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Article

Comparative Electromyographic Analysis in Leg Press of Traditional Fitness Equipment, Traditional Outdoor Fitness Equipment, and a New Model of Outdoor Fitness Equipment in Trained Young Men

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Featured Application: The main practical application of this research is the presentation of a new type of outdoor fitness equipment (OFE) available to both trainers and users, with scientific support regarding its ability to recruit the desired muscles in a similar way to conventional gym machinery. In addition, it was possible to improve the effectiveness of the OFE by including an intensity regulation system, thus allowing the principle of intensity progression to be considered, as well as increasing the control of training intensity in this type of machinery.

Abstract: This study compares the electromyographic activity (EMG) of different muscle groups (rectus femoris, vastus lateralis, biceps femoris, tibialis anterior, and gastrocnemius) of the lower limbs when performing a traditional seated leg press (SLP) with a classic piece of outdoor fitness equipment (OFE-SLP), and with a new OFE leg press that allows the user to adjust the intensity of the exercise by means of a selectorized system (BIOFIT-LP). It was found that the EMG of the OFE-SLP was significantly lower than that of the SLP, but similar activations to those of the SLP were achieved with the BIOFIT-LP. In conclusion, the inclusion of a system to be able to change intensity of the exercise in OFE achieves an EMG activity similar to traditional machinery in trained young men.

Keywords: leg press; lower limb muscle; outdoor gym; resistance training; selectorized stack machine; surface EMG

1. Introduction

The practice of strength training has become popular in recent years, due to the various benefits it brings to the health and functionality of its practitioners [1–3]. Increased strength, hypertrophy, and metabolic improvements are some of the results sought through this type of training [1,4]. To carry this out, multiple resources can be employed, with the use of conventional gym equipment for strength training being one of the most common methods [4–6]. In addition, in recent years, a new line of outdoor fitness equipment (OFE) has emerged, which is sports equipment similar in operation to traditional gym equipment, but commonly located in outdoor public spaces such as parks [7,8]. It has become easier to find OFE due to its increasing popularity, especially among adults and older people who want to improve their health through outdoor strength training [8,9].

It is known that lower limb muscle mass and strength is a determining factor for multiple aspects such as functional capacity [10] and sports performance [11], with strength training of this part of the body being the quintessential means of skeletal muscle mass gain [12]. This has led to a proliferation of machinery to exercise the lower limb musculature, most of them being multi-joint [11,13,14] and involving different muscle groups [11].

However, prior to the use of any type of machinery for strength work, it is necessary to analyze whether it is effective, i.e., whether it achieves a sufficient activation to generate adaptations of the musculature involved, and whether it is safe, i.e., whether it is not harmful to the musculoskeletal and joint health of the exercise performer [15]. In terms of efficacy, techniques such as surface electromyographic analysis (sEMG) are used to determine the musculature involved in the exercise action. This tool allows the study of muscle function through electrophysiological recording techniques that detect the electrical potentials that cross the membrane of the fibers in the superficial muscles involved in each exercise [16]. In this way, electromyographic activity (EMG) makes it possible to discover the degree of neuromuscular activation during the execution of an exercise for each of the muscle groups that are analyzed, demonstrating its efficacy [17,18].

Many studies have analyzed the EMG of the different muscle groups of the lower limbs in exercises performed with conventional gym equipment [19,20], finding that guided machines such as the traditional seated leg press (SLP) are effective for the work of this muscle group, with activation especially observed in the quadriceps femoris muscles [21]. In this type of equipment, it has also been shown that submitting the subject to a greater intensity generates a greater EMG of the involved muscles [22]. However, despite the popularity of OFE and, in many cases, the large investment of public funds being made for the purchase and installation of these machines in public spaces [8,23], thus far it has only been found that their use can improve both the body composition and strength production capacity in legs and arms in the older population [9], and no studies have analyzed whether OFE is effective, i.e., whether it involves the target musculature at an intensity sufficient to generate structural adaptations in the muscle. On the other hand, classical OFE does not allow progression of the intensity of the exercise, as it allows work exclusively with a self-body mass as the unique intensity of the exercise [24]. Therefore, it would be interesting to also analyze the EMG with a new line of OFE that does allow an increase in intensity of the exercise, with a system similar to that of traditional gym equipment. However, so far there are no data available in this regard either.

