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Research Article

Effect on Metabolic Health and the Ability to Work With the Use of Technology Associated with Learning Healthy Habits in the Work Environment

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Abstract

Objectives: Our objective was to use high performance sports technology combined with a training program in healthy habits, to promote the acquisition of habits related to the care of metabolic health in the workplace.

Methods: Values related to body composition, heart rate variability, capacity of work (WAI) and the perception of the subjects with respect to their physical, mental and social health and their capacity to face the labor demands.

Results: Significant improvements were obtained in the percentage of water and total fat; and lean mass; as well as improved visceral fat and BMI (Body Mass Index). No significant differences were found in the HR (Heart Rate) of rest or in the maximum HR, nor in the percentage of stress or recovery, although we observed a tendency to improve the % of stress and recovery. The subjects evaluated show a general improvement in the ability to work from moderate to good.

Conclusion: The design of health improvement and promotion programs, enhanced with the use of technology with the objective of obtaining evaluation and monitoring metrics, offer a positive return on the economic investment made, improving the workers' ability to work.

ABBREVIATIONS

WAI: Work Ability Index; BMI: Body Mass Index; HR: Heart Rate; SEEDO: Spanish Society for the Study of Obesity; SD: Standard Deviation; WHO: World Health Organization; CM: Centimeters; KG: Kilograms

INTRODUCTION

At a time when everything seems to revolve around the disruptive changes in technologies, the evolution of the behavior of human life, in relation to the duration of it, presents us with necessary forecasting actions (economic, social) and prevention (health, hygiene and quality of life) that make the most of the "human experience" as a wrapping of the "customer experience", the "experience used", etc. If at first the impact on the financial is what logically concerns us most, longevity is a great challenge-opportunity for intangible health resources.

In recent years participation in medical examinations proposed by companies has decreased considerably due perhaps to a "better quality of life" compared to previous years, the lack of importance that many people attribute to them while they feel good and/or due to another cause heard in the medical services and not referenced as it is the worker's feeling that the medical examination "is useless" and that a correct assessment of occupational risks is not made.

However, many of the most common diseases of civilization occur in a totally asymptomatic way or what is the same, without they manifest in our day to day. In the most prevalent pathologies in our industrialized environment (diabetes, ischemic heart disease, obesity, COPD, etc.) it is necessary to diagnose them early in order to avoid the dreaded complications ensuring a full life development of the subject as well as a performance healthy work.

It is here that portable sensors begin to be implanted more and more in primary care, which allow the monitoring of health outside the clinical environment. Health areas such as metabolic, cardiovascular and gastrointestinal monitoring; sleep, neurology, movement disorders and mental health; maternal, pre and neonatal care; and lung health and environmental exposures

are already adopting portable sensors within their current healthcare ecosystem [1].

Specifically, metabolic health problems such as obesity is a risk factor for cardiovascular diseases, diabetes, musculoskeletal disorders, diseases associated with age such as cancer (including colon and breast cancer), Alzheimer's and sarcopenia, the loss of strength and muscle mass associated with aging [2,3]. In recent years, overweight and obesity, due to the impact they have on chronic diseases, health cost and quality of life, have become a public health problem worldwide [4,5]. In Spain, the prevalence of overweight is estimated at ~39% in adults while the prevalence of obesity is ~21% [6].

Specifically in the workplace, the Spanish Society for the Study of Obesity (SEEDO), recently presented data from the study "High prevalence of obesity in a working population in Spain", in which they analyzed a sample of 1,336,055 check-ups doctors of workers between the years 2004-2007. In this study show that more than 50% of the active working population of Spain is obese and overweight, with the prevalence of obesity higher in men than in women, and higher in manual workers than in intellectual workers.

Obesity, such as depression or alcoholism is considered one of the factors that can be inferred in labor productivity. It is believed that stress at work, produced by long working hours, characterized by periods of inactivity (i.e. many hours sitting in front of the computer), and the difficulty of eating properly in the workplace, with a tendency to high-fat meals and carbohydrates that could contribute to the increase of obesity in the work environment. The determinants of obesity and overweight include the level of studies and lifestyle [7,8].

