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ORIGINAL ARTICLE

New Deconstruct Elliptical sports machine and Elliptical machine: Comparative analysis of muscle functionality and physiological response in low and high intensity training

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ABSTRACT

The objective of this article was to compare different cardiovascular training machines and their effects on the body, as well as to determine their suitability for people with low intensity or high intensity training needs. A total of 8 physically active and healthy male subjects (mean ± standard deviation; age: 28.45 ± 1.75 years; height: 1.84 ± 0.07 m; body weight 76.42 ± 8.62 kg; body mass index: 25.5 ± 2.6) were evaluated through of an incremental exercise test at different intensities on two different machines: Elliptical Domyos 680 (BED) and Deconstruct Elliptical 331-EF (DEC). To compare both machines against the two mentioned training needs, two different protocols were carried out: Low Intensity Protocol (LIP) and High Intensity Protocol (HIP). As the DEC machine is specifically designed to perform several training positions of different intensities, the LIP was performed in one of its low intensity positions and the HIP in four of its high intensity positions. On the contrary, in the BED machine, both the LIP and the HIP were performed in the only position that its design allows. In the LIP the subjects' heart rate (HR) and energy expenditure EE were analysed. In addition, a thermographic analysis was carried out in order to determine the temperature differences reached in the musculature. No significant differences were found in HR and EE ($p < .05$) between the two machines. However, a greater and more progressive activation of the muscles of the upper extremities was observed in the DEC machine. In the HIP, HR and EE were measured, obtaining significant differences ($p < .05$) higher in the DEC machine. Therefore, in our comparison, the Deconstruct Elliptical machine produced more appropriate results for both low and high intensity training compared to the Elliptical machine. These results and the novel nature of the Deconstruct Elliptical raise the need for further studies to better understand this machine.

Keywords: Performance analysis of sport, Physical conditioning, Deconstruct elliptical, Elliptical machine, Muscle functionality, Physiological response.

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INTRODUCTION

In the context of sports performance and rehabilitation, exercise is in constant progress and popularity (Sozen, 2010). Recent developments in technology have made the monitoring of physical parameters accessible at any time and place for any type of user (Lunney et al., 2016). The continuous advances in research have given rise to increasingly sophisticated equipment, machines and application development in order to collect data regarding physiological, kinanthropometric and sports performance (Sozen, 2010; Peart et al., 2019; Muntaner-Mas et al., 2019).

In this sense, multiple current investigations compare different exercise machines in order to obtain information on their involvement in performance and health (Turner et al., 2010; Bouillon et al., 2016; Hummer et al., 2020; Hummer et al., 2021). In various studies that are carried out with different exercise methodologies, numerous effects can be produced at the cardiovascular level (Haskell et al., 2007; Arikan & Revan, 2020), however, there may be differences in the EE depending on the intensity (Brown et al., 2010). The treadmill, bicycle or elliptical are some of the most studied classic machines in the field of research (Hahn et al., 2013; Arikan & Revan, 2020; Filipovic et al., 2021; Reer et al., 2021) such as titration, performance monitoring and physical analysis equipment (Gumming et al., 1978; Montoye, 1982; Bermejo et al., 2019; Octavio et al., 2019; Björkman et al., 2021; Lee & Zhang, 2021).

In previous studies, training on a bicycle or elliptical trainer has been shown to facilitate coordination or improve reciprocal muscle activity (Damiano et al., 2011; Hornby et al., 2012). In fact, not only has its implementation been proposed in the field of sports performance, but it has also been prescribed by health professionals as a low-impact alternative to reduce stress on the joints (Johnston, 2007).

As for training on the elliptical, it provides beneficial effects at the level of the musculoskeletal system and the cardiovascular system (Lu et al., 2007; Huisinga et al., 2011; Petrofsky et al., 2013). This machine promotes a different trajectory of movement when compared to the treadmill or bicycle (Sozen, 2010) and a different muscle recruitment activity (Cheng et al., 2007). That is why it is considered a good alternative to the treadmill and the classic bicycle, since it also allows muscular synchronization between the upper and lower limbs (Chien et al., 2007; Lu et al., 2007; Sozen, 2010). Although it is important to note that the person must be aware during the execution when it comes to involving all the extremities, causing greater global muscle activation (Batté et al., 2003). On the other hand, the elliptical has been successfully included in a multitude of investigations and tests analyzing the HR or the oxygen consumption reached in various protocols (Mercer et al., 2001; Green et al., 2004; Joubert et al., 2011; Ozkaya et al., 2014), in populations with different pathologies and rehabilitation (Jackson et al., 2010; Orekhov et al., 2019; Roxburgh et al., 2021; Ismail, 2022), as well as in the field of athletic performance and recovery (Tan et al., 2014; Martínez Navarro et al., 2021).

Regarding the comparative aspect, its functionality and response with other machines have been verified, obtaining evident improvements in the upper extremities (brachial biceps, brachial triceps, pectoralis major and trapezius) compared to the bicycle or the treadmill measured with electromyography (Sozen, 2010). In addition, it elicited greater benefits in maximal oxygen consumption in sedentary middle-aged men compared to the treadmill (Velmurugan, 2016). Another study analyzed, in different tests, the differences in maximum oxygen consumption and maximum heart rate in the elliptical and treadmill, finding no significant differences, but higher values in HR on the treadmill (Brown et al., 2015). It has also been compared with other activities to analyze muscle functionality and its aerobic involvement, such as dancing (Hahn et al., 2013), as well as in recovery processes with respect to running in neuromuscular performance after a marathon (Martínez-Navarro et al., 2021).

