2016;58:784-9.

16. Parks KM, Steelman LA. Organizational Wellness programs: A meta-analysis. J Occup Health Psychol. 2008;13:58-68.

17. Schroer S, Haupt J, Pieper C. Evidence-based lifestyle interventions in the workplace--an overview. Occup Med (Lond). 2014;64:8-12.

18. Proper KI, Heymans MW, Paw M, van Sluijs EMF, van Poppel MNM, van Mechelen W. Promoting physical activity with people in different places - A Dutch perspective. J Sci Med Sport. 2006;9:371-7.

19. White MI, Dionne CE, Wärje O, Koehoorn M, Wagner SL, Schultz IZ et al. Physical activity and exercise interventions in the workplace impacting work outcomes: A stakeholder- centered best evidence synthesis of systematic reviews. Int J Occup Environ Med. 2016;7:61-74.

20. Pereira MJ, Coombes BK, Comans TA, Johnston V. The impact of onsite workplace health-enhancing physical activity interventions on worker productivity: a systematic review. Occup Environ Med. 2015;72:401-12.

21. Instituto Nacional de Seguridad, Salud y Bienestar en el Trabajo. Beneficios del fomento de la actividad física y la práctica deportiva, en términos de mejora de la salud, el-bienestar y la productividad empresarial. Madrid: Instituto Nacional de Seguridad, Salud y Bienestar en el Trabajo (INSSBT); 2017.

22. Adecco. IV Informe Adecco sobre absentismo laboral. Madrid: Adecco; 2015.

23. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4:1.

24. Cohen JA. Coefficient of Agreement for Nominal Scales. Educ Psychol Meas. 1960;20:37-46.

25. Verhagen AP, de Vet HC, de Bie RA, Kessels AG, Boers M, Bouter LM et al. The Delphi list: a criteria list for quality assessment of randomized clinical trials for conducting systematic reviews developed by Delphi consensus. J Clin Epidemiol. 1998;51:1235-41.

26. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61:344-9.

27. Cox M, Shephard RJ, Corey P. Influence of an employee fitness programme upon fitness, productivity and absenteeism. Ergonomics. 1981;24:795-806.

28. Baun WB, Bernacki EJ, Tsai SP. A preliminary investigation: effect of a corporate fitness program on absenteeism and health care cost. J Occup Med. 1986;28:18-22.

29. Lynch WD, Golaszewski TJ, Clearie AF, Snow D, Vickery DM. Impact of a facility-based corporate fitness program on the number of absences from work due to illness. J Occup Med. 1990;32:9-12.

30. Steinhardt M, Greenhow L, Stewart J. The relationship of physical activity and cardiovascular fitness to absenteeism and medical care claims among law enforcement officers. Am J Health Promot. 1991;5:455-60.

31. von Thiele Schwarz U, Hasson H. Employee self-rated productivity and objective organizational production levels: effects of worksite health interventions involving reduced work hours and physical exercise. J Occup Environ Med. 2011;53:838-44.

32. Bowne DW, Russell ML, Morgan JL, Optenberg SA, Clarke AE. Reduced disability and health care costs in an industrial fitness program. J Occup Med. 1984;26:809-16.

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;63:10-6.

34. Losina E, Yang HY, Deshpande BR, Katz JN, Collins JE. Physical activity and unplanned illness-related work absenteeism: Data from an employee wellness program. PLoS One. 2017;12:e0176872.

35. Proper KI, van den Heuvel SG, De Vroome EM, Hildebrandt VH, Van der Beek AJ. Dose-response relation between physical activity and sick leave. Br J Sports Med. 2006;40:173-8.

36. Tolonen A, Rahkonen O, Lahti J. Leisure-time physical activity and direct cost of short-term sickness absence among Finnish municipal employees. Arch Environ Occup Health. 2017;72:93-8.

37. Neuhaus M, Eakin EG, Straker L, Owen N, Dunstan DW, Reid N et al. Reducing occupational sedentary time: a systematic review and meta-analysis of evidence on activity-permissive workstations. Obes Rev. 2014;15:822-38.

38. Amlani NM, Munir F. Does Physical Activity Have an Impact on Sickness Absence? A Review. Sports Med. 2014;44:887-907.