The use of technology for weight control in people has advanced a lot in recent years. The most recent studies tell us about the advances in omic technology that allow controlling individual responses to excess weight, even if they are heterogeneous and unpredictable, combining multiple omics strategies [9]. However, when we transfer the use of technology for the improvement of health and body composition to society, it is not entirely useful on its own [10].

In recent years there are many companies that have begun to implement and promote programs / strategies of health and physical activity with the aim of improving health in general and healthy habits in particular. The most common objectives are the increase in the level of physical activity [11]; changes in nutritional habits [12] and the promotion of changes in harmful behaviors such as alcohol or tobacco consumption [13-15].

At this point where companies need better health promotion programs, absenteeism for example, in Spain, increased by 11% in 2017 compared to 2016, which implied an expense in terms of economic benefits of the Social Security equivalent to 6,614.46 million euros. To this amount it is necessary to add the direct impact that these labor losses produced to the companies, estimated in 6,273.99 million euros, and the lost opportunity cost (goods and services that stopped producing) that amounted to 63,863.20 million euros. In summary, the total cost of absenteeism in 2017 reached 76,751.65 million euros in this country (Confilegal, 2018) generating a latent need for health care in an efficient and effective way that can be maintained at short, medium long term.

Specifically, the problems of overweight and obesity are associated with a higher level of absenteeism [16], higher levels of stress and long-term health problems, taking into account the relationship between regular physical activity and exhaustion [17,18] the management of stress based on the physical and psychological demand perceived at work [19,20]; as well as physical exercise can contribute to a better mood and increased energy [21,22]. That is why the improvement of intervention programs in the field of welfare and health in the workplace become one of the key objectives and levers to promote the improvement of health and cost reduction globally.

In this regard, the research group of Crespo-Ruiz et al. [23,24], is aimed at the use of technology for the improvement of welfare and health interventions within companies. The use of technology by itself may not be positive in health management or disease prevention [10]; however, the first conclusions of the studies published to date, show how the use of high performance sports technology, accompanied by a methodology of implementation of wellness and health programs focused not only on the needs of people, but also on the future, their companies can be a useful and reliable tool that helps companies to generate sustainable improvement indicators in terms of prevention of occupational diseases such as stress. But not only high performance technology (and high economic cost) could be good indicators, since according to a study, the use of cheaper technology such as portable biosensors for the collection of physiological measurements related with health, they provide useful information to monitor personal activities and their physiology, playing an important role in health management. The great challenge is to encourage the voluntary participation of workers in increasingly digitized programs.

Based on all this and under the hypothesis that the contribution of technological tools of measurement to health and welfare programs in companies serve to provide reliable and valid feedback to workers and their companies on the impact of such programs on the improvement of the state of physical health., the objective of this study was to use high performance sports technology combined with a training program in healthy habits of 6 months, to promote the acquisition of habits related to metabolic health care in the work environment.

MATERIALS AND METHODS

Participants

The total sample of the study is 17 subjects (N = 17); 3 men and 14 women, all of them employees of the same company with different levels of responsibility (Table 1. Participants). We decided to include only one control group because were all employees of the company and if they had had separated in two groups had been too small groups. The different between men and woman were insignificant so we explain the global results about the company.

The reason why we use a pre-post study was because we consider that the results have been greatly improved due to our intervention.

Table 1: Participants.

Subject	Age (years)	Sex	Height (cm)	Weight (Kg)
1	30	Woman	152	54.00
2	31	Woman	155	105.70
3	25	Woman	163	51.90
4	31	Man	183	54.90
5	22	Woman	162	57.30
6	29	Woman	162	58.30
7	30	Woman	164	52.30
8	23	Woman	170	96.40
9	29	Man	179	76.30
10	37	Woman	175	86.40
11	24	Woman	162	47.90
12	35	Woman	174	70.70
13	26	Man	186	71.70
14	32	Woman	180	70.70
15	41	Woman	167	80.90
16	29	Woman	172	79.10
17	26	Woman	163	63.50
	29.41±5.03		168.76±9.71	69.29±16.64

Note: The variables of the group of statistical data (mean ± standard deviation). cm = centimeters, Kg = kilograms.