Regarding the field of quality of life and rehabilitation, it has been observed how, in patients with multiple sclerosis, the prescribed exercise on an elliptical machine improved the ranges of fatigue and quality of life (Huisinga et al., 2011). In this sense, an 8-week elliptical training program also improved motor, cognitive, and neurobehavioral function in adult subjects with chronic traumatic injury (Damiano et al., 2016). Likewise, in patients with cerebrovascular accidents, training on the elliptical for 8 weeks did not improve gait speed, but it obtained beneficial effects in other aspects such as resistance, balance and mobility of the same (Jackson et al., 2010).

Regarding the thermographic analysis, skin temperature has been related to muscle activation in incremental cycling tests in the lower limbs (Priego Quesada et al., 2015). Previous studies have verified how physical condition is related to thermoregulation and the changes produced in skin temperature and neuromuscular activation (Abate et al., 2013). In addition, to compare and evaluate different types of strength training and the effects produced before, during and after exercise, thermography has been used as a method of analysis (De Andrade Fernandes et al., 2014; Neves et al., 2015; De Almeida Barros et al., 2020).

On other machines, such as the exercise bike, there is a greater number of investigations in the comparative aspect between equipment (Sozen, 2010; Bouillon et al., 2016; Gillinov et al., 2017; Smith et al., 2019; Mady et al., 2019), both in the field of rehabilitation and performance (Sinha et al., 2013; Miki et al., 2014; Madsen et al., 2015; Ferraz et al., 2018), as well as in its thermographic analysis (Duc et al., 2015; Priego Quesada et al., 2015).

The DEC sports machine (Figure 1) corresponds to the Spanish patent with publication number ES2723981 and issue date 08/13/2021. Its design allows for a new cardiovascular and functional exercise in which all the joints and mobilizing muscles of the body receive resistance during both flexion and extension. As well as carrying out, if desired, proprioception and balance exercises together with cardiovascular exercise and, in addition, stretching and strength exercises with the weight of one's own body.

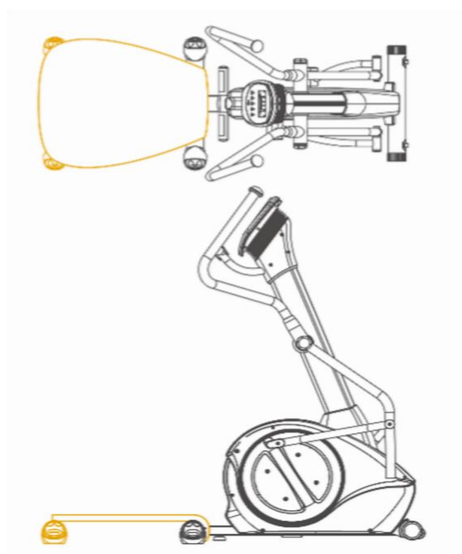

Figure 1. DEC Sports Machine.

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The upper part of the DEC machine is designed for guided training of the upper body. It consists of two mobile handlebars that are operated by hand and that offer adjustable resistance to the forward and backward movement of the arms. Its two-way rowing system (2WR®) enables the athlete to perform the push and pull or push and rower exercise with both arms in parallel describing the same trajectory in unison, overcoming the same resistance in both directions without stopping during the exercise, even at high speeds. This exercise being named by the patent holder as *Main Position* (Figure 2). Being able to combine this exercise of the upper body with other exercises for the legs if you wish.

The lower part is designed for free and voluntary training of the lower body. It consists of a platform or step that allows you to perform from a slight leg flexion to deeper flexions or different choreographies. In this way, the athlete can perform the exercise called by the patentee as *Deconstruct* (Figure 3). Exercise in which the athlete continuously flexes and extends all the joints of the body, thus overcoming with the upper body the resistance offered by the handlebars and with the lower body the resistance offered by the mass or weight of their own body. Without both resistors overlapping each other.

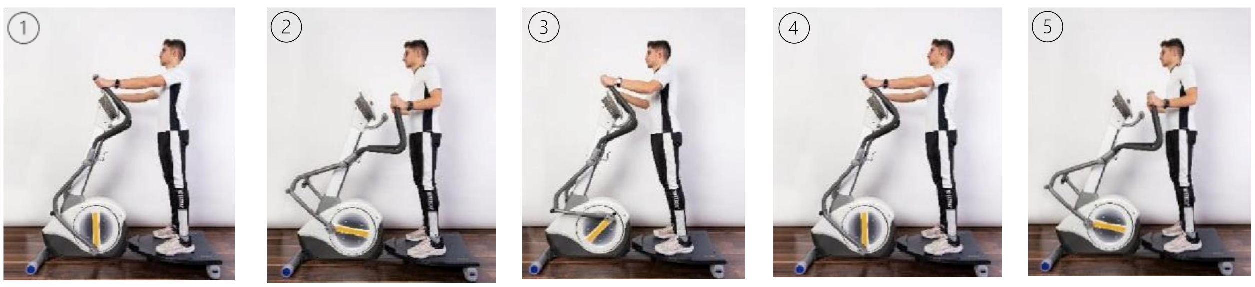

Figure 2. DEC Sports Machine. In main position (pull and push).

Using the machine in the main position results in muscle activation of the following parts of the body:

Pull Phase: Hands and forearms, arm biceps, posterior shoulder, back and core muscles (abdomen, lower back, glutes) as stabilizers.

Push Phase: Hands and forearms, triceps of the arm, front shoulder, pectoral and core muscles (abdomen, lower back, glutes) as stabilizers.