Therefore, the objectives of this research were: (a) to analyze and compare the EMG of the lower limb muscle groups when performing an SLP with traditional gym equipment, a leg press machine of classic OFE (OFE-SLP), and a leg press machine belonging to a new line of OFE which allows an adjustment in the intensity of the exercise by means of a selectorized system (BIOFIT-LP); and (b) to determine the differences in the EMG of the lower limb muscle groups at 60 and 75% of the 1RM in the machines that allow the selection of the intensity of the exercise (SLP and BIOFIT-LP).

Regarding the hypotheses of the present investigation, it is hypothesized that: (a) there will be an EMG activation of the lower limb muscles when performing the SLP in the three machines, with the activation being greater when using the machines that allow increasing the intensity of the exercise (SLP and BIOFIT-LP) than in those that only allow working with a self-body weight as the unique intensity of the exercise (OFE-SLP). This could imply that the SLP and BIOFIT-LP machines are more effective for lower limb strength training than the OFE-SLP machine. It is also hypothesized that the activation will be similar between the machines that allow selecting the intensity of the exercise (SLP vs. BIOFIT-LP) for the major muscle groups involved, with differences in some of the synergists. This would imply that both could be equally effective in working on lower limb strength in general, with the differences in EMG activation found between both machines being due to biomechanical differences in their execution. Because of the above, the machinery to work with could be selected according to the synergists one prefers to involve to a greater extent; and (b) the greater the intensity of the exercise on the machine, the greater the EMG of the muscles involved in both machines. The consequence of this hypothesis, if it is proven, would be that the intensity of the exercise can be used as another variable in the estimation of the training load, regardless of the model, in the machines that allow a selection of the load.

2. Materials and Methods

2.1. Experimental Approach to the Problem

A randomized cross-sectional study was carried out. It consisted of a cross-sectional study where the 1RM was calculated on the seated leg press (SLP) (Figure 1a) and the new BIOFIT leg press (BIOFIT-LP) (Figure 1b) (session 1 and session 2, 72 h apart), and the EMG activity of five muscle groups was analyzed on three different types of leg press machines (session 3, 72 h after session 2). With respect to the machines chosen, one belongs to a line commonly used in the fitness field, more specifically the SLP model (Technogym; Cesena, Italy), which allows adjusting the intensity of the exercise through the use of a selectorized system [4] (Figure 1a); another is from a classic OFE machine line, corresponding with the same machine model, the Columpio (OFE-SLP) (Entorno Urbano, Murcia, Spain) (Figure 1c), which only allows exercising with self-weight as the unique intensity of the exercise (Chow et al., 2021) [25]; and a third one belongs to a new line of OFE, corresponding to the same machine model, called BIOFIT-LP (Entorno Urbano, Murcia, Spain), which allows adjustment of the intensity of the exercise by means of a selectorized system [4], and which is currently under patent registration (patent registration for the OFE-SLP at the Spanish Patent and Trademark Office, application number: ES2975897; and patent registration for the selector of the intensity of the exercise, Spanish Patent and Trademark Office, application number: ES2975886) (Figure 1b). The operation of this machine is based on two handles to be taken on both sides of the body, starting the movement from a 90° flexion of the knee, and from here one must complete a full knee extension against resistance and against gravity (concentric phase). The intensity of the exercise is selected with a selectorized system. On the other hand, the eccentric phase of this exercise goes from knee extension to 90° knee flexion, a descent movement that is done in favor of gravity (eccentric phase). The study utilized a specific research model, as illustrated in Supplementary Table S1.