All subjects were healthy subjects who had not suffered any type of cardiovascular or nervous system disease/disorder. The exclusion criteria for participation in the RR interval recordings included severe heart disease, very high blood pressure (≥ 180 / 100 mmHg), type 1 or 2 diabetes with autonomic neuropathy, severe neurological disease, fever or other acute illnesses, and a BMI> 40 kg / m2. These exclusion criteria represented by the manufacturer of the analysis software are presented in detail [25]. In all cases, acceptance and voluntary and informed signing of participation in the study was indispensable.

We certify that during the course of our investigation all the regulations marked on the ethical use of human volunteers marked in the Declaration of Helsinki were followed. In addition, the personnel in charge of collecting the data of the subjects included in the study did not include in the study data that could accurately identify the worker in accordance with the requirements of the General Data Protection Regulations (RGPD) (EU) 2016/679.

Materials

For the analysis of the data, demographic data were collected, such as sex, age, height, weight and body mass index (BMI). The set of measures was adapted to the characteristics of the population analyzed following the Healthy Box® methodology (Freedom and Flow Company, Spain).

The set of measures chosen to carry out the analysis of the collective of workers of the company was composed of a bioimpedance scale BC-601 of the Tanita® ISO 9001 Certified brand, in addition, the measurement was also carried out through the device Body Guard 2 (Firstbeat Technologies Ltd, Jyva skyla, Finland) for the analysis of stress and the quality of recovery. The device is installed in the body through electrodes (non- invasive method) (Figure 1 - Firsbeat Bodyguard 2. Firstbeat Technologies Ltd).

The data was analyzed using Firstbeat Analysis Server Software (version 6.3, Firstbeat Technologies Ltd.), which includes the artifact detection and correction function for irregular ectopic beats and signal noise.

For the evaluation of the impact of the program and the use of technology in the work environment we use the "Work Capacity Index" (WAI); considers the self- evaluation capacity of workers in relation to work requirements, health status and workers' resources [26]. The WAI Scale has been used in different articles, providing adequate psychometric properties, and can therefore be used in association studies between aspects of work and its impact on health [27].

The analysis of both the data extracted from Bodyguard and data obtained from the WAI scale; were analyzed with SPSS® V.23. (SPSS Inc., Chicago, IL, USA) for Windows and the statistical treatment was carried out with SPSS statistic v.23.0.

Protocol

The protocol for collecting and analyzing the data was carried out after the acceptance of the informed consent by the workers. The Healthy Box® package was made available to the group after its analysis, being part of the program's strategy. Their results were detailed individually to each worker by professionals in the field.

The order of collection was first the bioimpedance, after which the Body Guard 2 device was installed for the analysis of the stress and the quality of the recovery. They received a device they used for 48 hours (two full business days) to ensure that, in case of device failure, electrodes or excessive sweating during the day, there would still be at least 24 hours of continuous recording. After the delivery of the device, the protocol to be followed was explained to them during the next 48 hours and they were given access to a diary where they could indicate all the activities that they carried out during the registration time, including the working hours and the time of dream.

For the analysis of the stress data, the same methodology described in the article Executive Stress Management was used: Physiological load of stress and recovery in executives on Workdays [24]. As well as more information about this method of

Figure 1 Firsbeat Bodyguard 2. Firstbeat Technologies Ltd.

analysis is available in a document from Firstbeat Technologies Ltd [28].

In Figure 2 you can observe the implemented experimental protocol.

Once analyzed the initial metabolic health profile and data related to stress levels, the report was explained individually as a training action so that they understood each variable analyzed and what could be the impact of training and the acquisition of healthy habits in each one of them.