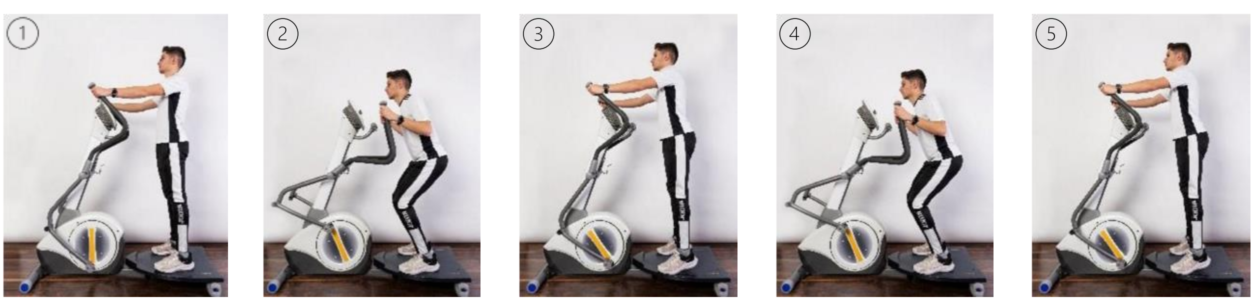

Figure 3. DEC Sports Machine. In the Deconstruct exercise (*pull and push* with light squat).

And the use in the Deconstruct exercise results in the muscle activation of the following parts of the body:

Pull and Down phase: Hands and forearms, arm biceps, posterior shoulder, back, abdomen, glutes, quadriceps, hamstrings and calves.

Push and Up phase: Hands and forearms, arm triceps, front shoulder, pectoral, lower back, abdomen, gluteals, quadriceps, hamstrings and calves.

Differentiating this comparison between low and high intensity training is due to the fact that the populations for which these two types of training are intended have different needs. In a non-limiting way, low-intensity training is considered that intended for populations such as the elderly, sports initiation, children, rehabilitation, physical reconditioning or health in the workplace. And as high intensity training that intended for professional or amateur sports performance, gyms, high intensity or interval training centres, group classes and professions such as firefighters, performing arts or rescue forces.

The Deconstruct Elliptical machine is a new and different cardiovascular training machine from the already known treadmill, stationary bike, rowing machine or elliptical, and there are no previous studies. For this reason, its investigation is necessary to determine its suitability for its use in its different applications. In this article, using thermographic technology, we analyse the differences in muscle functionality between the Domyos 680 (BED) elliptical bike (www.decathlon.es) and the new Deconstruct Elliptical 331-EF (DEC) machine from the Deconfree brand (www.deconfree.com). In addition, the physiological response was analysed by measuring the effects on heart rate (HR) and energy expenditure (EE) in various stress tests at different intensities, comparing the response obtained on both machines.

MATERIAL AND METHOD

Participants

A total of 8 physically active and healthy male subjects (mean ± Standard Deviation; age: 28.45 ± 1.75 years; height: 1.84 ± 0.07 m; body weight 76.42 ± 8.62 kg; Body Mass Index: 25.5 ± 2.6) participated in the present study. They carried out the intervention voluntarily. They all belong to the same group.

Process

Unlike the Elliptical machine, in which the intensity of the exercise can only be regulated through the adjustment of the resistance element (brake on the flywheel), in the Deconstruct Elliptical machine the intensity of the exercise in addition to this same adjustment, it can be modified by incorporating different lower body exercises while continuing to exercise the upper body. For the purposes of the study, to compare the two machines at low and high intensity, two exercise protocols described in Table 1 were carried out.

Below is a schematic description of the exercises carried out in the DEC for the LIP and for the HIP:

Exercise carried out in the LIP

For the LIP, the Deconstruct exercise was selected because it involves a continuous activation of the arms and legs muscles, as it happens in an elliptical machine. It consists of the forward/backward movement of the arms in parallel, overcoming the resistance offered in both directions by the handlebars (*push and pull),* as well as the up/down movement of the legs in parallel performing a light squat (LS). Carrying out the flexion/extension of both segments in unison (Figure 3).

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Table 1. Exercise protocol: low intensity (LIP) and high intensity (HIP).

	Low Intensity Protocol (LIP)	**High Intensity Protocol (HIP)**
BED	Intensity: Gradual resistance adjustment Type of exercise: Known motion on an elliptical bike	Intensity: Gradual resistance adjustment Type of exercise: Known motion on an elliptical bike
DEC	Intensity: Gradual resistance adjustment Type of Exercise: Deconstruct Exercise (DE): Push and pull (PP) with Light squat (LS)	Intensity: Gradual resistance adjustment Types of exercises: DE with medium squat (MS) DE with stride squat (SS) DE with deep squat (DS) DE with maximum deep jumps (MDJ)

Exercises carried out in the HIP

For the HIP, among several high intensity positions, the following were selected:

- Deconstruct exercise with medium squat -MS- (Figure 4).
- Deconstruct exercise with stride squat -SS- (Figure 5).
- Deconstruct exercise with deep squat -DS- (Figure 6).
- Deconstruct exercise with maximum deep jumps -MDJ- (Figure 7).

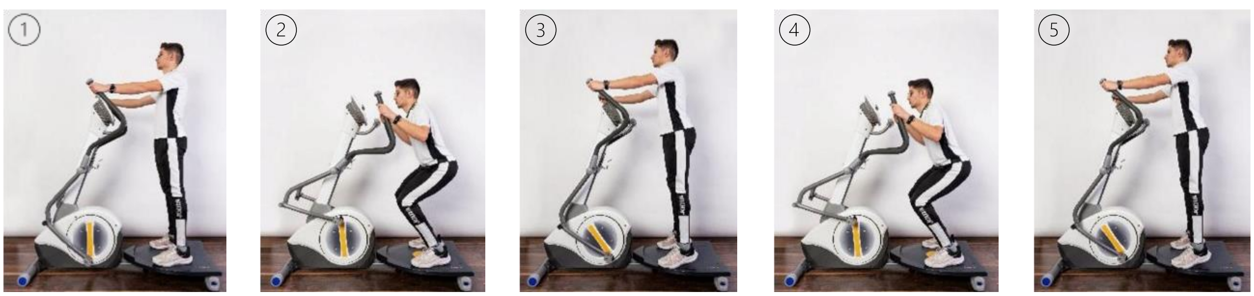

Figure 4. Deconstruct exercise with medium squat (MS).

