



Effects of a Worksite Intervention to Promote Physical Activity on Cardiometabolic Health During Covid-19 Lockdown

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Abstract

Introduction: Active people have a lower risk of developing multiple diseases. However, approximately one third of adults do not reach the minimum recommended levels of physical activity, situation that was aggravated during the COVID-19 pandemic.

Objective: This research studied the impact of a physical activity promotion program to improve different cardiovascular risk factors of workers during the COVID-19 pandemic.

Methods: 54 office workers (17 women; 47.0 ± 9.1 years) participated in the study. The 19-week intervention was based on the theoretical model of behavior change Behavior Change Wheel and included the prescription of an individualized physical activity (PA) program and nine workshops to increase the participants' knowledge about the positive impact of physical activity on health.

Results: The intervention shown to reduce body weight, body mass index, waist circumference, mean arterial pressure and glycosylated hemoglobin concentration and it also appears to contribute modestly to reduce the risk of metabolic syndrome.

Keywords: Workplace; Health Promotion; COVID-19; Physical Activity; Metabolic Risk

Introduction

SARS-CoV-2 (COVID-19) started in December 2019, and was declared a global pandemic by the WHO on March 11, 2020 [1]. One of the main measures that many countries adopted to contain the spread of the virus was home confinement. Most research indicates that during confinement the level of physical activity was reduced, the time dedicated to sedentary behaviors increased and, in general, there was a worsening of eating behaviors [2] and an increase in body weight [3,4]. This finding suggests that cardiovascular and metabolic health in general population worsen during COVID-19 pandemic, and the few studies that have analyzed changes in biochemical health indicators during the lockdown shows that [5,6].

In this unexpected context, our research group was implementing a workplace physical activity intervention in a technological multinational enterprise in Spain, so the intervention was coincident in the time with the extension of the COVID-19 pandemic in Europe. The program of physical activity promotion was

not suspended, just adapted to the extraordinary circumstances changing face-to-face interaction for online-interaction, and training activities for those modalities that could be done according to restrictions in every time.

The relation between physical activity and health are well established and current evidence supports that active people have a lower risk of suffering from multiple diseases compared to those with a lower level of physical activity [7]. Specifically, effects of physical activity on cardiovascular and metabolic are especially strong and are well documented [8]. Despite this evidence, more than 27% of the adult population worldwide [9] and more than 35% of Spanish adults do not reach the minimum recommended levels of physical activity [10].

Currently, a large part of the population spends most of their time in a waking state in the workplace [11]. For this reason, the World Health Organization maintains that the workplace is an ideal place to implement programs to reduce the risk of cardiovascular

diseases, diabetes, or obesity [12], due to its great potential in relation to health. Numerous studies have analyzed the impact of physical activity programs at work on different health indicators. There are promising results in relation to the improvement of body weight, BMI, or waist circumference [13], but there are contradictory conclusions about the effects on several cardiometabolic risk factors such as blood pressure, serum lipids or blood glucose [14]. Also, the most rigorous reviews highlight that the heterogeneity of the interventions and the poor methodological quality of much of the research still prevent the establishment of solid evidence on the real impact of these programs. The most recurrent limitations pointed out are the absence of some theoretical model of behavior change that supports the interventions [15], the necessity of precise and in-depth information about the design of the interventions [16] and the development of interventions focused exclusively on physical activity, since the multicomponent design makes it difficult to interpret the results [17].

Given this situation, this research studied the impact of a physical activity promotion program to improve health in the workplace in a unique and unexpected situation, the harder period of the COVID-19 pandemic in Europe between March and June of 2020, analyzing its effects on several cardiometabolic risk factors, including anthropometric, fitness and biochemical ones.

Materials and Methods

Participants

A total of 82 workers signed the informed consent form of the study and were qualified as suitable for the practice of physical activity by the company's medical services. They started the program and did initial assessment, but 11 participants (13%) dropped out from the study by job rotation (6 subjects) or personal motivations (5 subjects). Other 17 subjects (20%) took part in the program, but they did not attend with the company's medical service for clinical assessment and blood extraction at post-intervention appointment. Therefore, a total of 54 office workers (17 women; 47.0 ± 9.1 years; height: 1.73 ± 0.09 meters; body weight: 78.2 ± 13.0 kg; BMI: 26.1 ± 3.9 kg/m²) had anthropometric, physical, and biochemical pre- and post-intervention data to be included in the analysis, which means two-third of initial sample. Performing a sensitivity analysis using the G*Power program [18], revealed that this sample could detect a small-moderate effect ($f = 0.21$) with a statistical power of 80% for the tests used during the study.