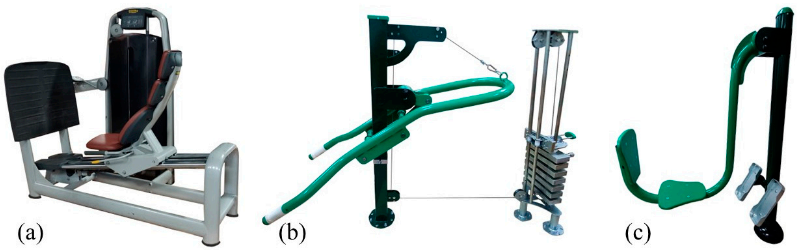

Figure 1. Fitness equipment used. (**a**) Seated leg press (Technogym; Cesena, Italia); (**b**) outdoor fitness equipment leg press with selectorized system (Entorno Urbano, Murcia, Spain); (**c**) outdoor fitness equipment seated leg press (Entorno Urbano, Murcia, Spain).

The study was designed according to the principles of the Declaration of Helsinki and with the prior approval of the institutional ethics committee of the Universidad Católica de Murcia (Ethical Application Ref: CE111908). All participants were informed of the tests to be performed and voluntarily signed a consent form prior to the start of the study.

2.2. Subjects

To calculate the sample size, we used the methodology from previous studies based on the standard deviation (SD) [26]. The Rstudio 3.15.0 software was used for this purpose. Sample size and power were established according to the standard deviation of the peak

EMG activity of the biceps femoris variable (SD = 49.68 μV) presented by a sample of similar characteristics, composed of young males (n = 10) [27]. With an estimated error (d) of 30.79 μV, a confidence interval of 95% (95% CI), a power of 95%, and a significance level of 0.05, the minimum sample needed for conducting the study was 34 subjects.

The sample consisted of 34 males (mean age = 21.54 ± 1.80 years; mean body mass = 74.27 ± 9.99 kg; mean height = 176.62 ± 6.67 cm). The inclusion criteria were: (1) having at least 2 years of experience in training with gym machines and currently training with this methodology at least three times a week; (2) being between 19 and 24 years old; and (3) being male. The exclusion criteria were: (1) having exercised in the 48 h prior to the first session or between evaluation sessions [20]; (2) having suffered any lower extremity, hip, or back injury in the last 6 months; and (3) having any known muscle abnormality or joint disease.

2.3. Measurements

2.3.1. Questionnaire

All participants completed an ad hoc questionnaire to obtain their sociodemographic characteristics, as well as their experience in sports and in the field of machine training and the injuries and pathologies suffered.

2.3.2. Anthropometric Characteristics

Anthropometric measurements of body mass and height were taken following the indications of the International Society for the Advancement of Kinanthropometry (ISAK) [28] by an ISAK-accredited level 2 anthropometrist. A Tanita BC-545N scale (Tanita, Arlington Heights, IL, USA) and an HR001 portable stadiometer (Tanita, Arlington Heights, IL, USA) were used.

2.3.3. Determination of 1RM

The calculation of the 1RM was performed on the SLP and BIOFIT-LP machine, both of which have a selectorized system that allows the intensity of the exercise to be modified. This test was not performed with the OFE-SLP as it does not have any system for increasing the external intensity of the exercise. For the 1RM tests, the order of execution of the SLP and BIOFIT-LP was randomized. In both cases, the protocol proposed by the National Strength and Conditioning Association [29] was employed. Volunteers warmed up by performing a set with an intensity of the exercise with which they could perform between 5 and 10 repetitions. After 1 min of rest, the intensity of the exercise was increased by 10 to 20%, an intensity of the exercise with which the participant had to perform a minimum of 3 and a maximum of 5 repetitions. After 2 min of rest, the intensity of the exercise was increased once again by 10 to 20%. With this intensity of the exercise, the participant had to perform a minimum of 2 and a maximum of 3 repetitions. After this, the intensity of the exercise was increased again by 10 to 20% to perform one repetition, with this weight increased or reduced by 5 and 10%, depending on whether it was lifted correctly or not, until the intensity of the exercise corresponding to the 1RM was obtained. This required a maximum of 5 attempts with different intensity of the exercises, with 4 min of rest between each of them [29]. After 72 h, the same protocol was performed on the other machine, according to the previous randomization performed.