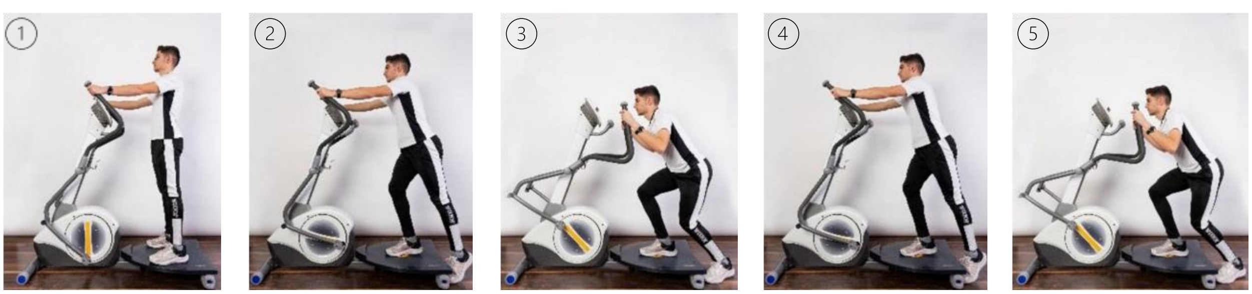

Figure 5. Deconstruct exercise with stride squat (SS).

Figure 6. Deconstruct exercise with deep squat (DS).

Figure 7. Deconstruct exercise with maximum deep jumps (MDJ).

The DEC machine allows other types of exercises or training positions in addition to those studied here but which have not been described as they are not the object of the study.

For more information the reader can refer to their website (www.deconfree.com).

The development of the research was carried out at the University of Alicante in 2020 for three days. On the first and second day, the measurements were taken using the Domyos 680 elliptical bike (BED) and the Deconstruct Elliptical 331-EF (DEC) machine, the participants exercising on both machines according to the low intensity protocol (LIP). The third day of the investigation focused on a comparison between equipment applying the high intensity protocol (HIP). The tests were carried out under controlled environmental conditions (indoors). During a previous week, the participants were informed about the development of the research and the duration of the tests.

Tests and trials carried out

The thermographic analysis was carried out in the (LIP) carrying out a stress test at different intensities in the BED and DEC machines. For this, thermal images of the trunk and legs were taken in their anterior and posterior views. The different shots were taken before starting the test and once at the end of each of the intensities. On the BED elliptical, an initial baseline shot and 6 subsequent shots were made at 6 different and incremental exercise intensities. In the case of the DEC, it was a basal shot and, after that, 5 shot at 5 incremental intensities. In all cases, an acclimatization period was followed and the same FLIR T530 camera with ThermoHuman software was used for image analysis.

The HR and the EE were carried out in the LIP and HIP. Energy expenditure (EE) was calculated during the exercises using the Harris and Benedict Equation (1919).

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Measures

Thermographic analysis in LIP

The software used for the research showed an analysis of the different regions of interest of the body. In figures 8 and 9, you can see the different colours that represent the significant variations in temperature in the different areas analysed. In the present study, mainly the thermal asymmetries (comparison between bilateral regions), the coefficient of variation (hyper or hypothermic variations depending on the standard deviation) and mean temperature values per region are collected.

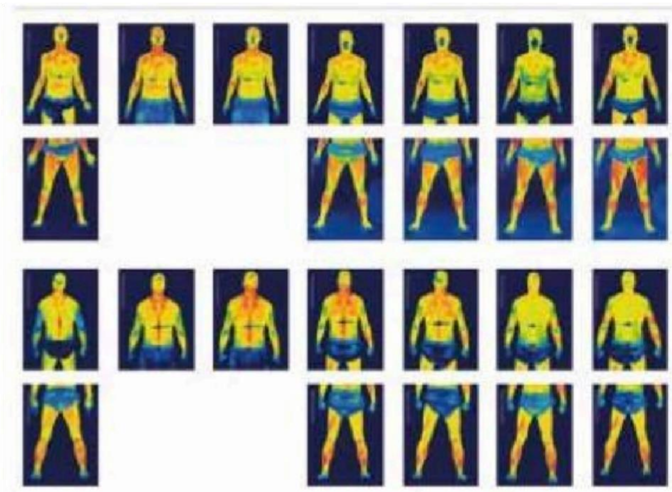

Figure 8. Thermograms of the test carried out with the BED machine.

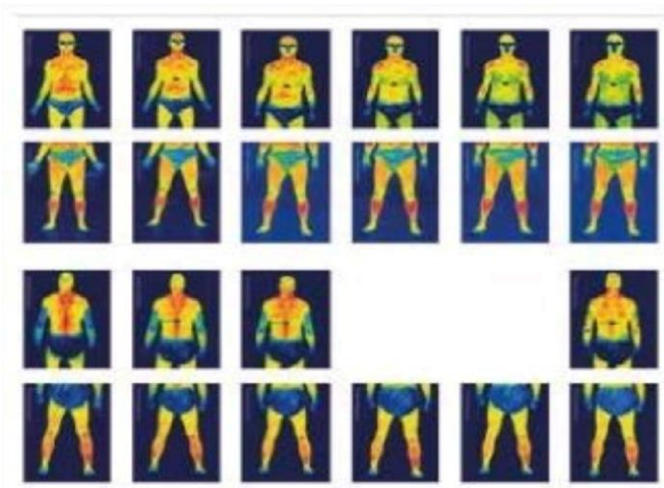

Figure 9. Thermograms of the test carried out with the DEC machine.