The study was conducted in accordance with the Declaration of Helsinki and Spanish legislation on biomedical research and data protection and was approved by the Research Ethics Committee of the Autonomous University of Madrid (CEI -1021946).

Intervention design

Following previous recommendations about gaps on research design of health workplace interventions [16] the intervention was based on the theoretical model of behavior change Behavior Change Wheel (BCW). It proposes the need to: i) define the determinants of behavior using the COM-B model (capacities, opportunities and motivations that determine the behavior), ii) select the intervention functions and iii) select adequate behavior change techniques [19]. Figure 1 shows the selection made for the purpose of this study. Behavior change techniques are coded (numbers in brackets in the figure) according to Michie., *et al.* [20].

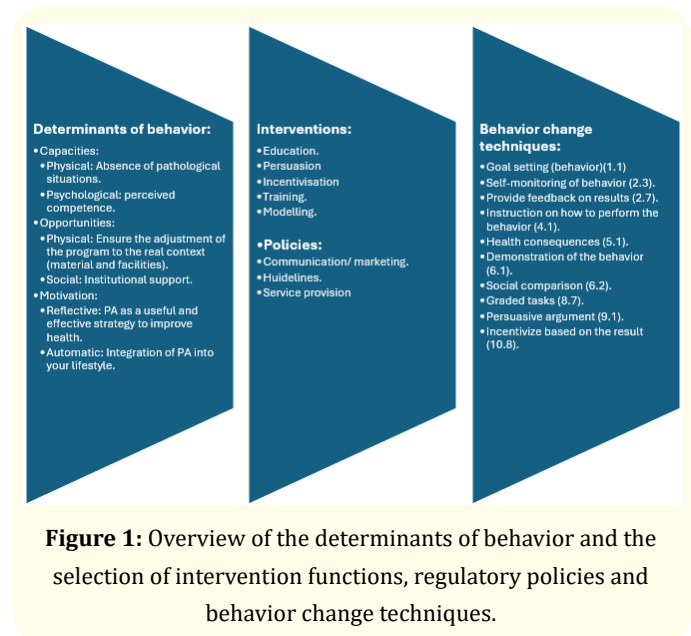


Figure 1: Overview of the determinants of behavior and the selection of intervention functions, regulatory policies and behavior change techniques.

The intervention lasted 19 weeks (February-June 2020) in which 9 workshops were held, lasting approximately 20 minutes, with the aim of increasing the knowledge of the participants about the positive impact of physical activity on health. Initially they were held every 15 days in person, although after the outbreak of the COVID-19 health crisis (March 10, 2020) they were held by video-conference with the same frequency. Likewise, a physical activity program was prescribed, sent, and commented with each participant, complying with the principles of individualization and progression in training, which included strength, resistance, and range of motion/flexibility exercises.

Lastly, physical activity was recorded every week through the sum of arbitrary units (AU) from the session-RPE quantification method [21]. The competitive element was conveyed through the publication of partial (weekly) and general classifications (computing the total sum of the project) in which the participants who have accumulated more UA were highlighted on standings.

Assessments and evaluation instruments

Both at the beginning and at the end of the 19 weeks of intervention, all the participants were measured and weighed, obtaining the necessary data to calculate the BMI (weight/height²). Likewise, systolic, and diastolic blood pressure was measured, allowing the calculation of mean blood pressure ($0.33*SBP + 0.66*DBP$). Hand grip strength was also measured (TKK 5401 Grip-D hand dynamometer, Takei Scientific Instruments Co., Ltd, Nigata City, Japan). Finally, blood samples were taken from an antero-ulnar vein using the Vacutainer technique. Thanks to this procedure, data on the following variables were obtained: glucose, glycosylated hemoglobin (HbA1c), triglycerides, total cholesterol, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C).

Participants were considered to have metabolic syndrome if they met three or more of the following criteria [22]: i) waist circumference ≥ 102 cm in men or ≥ 88 cm in women [23], ii) systolic/diastolic blood pressure $\geq 130/85$ mm Hg or people on medication, iii) triglycerides ≥ 150 mg/dl, iv) HDLc < 40 mg/dl in men or < 50 mg/dl in women and v) fasting glucose ≥ 100 mg/dl or medicated persons. In addition, a continuous indicator of metabolic syndrome, called MetScore, was calculated following the guidelines offered by Eisenmann [24]. For this purpose, waist circumference, mean arterial pressure, triglycerides, HDLc, and fasting glucose were selected. Then, all the variables were standardized using the aforementioned cut-off points [22,23] and the typical deviations of each of them at the population level [25]. This indicator reports how many standard deviations each measurement separates from the normative cut-off point. Negative values of this indicator indicate values below the normative cut-off point, while positive values indicate values above it. Its calculation is done using the following

MetScore of each variable = (value - normative cut-off point) / population standard deviation

After performing this procedure, the global MetScore was calculated by averaging the five variables.

