

Physical Fitness Comparison of Trained and Untrained Industrial Emergency Brigades

Esteban Oñate and Elías Apud*

Department of Ergonomics, University of Concepción, Barrio Universitario s/n, Concepción, Chile

***Corresponding Author:** Elías Apud, Department of Ergonomics, University of Concepción, Barrio Universitario s/n, Concepción, Chile.

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Abstract

Emergencies can occur at any time and may reach unpredictable magnitudes. Unfortunately, in many companies, emergency brigades are often organized with people who perform work of sedentary nature and they are not prepared to face sporadic tasks of high physical demands.

The objective of this study was to compare the physical fitness of workers with different degree of training. They worked for the same company, but in different industrial plants. In one of them they had a physical training program, guided 3 times per week during working hours by a physical educator; In the other plant there was no facilities for training.

Age, stature, body mass, body fat and aerobic capacity were evaluated with conventional methods in 57 physically trained and 21 untrained workers.

Results showed that aerobic capacity was 20.8% higher in the trained brigade. Body fat content was significantly higher in the untrained brigade. A further analysis showed that according to Chilean standards for emergency brigades, 58% of the untrained brigade members do not reach the recommended level, while only 19% of the trained workers are below the reference level.

As conclusion, the results only confirmed the importance of physical training to improve working capacity and this is particularly important for workers who perform light activities and in isolated occasions have to face high and dangerous demands. Therefore, the main recommendation is to stimulate training within working hours as part of the preparation of the brigade members.

Keywords: Brigades; Physical Training; Work Capacity; Body Composition; Overweight; Obesity

Abbreviations

BMI: Body Mass Index; FFM: Fat Free Mass; VO_2 max: Aerobic Capacity

Introduction

From an ergonomic point of view, the work of emergency brigades is one of the most difficult to adapt to achieve efficiency without exposing brigade members to risks to their physical and mental health. This is because emergencies can occur at any time

and reach very different magnitudes. Studying the physiological and psychological response during real emergencies would require a team of researchers dedicated to the continuous monitoring of the brigades, having available non-invasive techniques that allow these evaluations without altering the work. This has a high cost, demands a lot of time and it is a contradiction to expect a real emergency to occur to study its risks [1].

For this reason, it is necessary to apply anticipatory methods that allow looking for the most efficient and safest forms of organi-

zation to control the various emergencies that the brigades must face. Although technical training is of paramount importance, the selection criteria and the physical and psychological maintenance programs of the brigade members constitute a fundamental element to face emergencies, whose success depends to a large extent on the organization and efficiency of the crews [2]. It is important to mention that the Ergonomics Unit of the Universidad de Concepción in Chile has conducted studies in emergency brigades and has established minimum requirements based on four variables, of which the most important are aerobic capacity, expressed in milliliters of oxygen per kilogram of weight and body fat percentage [1]. The levels required for young workers are greater than for those responsible for directing the crews, as can be seen in the table 1.

| Young brigade members | Senior brigade members |
|--|--|
| Aerobic capacity greater than 43.5 ml/min/kg body weight | Aerobic capacity greater than 37.5 ml/min/kg body weight |
| Fat mass not exceeding 15% | Fat mass not exceeding 20% |

Table 1: Recommendations of aerobic capacity and body fat levels for brigade members.

It is necessary to state that the above-mentioned values are optimal, but flexible criteria are required and also to consider that these indices are modified with training and with a sedentary lifestyle.

In the last decades, there have been important technological advances for the detection and control of emergencies. However, independent of the efficiency in the management of resources, it is necessary to consider that in every workplace there are human beings and their response is fundamental to promptly control the different types of emergencies [2]. From this point of view, there are many concerns about the limits of physiological demands of emergency brigades, which need to be studied systematically. Unfortunately, in many companies in Chile, emergency brigades are organized with people who perform different types of work, often of a sedentary nature, without any special preparation to comply with these dangerous tasks.

Consequently, the objective of this study was to compare the physical fitness, in terms of body composition and response to

controlled exercise, of two groups of workers one with scheduled training and the other without any physical training at work.

Materials and Methods

The subjects were 78 volunteers who carried out different activities in two different plants of a holding of wood industries. One of these plants had a training program for their volunteers, which was performed by a physical education teacher, for 45 minutes, three times a week, during work hours. In the plant that was used for comparison the volunteers that made up the brigades did not perform any special physical activity in their working time.

Before beginning the study, the volunteers were given an explanatory talk about the objectives of the study and also about the tests they would undergo. The subjects participating in the study did not carry any pathology that prevented them from being members of the brigades of the two companies.

The studies were carried out in the polyclinics of the companies, in a room with air conditioning that was maintained at 20°C. Age was recorded and body mass and stature measured on a clinical beam scale (Precisión Hispana, Madrid). VO_2 max was estimated from the technique of Maritz., *et al.* [3]. The subjects exercised on a mechanically braked cycle ergometer (Body Guard, Norway), at three loads, so as to obtain the VO_2 max from extrapolation to a predicted maximal cardiac frequency. Body composition, in terms of fat mass and fat free mass (FFM) was estimated from the technique of Durnin and Womersley after measuring biceps, triceps, subscapular and suprailiac skinfolds [4]. These technique was demonstrated valid for the evaluation of Chilean workers [5]. The skinfolds were measured with a Holtain/Tanner caliper (Holtain, Crymmych, U.K.) which exerts a constant pressure at all openings and can be read to the nearest 0.1 mm.

Results and Discussion

Table 2 summarizes the set of variables measured in the members of the trained and untrained emergency brigades.