Stress test in LIP

A stress test was performed at different intensities on the different machines. HR was collected using Polar H9 heart rate straps. In addition, perceived exertion (RPE) was added at different intensities using the Borg scale as a reference (Borg, 1970). Finally, the caloric expenditure measured in METs and calories/minute was analysed.

Comparative analysis in the HIP

For the high intensity proposal, the protocol described in the Procedure section was selected. RPE and HR were used as a measure of perceived exertion and a comparison of the HR obtained on the two machines was made. Thermometric measurements were not taken for this comparison.

Statistical analysis

The one-way ANOVA test was used to analyse the thermography values obtained from the muscles analysed during the exercises using the SPSS 25.0 program (SPSS Inc., Chicago, IL, USA). In addition, the differences between the groups were verified through the Scheffe test, a Post hoc test. The significance level used in this study was $p < .05$.

RESULTS

Average temperature asymmetries by region

In the following metric (figures 10 and 11) all the zones are compared bilaterally, showing those that are hotter from 0.3ºC. In this case, it can be seen how the BED machine generated a prominent asymmetry in the right arm, while in the DEC machine it was less prominent, being more localized in the forearm. Due to the segmentation problem we avoided the alarms in the hamstrings and adductors. On the other hand, we highlight that the DEC machine increased the asymmetries in the heel and inner calf of the right leg.

Figure 10. BED machine asymmetries.

Figure 11. DEC machine asymmetries.

Neutralized asymmetries

In the following avatars (figures 12 and 13) individualized asymmetry is shown for each region. The number of alarms is reduced and the cut-off points are individualized as long as there is no pain and/or injury. In this case, the measure does not generate very solid results over time in the case of the BED machine and the DEC machine.

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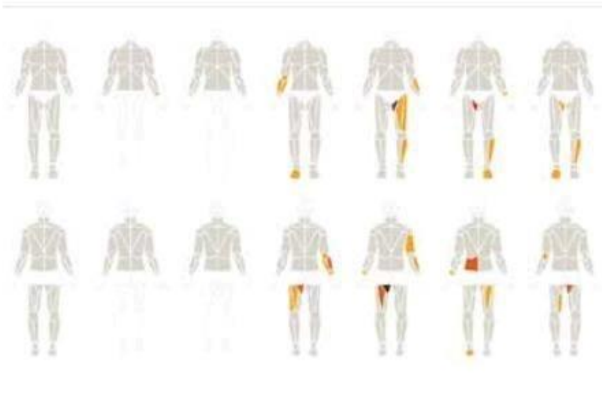

Figure 12. BED neutralized asymmetries.

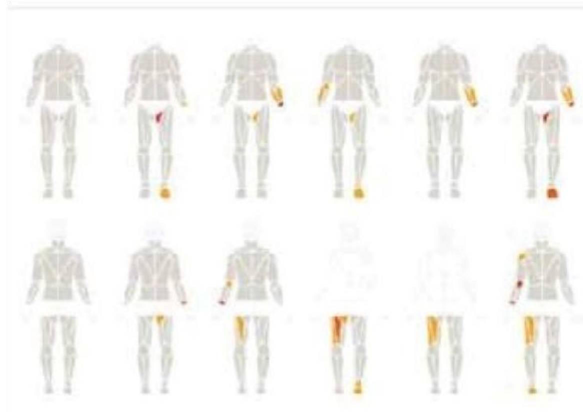

Figure 13. DEC neutralized asymmetries.

Coefficient of variation

In the following complementary metric (figures 14 and 15), hyper and hypothermic trends are observed without dependence on the asymmetry or the absolute values of temperature. When analysing the thermal trends, it is observed that, in the BED machine, the gradual heating of the forearms and triceps stands out. However, in the DEC machine, higher coefficient values are generated in those regions, including the shoulders and anterior forearm.

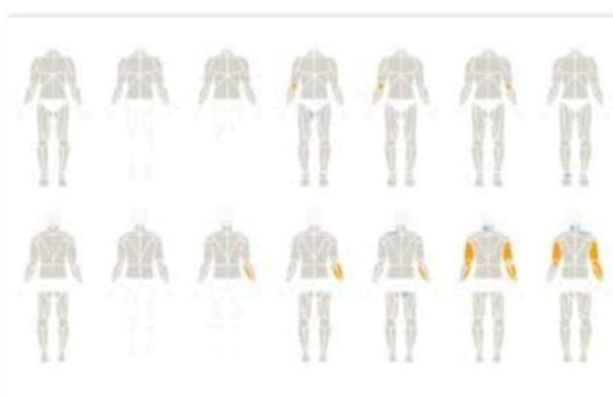

Figure 14. Smoothed coefficient of variation(BED machine).

Figure 15. Smoothed coefficient of variation (DEC machine).

Total thermographic analysis

In the following figures 16 and 17, a total thermographic analysis can be observed in both machines in relation to the average temperature obtained from the anterior shoulder, biceps brachial, dorsal and pectoral regions. If we analyse the results, we observe that there are two easily recognizable trends: On the one hand, in the case of the BED machine, the temperatures of the regions mentioned above have a symmetrical and quite similar behaviour throughout the test, with a decrease in the last test. On the contrary, the DEC machine also demonstrates a fairly symmetrical behaviour with an increasing trend in the shoulder and biceps, observing maintenance with a slight decrease in the case of the pectoral muscle.