2.3.4. Electromyographic (EMG) Analysis

In a third measurement session, separated by 72 h from the previous session, the EMG of the quadriceps femoris (rectus femoris and vastus lateralis), biceps femoris (long head), tibialis anterior, and gastrocnemius (medial head) muscle groups was measured when performing 5 repetitions on the SLP and BIOFIT-LP machines at 60 and 75% of 1RM. These intensities were chosen as they are commonly used in different training programs, as well as in different EMG studies with guided machinery [30]. The OFE-SLP EMG was analyzed with a single intensity of the exercise allowed (self-weight).

For electrode placement, the different skin areas where the electrodes would be placed were prepared by shaving the hair and cleaning the skin with 96% alcohol and sterile gauze to reduce skin impedance [11,18]. Gelled disposable surface electrodes were used, placed with a 2 cm center-to-center distance, aligned with the longitudinal axis of the muscle fibers, following the methodology from previous studies [31]. The electrodes were placed according to the recommendations of the Surface Electromyography for the Non-invasive Assessment of Muscles (SENIAM) [31] for each of the muscles measured: quadriceps femoris (rectus femoris and vastus lateralis), biceps femoris (long head), tibialis anterior, and gastrocnemius (medial head) (Figure 2). Consistent with similar research, bilateral symmetry was assumed during exercise performance, so electrode placement on the right side of the body was standardized [32]. EMG activity during the exercises was recorded using a surface electromyography system at a sampling rate of 1500 Hz (MuscleLab Ergotest Innovation AS, Stathelle, Norway). The electromyographic signal during the calculation of the 1RM was not taken, since the variability that the EMG signal would present due to fatigue because of the procedure used following the indications of the National Strength and Conditioning Association could lead to bias. In addition, as the sessions in which 1RM was calculated and the sessions in which EMG data were collected were different, variables such as skin impedance or hydration could include more intra-subject variability [11,18]. Therefore, it was decided to measure EMG activation only on the third day, which was the day on which the performance on the different machines was compared.

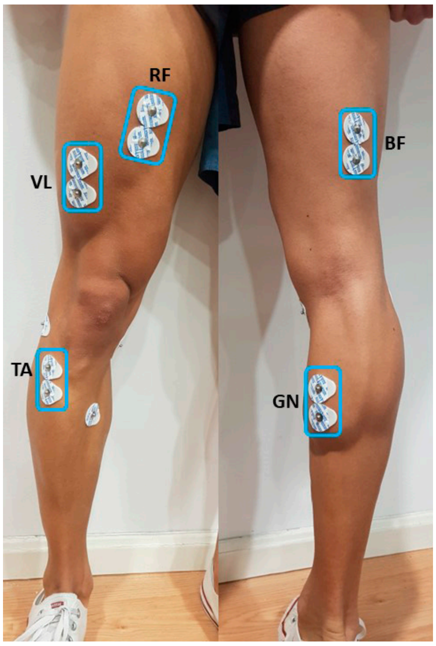

Figure 2. Electrode location on the right leg (**left**—anterior view; **right**—posterior view). RF—rectus femoris, VL—vastus lateralis, BF—biceps femoris, TA—tibialis anterior, GN—gastrocnemius.

Prior to the study, intra-instrument reliability was assessed with a group of 10 training young men by means of test–retest. The tests described above were performed two times in the same session on the same volunteers [33]. It was determined that the electromyographic analysis used in the present study was highly reproducible with a coefficient of variation between 7 and 14% for all muscles on all machines, confirming that the measurement used was sufficiently reproducible.