As can be seen in table 2, untrained brigade members have lower average aerobic capacities and a higher percentage fat mass than those trained. The analysis summarized in table 3 reveals that these differences are statistically significant.

| Variable | Trained brigade (n = 57) | | Untrained brigade (n = 21) | |
|------------------------------|--------------------------|----------|----------------------------|----------|
| | Average | St. Dev. | Average | St. Dev. |
| Age (years) | 37.5 | 8.1 | 44.0 | 10.0 |
| Weight (Kg) | 74.2 | 8.2 | 81.4 | 11.7 |
| Height (m) | 1.70 | 0.1 | 1.70 | 6.1 |
| Aerobic capacity (l/min) | 3.1 | 0.6 | 2.7 | 0.5 |
| Aerobic capacity (ml/min/kg) | 41.4 | 7.0 | 33.0 | 6.0 |
| Fat mass (%) | 22.3 | 3.6 | 26.2 | 3.3 |
| Fat mass (Kg) | 16.6 | 3.6 | 21.6 | 5.2 |
| FFM (Kg) | 57.6 | 5.9 | 59.9 | 7.5 |
| BMI (Kg/m ²) | 26.1 | 2.7 | 28.0 | 2.6 |
| FFM/height (Kg/m) | 34.1 | 3.0 | 35.1 | 3.2 |

Table 2: Summary of variables measured in trained and untrained emergency brigades.

| Variable | Trained Brigade Average | Untrained Brigade Average | t-value | df | p |
|------------------------------|-------------------------|---------------------------|----------|----|----------|
| Aerobic capacity (ml/min/kg) | 41,4 | 33,0 | 4,89871 | 76 | 0,000005 |
| Fat mass (%) | 22,3 | 26,2 | -4,41321 | 76 | 0,000033 |

Table 3: Statistical analysis of the differences between trained and untrained brigades.

One aspect that needs to be highlighted is that the untrained brigade was made up of workers whose average age was higher than that of the brigade with training. Therefore, it is important to consider this variable in the analysis, which can be seen in table 4.

As shown in table 4, the differences in aerobic capacity and body composition clearly reveal that trained workers, at equivalent ages, have a better physical condition.

| Brigade | Age | n | Aerobic Capacity (ml/min/kg) Average | Aerobic Capacity (ml/min/kg) St. Dev. | Fat mass (%) Average | Fat mass (%) St. Dev. |
|-----------|---------|----|--------------------------------------|---------------------------------------|----------------------|-----------------------|
| Untrained | 20 a 29 | 0 | - | - | - | - |
| Untrained | 30 a 39 | 7 | 36.6 | 5.9 | 23.2 | 2.0 |
| Untrained | 40 a 49 | 8 | 33.0 | 5.0 | 27.5 | 3.5 |
| Untrained | ≥ 50 | 6 | 28.6 | 5.3 | 28.1 | 1.3 |
| Trained | 20 a 29 | 9 | 44.4 | 5.3 | 18.9 | 3.1 |
| Trained | 30 a 39 | 24 | 42.8 | 7.1 | 21.4 | 2.9 |
| Trained | 40 a 49 | 19 | 39.1 | 6.5 | 24.4 | 3.4 |
| Trained | ≥ 50 | 5 | 38.2 | 8.7 | 24.4 | 2.0 |

Table 4: Comparison of aerobic capacity and percentage of fat mass of trained and untrained brigades classified by age groups.

Looking in more detail, in figure 1 it is possible to see the distribution of the aerobic capacity of the trained and untrained brigade.

Looking at figure 1 and taking the reference level for aerobic capacity of 37.5 ml/min/kg body weight, indicated as a reference for senior brigade members, 58% of the untrained do not reach that level, while only 19 % of trained workers do not reach this figure.

On the other hand, body composition in terms of percentage of fat mass indicates better levels in the trained group since, as can be seen in figure 2, 58% of the untrained workers are at a level higher than 25 % and there are no workers with less than 20% fat mass. In other words, everyone has some degree of overweight. In the case of the trained brigade, the number of workers with more than 25% fat mass is reduced to 27% and there are 22% of brigade members with less than 20% body fat.

Figure 1: Aerobic capacity distribution of trained and untrained brigade's members.

Figure 2: Percentage body fat distribution of trained and untrained brigade members.

The results are not surprising since there is a significant amount of information that reveals that programmed physical activity improves physical fitness. In Chile has been observed that volunteers from a steel company and an oil refinery, in both cases without training, had low aerobic capacities [1], even lower than those found in this study. Moreover, in forest fire brigades integrated by seasonal workers, the groups subjected to systematic training sig-

nificantly improved their response to effort and body composition, while those who did not participate in any programmed physical activity tended to worsen. Therefore, it is important to consider the need for emergency brigades to be in optimal conditions, particularly when they have sedentary work and they have to face very heavy activities during emergencies. The important thing is that a low physical fitness can be reversed with training and adequate

feeding in reasonable periods of time. Although the word reasonable appears as very vague, the truth is that the changes depend on the intensity and frequency of training and also the willingness of people to regulate their diet.

Finally, it is important to characterize the members of the brigades, but to refine the criteria of selection and control of the physical aptitude it would be necessary to evaluate simulations close to the real situations to have an estimation of the demands of the work.

Conclusion

- The study reveals that, both in terms of aerobic capacity and body composition, the trained brigade has a better physical fitness than the untrained brigade.
- The results allow to recommend that the brigades participate in regular training programs run by qualified professionals.
- It would also be advisable to strengthen education for good nutrition, since the tendency to overweight and obesity is a problem that affects the response to high physical demands.
- Finally, it is essential to conduct studies in different simulations to determine the demands of each of them and improve the selection and control criteria of the people who are exposed to these critical tasks.

Conflict of Interest

Authors claim no conflicts of interest.

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