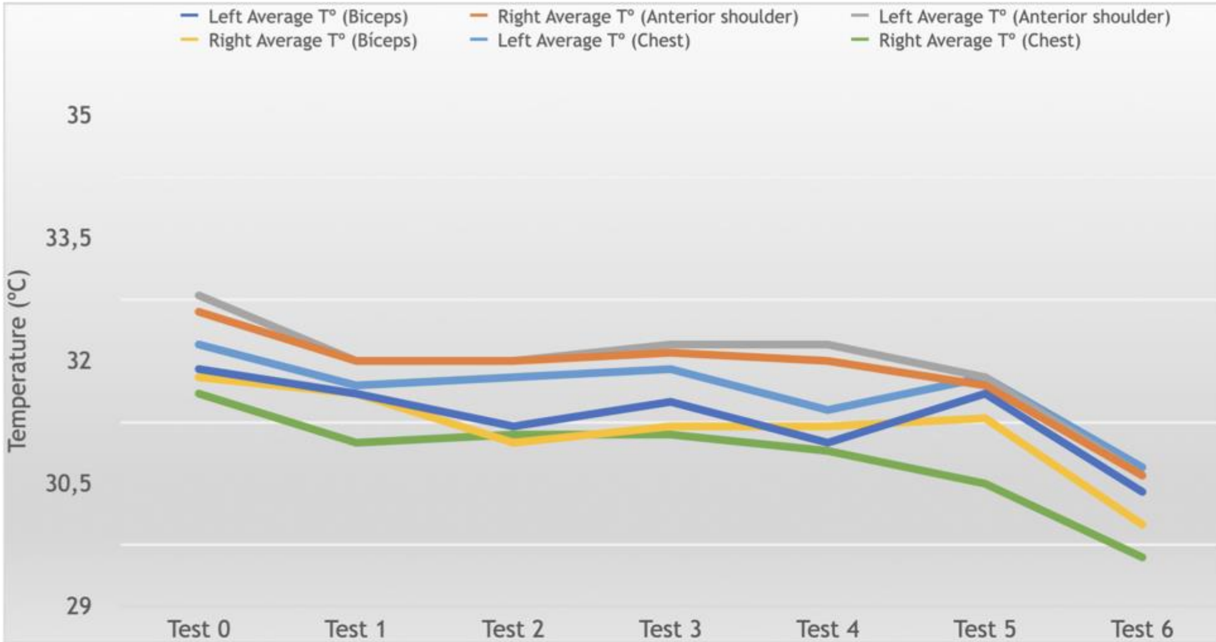

Figure 16. Total thermographic analysis (BED machine).

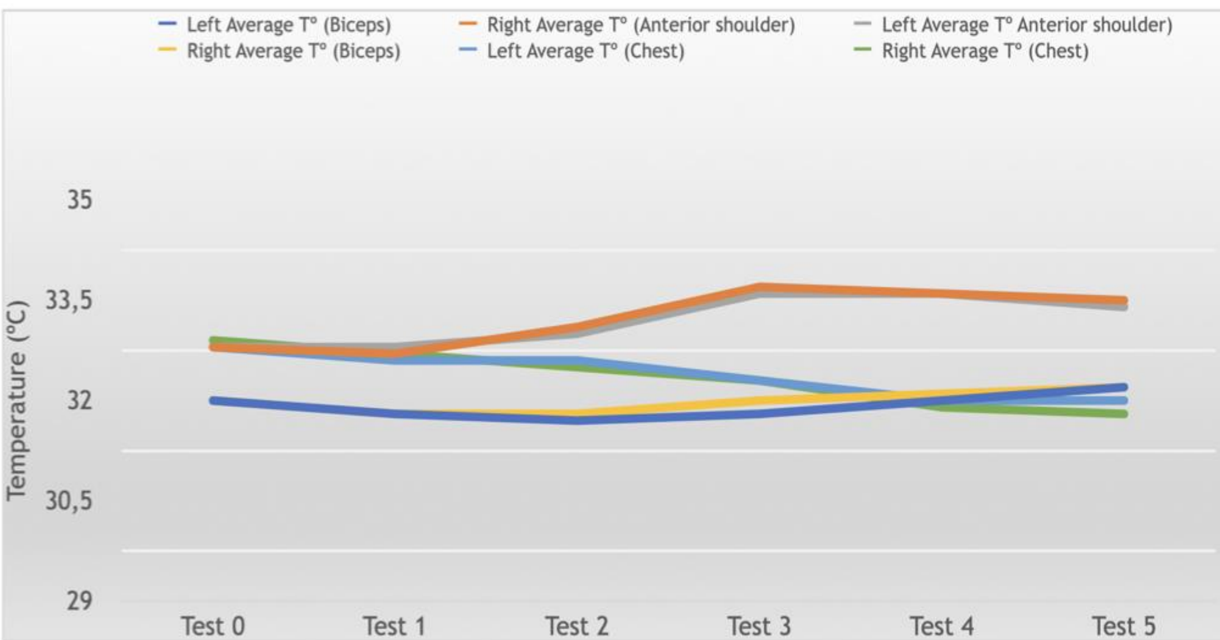

Figure 17. Total thermographic analysis (DEC machine).

Analysis of the HR in LIP

Table 2 shows the HR values (absolute and relative) on both machines, as well as the different degrees of intensity using a scale of perception of effort (Borg, 1970). The BED machine presents higher work intensities than the DEC machine. However, in the present study no significant differences were found in terms of the HR reached in both machines ($p < .05$).