The training program of 4 work tables was designed with the aim of establishing the bases of healthy habits necessary to improve the metabolic health of each subject. Once the 6 months had elapsed since the pre-test, the data collection protocol was replicated to obtain the post evaluation and compare the results obtained.

Variables

From the Healthy Box measurement set we analyze the following variables:

❖ **Body Composition Indicators:**

- % Body Fat: is the amount of fatty tissue that we store in the body in relation to our total body weight. We measure it in percentage.
- Lean Mass: is the amount of body tissue formed by the muscles, organs and viscera.
- Bone Mass Index: is the index corresponding to bone mineral density.
- Body Mass Index: it is the global indicator of health in which height and body weights are related.
- % Body Water: is the percentage relative to the weight corresponding to water.
- Visceral Fat: It is the fat that accumulates in the abdomen and between the internal organs.

❖ **Cardiovascular Indicators – Stress & Recovery [24]:**

- Time stress in 24 h (minutes): time in minutes of an average of 24 h reacting to stress.
- Stress Percentage (%) (% Stress): percentage of reaction to stress in an average of 24 h.
- Recovery time in 24 h (minutes): total time, measured in minutes, in which the body is recovering.
- Percentage Recovery (%) (% Recovery): percentage of total recovery time in 24 hours.
- Stress balance 24 h: determine the balance between stress and relaxation for 24 hours in the body. With this variable we can know the physiological tendency of the organism in 24 hours towards stress or relaxation.

❖ **Work Ability Index (WAI):**

The WAI, a widely used index of work ability, measures respondents' perceptions regarding their physical, mental, and social health and their ability to cope with job demands [29]. The questions cover:

- Current work ability
- Ability to work within job demands
- The number of illnesses/limitations
- Impairments affecting work ability
- The amount of sick leave taken within the last year
- An estimate of work ability within 2 years' time.

As each answer has a different score, the total work ability score is calculated by adding scores across the dimensions. The resulting score range is 7 (low work ability) to 49 (high). The authors reported a Cronbach's alpha coefficient of 0.83 and a content validity index of 0.79 [29].

Statistical analysis

All statistical analysis was performed with SPSS® V.23. (SPSS Inc., Chicago, IL, USA) for Windows. All values are shown as mean ± standard deviation (Mean ± SD).

Due to the size of the sample, less than 30 subjects, the Shapiro-Wilk test was carried out to verify the normality of the sample distribution. The level of significance was set for $p<0.05$. Those variables that followed a normal distribution were applied the Student's T-test for dependent samples (PRE-POST) with two-tailed analysis, making the comparison with a confidence interval of 0.95 percent. In case of finding differences and in order to avoid the type I error that is made when making multiple comparisons, the Bonferroni post hoc test was performed. For those variables that needed their corresponding analysis of nonparametric type, Friedman's Nonparametric Test was used. To determine between which intervals differences were obtained, we used the nonparametric test of 2 Wilcoxon-related samples. The level of significance is set at $p<0.05$.

RESULTS AND DISCUSSION

After the training program that we remembered lasted 6 months to give time to incorporate new habits or change existing ones, the results obtained, presented in the first place the data

Figure 2 Experimentation protocol study.

on metabolic health and then on the ability to work, were the following:

❖ **Body Composition Indicators:** Significant improvements (<0.05) were obtained in the percentage of water (54.13% Vs 55.94%), percentage of total fat (26.53% Vs 24.64%) and (<0.07) lean mass (46.95 Vs

48.20). It also improved visceral fat (3.71 Vs 3.35) and BMI (24.02 Vs 23.81). Table 2 - Group Results of Body Composition. shows the average group results obtained in the pre- post related to the study of body composition.

❖ **Cardiovascular Indicators – Stress & Recovery:** No significant differences were found (<0.05) neither in the resting heart rate nor in the maximum heart rate, nor in the percentage of stress or recovery, but we can observe a tendency to improve the% of stress (decreasing after the intervention) and in% recovery (increasing after the intervention). Group results of the impact on cardiovascular indicators in 24h are in Table 3.