Finally, the IPAQ questionnaire to assess the level of physical activity, developed by Craig, *et al.* [26] and subsequently translated and validated for the Spanish population [27] was used.

Statistical analysis

Normality was checked using the Kolmogorov-Smirnov test. The student's t-test was used to compare two related samples, the McNemar test to compare intragroup proportions in the weight status variable, and the chi-square test to compare percentages. In all cases, the level of significance was established at $p < .05$. Finally, the effect size was calculated using Cohen's d_c [28], for the related

samples t-test and Cramer's V (equivalent of ϕ) for the McNemar test [29].

Results

Table 1 shows that there was a statistically significant reduction in weight, BMI, waist circumference, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and glycosylated hemoglobin (HbA1c). In addition, hand grip strength improved significantly. The effect size of the observed changes was moderate for waist circumference, SBP, DBP, MAP, HbA1c (ES = 0.24-0.47) and low for the rest of the variables (ES < 0.20).

	Overall (n = 54)			
	Pre	post	p	ES
Weight (kg)	78.2 (13.0)	76.6 (12.8)	.007	0.12
BMI (kg/m ²)	26.1 (3.95)	25.6 (3.99)	.010	0.13
Weight status, n (%)				
Normal weight	24 (44.4)	27 (50.0)	.276	0.15
Overweight	22 (40.7)	22 (40.7)		
Obesity	8 (14.8)	5 (9.3)		
Waist circumference (cm)	95.1 (11.6)	92.4 (11.8)	.000	0.24
SBP (mmHg)	115 (16.2)	112 (15.8)	.040	0.23
DBP (mmHg)	76.8 (11.3)	72.9 (11.3)	.005	0.34
MAP (mm/Hg)	89.6 (13.0)	85.8 (12.2)	.007	0.31
Triglycerides (mg/dl)	83.1 (36.1)	82.0 (30.2)	.791	0.03
Total cholesterol (mg/dl)	189 (33.9)	185 (28.9)	.143	0.11
cHDL (mg/dl)	59.9 (15.1)	59.2 (13.7)	.427	0.05
cLDL (mg/dl)	113 (29.3)	110 (25.0)	.123	0.12
Glucose (mg/dl)	86.5 (10.4)	86.0 (8.0)	.680	0.06
HbA1c (%)	5.12 (0.29)	4.99 (0.29)	.000	0.47
Manual dynamom. dom (kg)	37.8 (11.8)	39.6 (11.6)	.002	0.15
Manual dynamom. not dom (kg)	36.1 (10.6)	37.9 (11.2)	.000	0.16
Total Physical Activity (METS/wk)	1311.4 (893.8)	1925.6 (1062.6)	.000	0.54

Table 1: Effect of the program on different cardiovascular risk factors.

Results are presented as mean (standard deviation). Significance levels $< .05$ appear in bold. *Tendentially significant ($p > .050$ and $< .100$). BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: mean arterial pressure; cHDL: cholesterol associated with high-density lipoproteins; cLDL: cholesterol associated with low-density lipoproteins; HbA1c: glycosylated hemoglobin. ES: Effect size calculated through the d_c Cohen's with Dunlap's correction (Interpretation: < 0.20 no effect, 0.20-0.49 small, 0.50-0.79 medium, > 0.80 large). In the weight status variable, the ES was calculated through Cramer's V (Interpretation: < 0.2 without effect, 0.2-0.6 moderate effect, > 0.6 large effect).

As can be seen in figure 2, the proportion of participants with metabolic syndrome, or any of the associated risk factors, was reduced during the intervention. This reduction was statistically significant for blood pressure and waist circumference ($p = .031$ and $p = .016$, respectively).

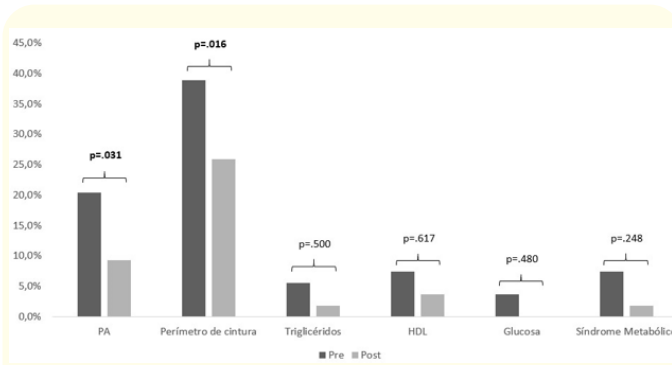


Figure 1: Evolution of the prevalence of risk factors related to metabolic syndrome (n = 54).