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Table 2. Heart rate (HR) analysis in LIP. Mean and standard deviation.

BED machine			**DEC machine**		
Intensity	HR (bpm)	% HR	Intensity	HR (bpm)	% HR
2	72	42	3	88	50
4	104	52	6	98	56
6	115	65	9	104	59
8	123	70	12	109	62
10	128	73	15	112	64
12	137	78			
Average ± SD	113 ± 23.1	64.5 ± 13.7	Average ± SD	102 ± 9.5	58.2 ± 5.5

As can be seen, the average HR is lower in the DEC machine, reaching lower exercise intensities, but without significant differences ($p < .05$).

Analysis of the EE in LIP

Table 3 shows the EE data (METs and calories/minute) in both machines. The DEC machine presents a lower EE compared to the BED machine. However, at a statistical level no significant difference is found in the established protocols ($p < .05$).

Table 3. Analysis of caloric expenditure obtained in both machines in LIP.

BED machine			**DEC machine**		
Intensity	MET	Cal/min	Intensity	MET	Cal/min
2	2.3	3.14	3	2.9	4
4	3.4	4.64	6	3.2	4.4
6	3.7	5.1	9	3.4	4.6
8	4	5.5	12	3.5	4.8
10	4.1	5.6	15	3.6	4.9
12	4.5	6.2			
Average ± SD	3.7 ± 0.7	5.03 ± 1.1	Average ± SD	3.3 ± 0.3	4.5 ± 0.4

HR analysis in HIP

Table 4 shows the HR data (absolute value and percentage) obtained on both machines according to the protocol described (Table 1). It can be observed how the DEC machine shows higher values and intensities than the BED machine, obtaining significant differences between both tests ($p < .05$).

Table 4. Comparison of HR in HIP.

BED machine			**DEC machine**		
Intensity	HR (bpm)	% HR	Intensity	HR (bpm)	% HR
6	117	67	6 MS*	134	76
8	126	72	9 SS*	141	80
10	139	79	12 DS*	158	90
12	145	82	15 MDJ*	174	99
Average ± SD	131.7 ± 12.6	75 ± 6.7	Average ± SD	151.7 ± 17.9	86.2 ± 10.3

*Note. *MS: Medium squat; SS: Stride squat; DS: Deep squat; MDJ: Maximum deep jumps.*

As we can see, the percentage of maximum HR obtained on the DEC machine exceeds 86% while on the BED machine 75% of maximum HR is obtained.

Therefore, the exercise intensity is higher in the DEC machine in HIP.

EE analysis in HIP

Table 5 shows the EE data (METs and calories/minute) in both machines. The DEC machine presents a higher EE compared to the BED machine, whit significant differences between both protocols ($p < .05$).

Table 5. Analysis of caloric expenditure obtained in both machines in HIP.

BED machine			**DEC machine**		
Intensity	MET	Cal/min	Intensity	MET	Cal/min
6	7.4	9.9	6 MS*	9.4	12.6
8	8.4	11.4	9 SS*	10.4	14.1
10	10.1	13.6	12 DS*	12.6	17
12	10.6	14.3	15 MDJ*	14.7	19.8
Average ± SD	9.1 ± 1.5	12.3 ± 2	Average ± SD	11.8 ± 2.7	15.9 ± 3.2

*Note. *MS: Medium squat; SS: Stride squat; DS: Deep squat; MDJ: Maximum deep jumps.*

DISCUSSION

The objective of this study was to establish the differences in muscle functionality and physiological response during exercise between the BED machine and the DEC machine for low and high intensity training, as well as to determine its suitability for different audiences.

In the present investigation, in the low intensity test, it was observed that there is a greater hyperthermic tendency in the upper extremities, being more relevant in the shoulder and biceps in the DEC machine and higher in the lower limbs in the BED machine. Thermographic measurements were not made for high intensities, but it would be expected that they would be higher in DEC due to the higher HR value obtained in this modality (Marins et al., 2015). On the other hand, during the established tests, two trends in the temperatures of some regions of the upper body (anterior shoulder, biceps, dorsal and pectoral) are differentiated. On the one hand, the BED machine, in terms of temperature analysis, behaves in a regular and symmetrical but decreasing manner. However, the DEC machine follows a symmetric and also incremental behaviour in temperature. Regarding the analysis of parameters such as HR or EE obtained in tests performed at low intensity, our study did not find significant differences between both machines ($p < .05$). However, when comparing HR and EE in high intensity training (HIP) on the DEC machine, significant differences were found between the two machines, being higher on the DEC machine ($p < .05$).

The importance of aerobic exercise has been demonstrated in numerous studies in the improvements produced at the cardiovascular level (Niebauer & Cooke, 1996; Miele & Headley, 2017; Nystoriak & Bhatnagar, 2018) and its importance in the EE (Strasser & Schobersberger, 2011; Drenowatz et al. al., 2015; Gastin et al., 2018; Ostendorf et al., 2019; Berge et al., 2021). That is why sports sciences are in constant evolution looking for methods and scientific research to improve sports performance and rehabilitation (Sozen, 2010). In this sense, there are many works and investigations that compare different exercise machines and methodologies, providing information on physiological parameters (Rebelo et al., 2015; Klein et al., 2016; Lesmawanto et al., 2019; Filipovic et al., 2021).