❖ **Effect of the training program on the ability to work:** The forecast of the economic impact of the health of the team before the intervention of Freedom and Flow Company and based on the results obtained in the initial scales was estimated at ≈3000€ / person / year in costs associated with the acquisition of diseases / pathologies that suppose a disability to work and in ≈1257€ / person / year in costs for absenteeism due to illness.

The effect of health on the ability to work and stress management evaluated through health scales validated by the national health system and the World Health Organization (WHO) show a general improvement of the capacity of moderate to good. that in numerical terms it means savings in disability costs to work per person / year from 3000€ to 1557€ and a saving in the costs of absenteeism per person / year from 1257€ to 643€ (data calculated from the studies carried out by the Finnish Institute of Occupational Health, experts in occupational medicine in 2011).

In total, and only taking into account this economic parameter, the training project and the improvements that the training of healthy habits has meant in learning has saved them per person / year approximately: 1443€ / person / year in estimate of costs for disability to work and 614€ / person / year, which for a staff of 17 employees represents a total saving of (Figure 3).

In this sense, the impact of the intervention shows a general improvement in all the parameters of interest analyzed, which indicates an improvement in the self-management of health by the team that has participated in the intervention and has a positive impact on the ability to work of the employees.

The main objective of the present study was met in which it was proposed to use high performance sports technology in combination with a training program in healthy habits of 6 months, to promote the acquisition of habits related to health care metabolic in the workplace.

The initial hypothesis is accepted, where it was stated that the contribution of technological tools of measurement to the welfare and health programs in the companies serve to offer reliable and valid feedback to the workers and their companies about the impact of said programs in the improvement of the physical health status.

In this sense, after the analysis of results has shown how the use of High Performance Sports technology in the workplace as a tool for evaluation and monitoring progress, combined with a training program in healthy habits, has a positive effect on the Metabolic Health We think that the main reason for its effectiveness is the generation of tracking metrics. In this regard, the use of parameters that serve to raise awareness and awareness of the physical state of each participant, along with teaching strategies in nutrition, physical exercise and emotional

Table 2: Group Results of Body Composition.

	Mean±SD Pre	Mean±SD Post	Healthy scale
Body Mass Index (BMI)	24.02±5.75	23.81±5.63	18.5-25
Visceral fat	3.71±3.35	3.35±2.76	<9
% Body fat	26.53±13.76	24.64±12.26**	Men: 8-19.9% Women: 21-32.9%
Lean mass	46.95±8.4	48.20±8.9	Men: 33.3-39.3 Women: 24.3-30.3
% Water	54.13±9.7	55.94±8.6**	Men: 50-65% Women: 45-60%
Weight	69.29±16.64	68.98±16.86	Men: 60.7-69.5 Women: 57.9-63.5

* The healthy scales of the table are those corresponding to the average of the total chronological age of the study sample analyzed, differentiated by sex. Extracted from the World Health Organization (WHO). ** P<0.005.

Table 3: Group results of the impact on cardiovascular indicators in 24h.

	Mean±SD Pre	Mean±SD Post	Healthy scale
Resting Heart Rate	50.63±7.89	51±7.29	Men: 62-84 Women: 72-94
Maximum Heart Rate	190.94±3.45	190.69±3.32	186bpm
% Stress	47.56±11.2	45±10.75	40-60%
% Recovery	27.47±10.04	28.47±9.04	20-30%
Stress Balance	0.33±0.24	0.26±0.25	<0 tends to stress >0 tends to relaxation

* The healthy scales of the table are those corresponding to the average of the total chronological age of the study sample analyzed, differentiated by sex. Extracted from the World Health Organization (WHO). ** P<0.005.