Resulting level of significance after applying the chi-square test for contrasting percentages. Significance levels $< .05$ appear in bold. Criteria to consider a risk factor: blood pressure (BP) $\geq 135/85$ mm Hg; waist circumference > 102 cm in men and > 88 cm in women; triglycerides ≥ 150 mg/dl; high-density lipoprotein (HDL) cholesterol < 40 mg/dl in men and < 50 mg/dl in women; glucose ≥ 100 mg/dl. The clinical identification of metabolic syndrome occurs by adding 3 or more of the above risk factors.

The intervention was shown to have a statistically significant effect in reducing the risk of metabolic syndrome assessed by the continuous indicator MetScore ($p = .021$), apparently as a consequence of the reduction in waist circumference ($p < .001$) and MAP ($p = .008$), as can be seen in table 2.

	Overall (n = 54)			
	Pre	post	p	ES
Waist circumference	-0.16 (1.18)	-0.44 (1.20)	.000	0.24
Triglycerides	-1.01 (0.67)	-0.99 (0.56)	.710	0.03
HDLc	-2.03 (1.63)	-1.96 (1.57)	.562	0.04
PAM	-0.72 (0.96)	-1.01 (0.94)	.008	0.30
Glucose	-0.69 (0.58)	-0.71 (0.46)	.778	0.04
MetScore	-0.93 (0.65)	-1.04 (0.59)	.021	0.16

Table 2: Effect of the program on metabolic risk.

Results are presented as mean (standard deviation). Significance levels $< .05$ appear in bold. * Tendentially significant ($p > .050$ and $< .100$). cHDL: cholesterol associated with high-density lipoproteins; MAP: mean arterial pressure. MetScore: global indicator of metabolic risk (higher values indicate greater metabolic risk). ES: Effect size calculated through the d_c Cohen's with Dunlap's correction (Interpretation: < 0.20 no effect, $0.20-0.49$ small, $0.50-0.79$ medium, > 0.80 large).

Discussion

This research studied the impact of a workplace physical activity promotion program during the COVID-19 pandemic on different cardiovascular and metabolic risk factors and has been shown to reduce body weight, BMI, waist circumference, SBP, DBP, MAP and HbA1c concentration. Consequently, it also appears to contribute to lower the risk of metabolic syndrome.

The participants in this study reduced their weight by an average of 1.55 kg. Consequently, the BMI was also reduced from 26.1 kg/m² to 25.6 kg/m². Likewise, the waist circumference decreased by 2.7 cm on average. These results agree with what was published by different authors, who reported reductions of between 1.2 and 1.6 kg in weight, between 0.46 and 0.55 kg/m² in BMI and between 1.9 and 2.7 cm in waist circumference after interventions of 6 months in the work environment [30] and are superior to those reported by previous studies in Spain [31,35]. However, our results are not as positive as those presented in other publications, whose sample included exclusively overweight or obese people [33-35].

The results of our study reveal mean reductions of 3.7 mm Hg in SBP and 3.9 mm Hg in DBP. Consequently, MAP was reduced by 3.8 mm Hg. These results are better than those published in most previous investigations, as reflected in the meta-analysis carried out by Mulchandani, *et al.* The studies that reported greater reductions than in our study were carried out on samples with higher baseline blood pressure values and had much longer intervention periods than in our study (12-48 vs 4 months) [36,37].

In our study, no statistically significant differences were found between the moments before and after the intervention in any of the variables related to lipids, although the mean values slightly decreased. Previous studies have shown conflicting results on these variables and very linked to the initial levels [34-39]. In our study, the initial level of triglycerides (83 mg/dl), total cholesterol (189 mg/dl) was quite low, so it could be expected that its reduction would be complicated and would not necessarily imply an improvement in relation to cardiovascular risk, since the starting level was within of normative values.

Finally, after the intervention, glucose levels remained stable at around 86 mg/dl in our study. This result is in line with what was published by Mulchandani, *et al.* [14], whose meta-analysis revealed the absence of significant reductions in glucose after physical activity interventions from the workplace. However, we found that HbA1c decreased in a statistically significant way, from 5.12% to 4.99% on average. This is a variable that has been included much less commonly in previous studies. Chen, *et al.* [30] found no relevant changes in this indicator (6.26% vs 6.25%) after 24 weeks of intervention based on counseling in relation to healthy behaviors. Another study conducted by Barham, *et al.* [40] in workers at risk

of diabetes was also not effective in significantly reducing HbA1c after 12 months of intervention. In contrast, Kramer, *et al.* [34] reported a statistically significant decrease in this variable after a 12-month program but reach a more moderate decrease than that presented in our study.