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Machines such as the cycle ergometer or the treadmill have traditionally been the most common for determining maximal oxygen consumption tests (Dalleck et al., 2004). They have been studied to observe their relationship with fat oxidation and their relationship with benefits at the cardiometabolic level (Filipovic et al., 2021), showing, for example, a higher proportion of oxidation on a treadmill compared to cycling (Chenevière et al., 2010). In this sense, some tests carried out on the elliptical and treadmill have not found significant differences in the values reached for maximum oxygen consumption in trained men and women (Dalleck, 2004). On the other hand, in previous investigations in which other machines such as the bicycle are analysed, they have determined differences in terms of fat oxidation with respect to other modalities and their active muscle mass (Achten et al., 2003). In relation to the elliptical and the treadmill, the various effects produced with respect to body composition, HR and maximum oxygen consumption have been observed, obtaining similar improvements (Mercer et al., 2001; Donne & Egana, 2004). Other works carried out with the elliptical did not find significant differences in terms of the improvement of the maximum oxygen consumption in trained runners beyond the initial 4 weeks, which led to a significant improvement like any aerobic exercise when starting a program (Joubert et al., 2011). In our study, when comparing the different machines in low intensity training, no significant differences were found between the BED machine and the DEC machine ($p < .05$). However, in high-intensity training, higher data were found on the machine DEC ($p < .05$).

Regarding thermographic analysis, some studies suggest using this technology to observe physiological responses to sports training and physical exercise (Neves et al., 2015; Neves et al., 2015). In this sense, the relationship between skin temperature and the neuromuscular response in lower limbs has been seen in incremental cycling tests (Priego Quesada et al., 2015; Duc et al., 2015). Depending on the intensity and type of exercise performed, it has been shown how the skin temperature over active muscles increases or decreases (Neves et al., 2015). On the other hand, thermography has been used in other fields of knowledge such as health (Neves et al., 2016; de Jesus Guirro et al., 2017; Neves et al., 2017). However, in the field of comparison between different machines in general, and in particular the elliptical, there is no extensive literature on the matter. Therefore, more research is needed in this aspect.

If we focus on the biomechanical analysis, some studies have compared the influence on different joints between different machines (Damiano et al., 2011; Rogatzki et al., 2012), considering the elliptical or the bicycle as good equipment to take into account for the rehabilitation of athletes and the recreational field (Johnston, 2007; Lu et al., 2007). It has been seen how the activation is greater in the upper limbs in the elliptical with respect to other machines such as the treadmill or the bicycle (Sozen, 2010). In addition, in another work it was observed how the involvement of the quadriceps and hamstrings was greater in the elliptical than in the bicycle or walking by means of electromyography (Prosser et al., 2011). On the other hand, studies have been proposed that support the need to incorporate training on a bicycle, treadmill or elliptical for the improvement and rehabilitation of different pathologies (Sweitzer et al., 2002; Harris et al., 2003; Laoutaris et al. , 2013; Fex et al., 2015; Yuing Farías et al., 2019). Therefore, we can consider these equipment as valid instruments both for improving sports performance, rehabilitation and improving quality of life according to the literature analysed.

In this sense, the DEC machine is considered interesting equipment in populations that need low-intensity training. And if we carry out the high intensity protocol in DEC, the intensity increases with respect to HR and EE, which shows that its use could also be extended to other areas such as sports performance.

Finally, it should be considered that the dorsal muscle is interrupted in the thermographic analysis since two images were not processed correctly. It would be expected, however, that since there is a greater hyperthermic tendency in the upper extremities, being more relevant in the shoulder and biceps, and taking into account the motor link between the biceps and the dorsal muscle, said dorsal muscle would have had a similarly greater hyperthermic tendency in DEC (Gutiérrez-Vargas et al., 2017). In contrast, not only the lats but also all the upper body muscles measured in the thermography show a gradual deactivation in the BED that is very clearly observable in Figure 16. This demonstrates what was observed by Batté et al. (2003) about the need to be aware during the exercise of activating the upper body on the Elliptical, which is not plausible as the data from this study show. In the Deconstruct Elliptical, due to its design, the upper body is working continuously without the need for the user to be aware during the exercise. The fact that, unlike the BED, the DEC offers multiple positions for the lower body, opens up a new field of study on the DEC. The authors suggest that more comparative studies with the Elliptical machine and other widely used and studied cardiovascular machines such as the treadmill, stationary bike or rowing machine, are necessary to help better understand the Deconstruct Elliptical machine.

CONCLUSIONS

The Elliptical machine is endorsed both by its widespread use and by the numerous studies carried out that show its suitability for different types of training. But the results obtained in this research suggest that the Deconstruct Elliptical is a cardiovascular machine that improves muscle functionality and the physiological response of the Elliptical machine.

In the present comparative study, the thermographic analysis shows that muscular functionality in the DEC machine is progressive and continuous. On the contrary, in the BED machine it is descending. This is a quality that would highlight better muscle functionality on the DEC machine over the BED machine and would make it more appropriate for low intensity training or conditioning and rehabilitation.

On the other hand, the DEC machine in its high intensity protocol exceeds the HR and EE value obtained in the BED machine with a continuous, gradual and ascending degree of muscle activation that does not occur in BED. Which places the DEC machine in a more favourable position with respect to the BED machine for populations that need high intensity training such as sports performance or in gyms, being able to extend its use to this area.

This is the first study done on the Deconstruct Elliptical as it is a novel cardiovascular machine. Due to the numerous exercises that are possible and that could not be collected in this study, it is suggested that more research is necessary to measure their effects. Also due to its importance for the health of the back, it would be of great interest to measure the activation of the lats in the DEC and verify that it actually increases over time, as occurs with the shoulders and biceps.

AUTHOR CONTRIBUTIONS

C.E.A. manuscript writing, collected the data, preparation and research design; M.T.S. manuscript writing and statistic analysis; M.J.G.G. critically reviewed the work and result interpretation; C.S.L. research design and critically reviewed the work.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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