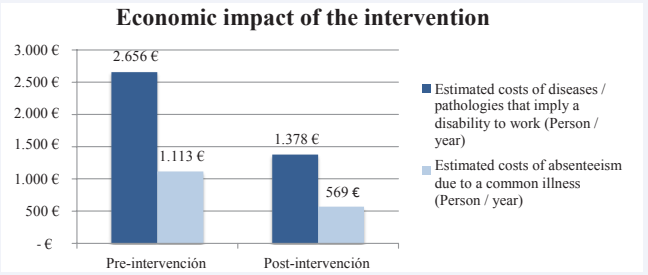

Figure 3 Economic Impact Intervention.

management to serve as a guide is the key for workers to take decisions in the change / acquisition of new life habits [30].

The improvements in metabolic health found after the 6 month plan justify the economic investment made by the company in a wellness program, providing HR managers with tools that not only serve to increase investment, but also access to new resources of equipment and professional advice in each of the welfare branches [31,32].

Regarding the design of training programs in the business world, the key lies in providing the worker tools that proactively guide the conscious acquisition of healthy habits, helping them to adapt to different lifestyles and the diversity of environments corporate It is therefore demonstrated that the teaching of competencies related to health and well-being must support an innovative pedagogical approach that enhances intra-entrepreneurship and personal autonomy.

Regarding the reflection oriented to the results obtained. The analyzed subjects managed to achieve better movement habits, increasing the hours of physical activity / weekly; thus achieving a significant increase in lean mass from 46.95Kg to 48.20Kg, as well as better nutritional habits that caused a significant decrease in the overall average percentage of total body fat (% fat) from 26.53% to a 24.64% and a significant increase in the percentage of water from 54.13% to 55.94%. We also obtained improvements in the BMI from 24.02 to 23.81, and better stress management.

The impact of the decision making that each worker has undertaken in their day-to- day habits during the 6 months that the program lasted directly affects the improvement of the determinant aspects of health and thus its impact on health status (Commission on Social Determinants of Health, WHO, 2005-2008). Achieving healthy values in% fat significantly reduces the risk of metabolic diseases such as diabetes, obesity or metabolic syndrome in the short, medium term, as well as secondary diseases derived from the main ones [33,34]. The improvement of lean mass provides workers an increase in basal metabolism, relating the need for energy with fat-free mass instead of fat percentage. Improvements in the percentage of body water help the body to the improvement of the functioning of processes such as brain, muscle and bone activation [35,36] and the optimal performance of organs and the hormonal system [37].

On the other hand, as we have already seen, stress is an aggravating factor in the health status of people, contributing to a worsening of it. Although the improvements presented by the subjects of the present study in the values of stress and recovery have not been significant, the trend of the values shows a positive impact on the variables analyzed, which indicates an objective response to the program. In this regard, it is possible that a longer intervention in the same training line and the monitoring of metrics related to these variables may provide significant improvement values in the intervention.

Specifically and analyzed from a global perspective on metabolic health, the impact of the program carried out in the present study has significantly improved variables that, associated with each other, have a significant impact on worker health, reducing the risk of suffering cardiometabolic diseases such as metabolic syndrome, obesity and type II diabetes, among others. That is why the efficiency of the design of combined programs of technology and education in improving the quality of life of people is demonstrated [38-40].

The impact of improving the quality of life of people with programs promoting health and well-being contributes significantly to reducing the costs related to the acquisition of common diseases, the prevalence of these (the number of times they occur during year), the duration of the same and with it its impact on the number of administrative losses, of short-medium duration [41,42]. Fact that we have been able to verify through the implementation of the WAI scale, through which a positive economic impact has been obtained in the investment made by the company, converting it into a saving of more than 30,000€ estimated in total costs per disability to work and more than 12,000€ in costs of absenteeism due to illness within the group analyzed.

CONCLUSION

The design of health improvement and promotion programs, enhanced by the use of technology in order to obtain evaluation and monitoring metrics, offer a positive return on the economic investment made, improving the working capacity of the workers involved in the process action.

Using technology for the generation of health and wellness metrics in corporate wellness programs favors the acquisition of reliable and valid management tools for decision making within the company.

The use of technology, combined with the design of training programs aimed at acquiring healthy habits in terms of nutrition, physical exercise and emotional management, has an impact on the metabolic health and positive wellbeing of the participants.

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