In line with the conclusions of the main reviews and meta-analyses carried out to date [13,14], baseline values in the variables studied seem to influence the results of workplace physical activity programs. Comparing our results with previous publications, only those studies conducted on participants with increased cardiovascular risk obtained greater reductions in the main cardiovascular risk factors.

Another variable that seems to influence the results is the duration of the intervention. Longer interventions seem to be more effective in reducing blood pressure [39], lowering total cholesterol [38], or increasing HDL-C [41]. This could be another of the reasons why no statistically significant changes in lipids were reported during our intervention, which lasted 4 months.

In addition, this study analyzed the effects on the prevalence of metabolic syndrome, as well as on each of the indicators that comprise it. As shown in figure 1, the percentage of people with metabolic syndrome was reduced after the intervention. The percentage of people with elevated levels in all five indicators of metabolic syndrome (glucose, HDL, triglycerides, waist circumference and blood pressure) was also reduced. The reductions in the blood pressure and waist circumference indicators turned out to be statistically significant. Likewise, after the intervention, an improvement in the MetScore as continuous metabolic risk indicator was observed.

These results agree with what was previously established by different authors, who have highlighted the importance of increasing the volume of physical activity and physical condition to prevent and improve the prognosis of metabolic syndrome [42]. Likewise, the results of our intervention confirm the potential of programs to promote physical activity from the workplace to reduce the prevalence of metabolic syndrome in workers, a fact that has already been revealed by some studies that had samples with higher metabolic risk than in our study [43,44].

Another of the variables in which positive effects were found after the intervention was the hand grip strength, evaluated through dynamometry, which increased by just over 1.7kg on average in both the dominant and non-dominant hand, with respect to the initial moment. These results agree with what was published by previous studies [45,46], confirming the potential of workplace programs to promote physical activity to improve hand

grip strength, an indicator that gathers increasingly convincing scientific evidence on its relationship with health [47].

Also, to our knowledge, this was the first study to analyze the impact of a program to promote physical activity from the workplace during the COVID-19 pandemic. Several studies have looked at changes in body weight over this time interval [48,49]. On the contrary, there are very few works that have investigated the changes produced during this period in other health biomarkers. The investigations to which we have been able to access sought to study the impact of confinement on the glycemic control of patients with diabetes [6], but only one of them included data from the general population [5].

Regarding body weight, Zachary, *et al.* [4] reported that 22% of their sample gained between 2.3 and 4.5 kg of weight during this period. 35% of participants in a large study of more than 37,000 French people also reported gaining weight during lockdown, namely 1.8kg on average [48]. These results are similar to those reported by Pellegrini, *et al.* [3] on 150 Italian people, with an average increase of 1.5 kg just one month after the beginning of the confinement. Finally, a survey conducted in Spain, with a sample of 1,000 people, showed that 44% of the participants increased their weight during confinement [49]. As can be seen, most research reflects a clear trend of weight gain during the COVID-19 pandemic. It is necessary to highlight that all of them were carried out based on self-reported questionnaires. Taking as reference the study by Karatas, *et al.* [5], which compared the changes in some of the main health biomarkers of 55 people in Turkey, it is observed that the increase in weight, 6 months after the beginning of the confinement, stood at 0.54 kg on average. All these results contrast with the reduction observed in our research, in which a reduction of 1.55 kg in weight was observed between the months of February and June 2020.

The study has some limitations associated to numerous difficulties on recruitment and assessment but also several strengths because of the singularity of the moment it was done. Therefore, regarding to assessment physical activity was just subjectively assessed using IPAQ questionnaire because of budget restrictions and was not possible to assess post-intervention cardiovascular fitness by peculiarity of situation and health restrictions. On the other hand, there was not control group because of the impossibility to recruit voluntary workers who would want to take part in the research if they would not receive any intervention.

Regarding to strengths, the main one is the situation on which intervention was done and data were collected, that is unique, and therefore has produced unique data. To our knowledge, no study

has reported data about a workplace physical activity program developed on the exceptional situation on COVID-19 lockdown and following weeks.

Conclusion

As conclusion, the physical activity program was effective on improve the cardiometabolic health on workers, even in so extraordinary circumstances of lockdown and mobility restriction by COVID-19 pandemic, mainly by significative effects on body composition and blood pressure. Improvements on strength and glycosylated hemoglobin were also observed. Unfortunately, the sample size limits the ability to detect other potential improvements.

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