2.3.5. Determination of Concentric and Eccentric Phases

To differentiate the concentric and eccentric phases during exercise execution, a MuscleLab twin axial electrogoniometer was used (Ergotest Innovation AS, Stathelle, Norway). It was placed on the subject's left leg at the knee joint on the lateral outer side. The distal gauge of the goniometer was aligned with respect to the leg, while the fixed gauge was aligned with respect to the thigh [34]. It was calibrated using a hand-held goniometer at 90° of knee flexion in stable relaxed sedentation. The point of maximum knee extension was checked in situ, thus differentiating the concentric phase as those data recorded from the beginning at 90° of knee flexion up to that maximum knee extension, and the eccentric phase as the data recorded from maximum knee extension to 90° of knee flexion. The complete phase consisted of the analysis of the entire joint range recorded from 90° of onset to 90° of end [35].

2.4. Randomization and Blinding

Following the methodology from previous studies, the order of execution of the machines for 1RM analysis, of execution of the machines for EMG analysis, and of the 1RM intensity at which each machine was to be started were randomized [27]. This process was performed by the principal investigator in the presence of investigators external to the present research, using a computer-generated random number table.

All measurements were performed after randomization. The investigators who performed the EMGs did not participate in the 1RM calculation tests. In the measurements, the two investigators involved in the data collection were also cross-blinded, whereby one controlled the exercise execution technique and provided the guidelines for the development of the protocol, and the other investigator was only in charge of verifying the correct recording of the EMG data.

2.5. Procedure

Figure 3 shows in schematic form the procedures carried out during the three sessions. In session 1, the volunteers self-completed the ad hoc questionnaire, followed by anthropometric measurements. After this, the key points for the correct execution on each of the three machines (SLP, OFE-SLP, and BIOFIT-LP) were explained to them, in order to familiarize the participants with the expected execution technique on each of them for data collection. More specifically, an indication was given to them that the executions on the different machines should include the full range of motion from a 90° knee flexion to full extension, keeping the sole of the foot fixed in position and maintaining contact with the floor/platform for the duration of the repetition.

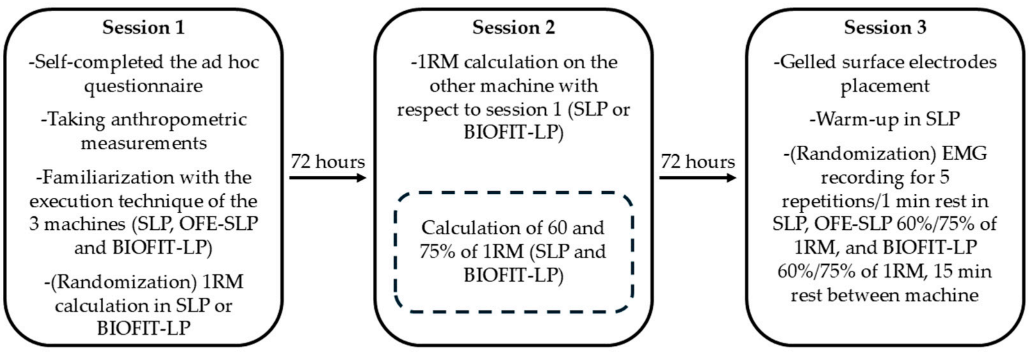

Figure 3. Flow diagram.

After this, the subjects performed the procedure for the calculation of the 1RM on the SLP or BIOFIT-LP machines, whose execution order was established randomly. In session 2, the process was repeated for the other machine. With the data obtained with this procedure, the 60 and 75% values of the 1RM intensity of the exercise were subsequently calculated for each subject on both machines.

In session 3, after electrode placement, participants performed a warm-up set consisting of 12 repetitions at 30% of 1RM, 10 repetitions at 50% of 1RM, 8 repetitions at 70% of 1RM, and 2 repetitions at 90% of 1 RM on the SLP machine, as the subjects had the most previous experience with it, as in similar studies [36]. Subsequently, the EMG measurement was started in the machine assigned randomly (SLP, OFE-SLP, or BIOFIT-LP). In the case of SLP and BIOFIT-LP machines, the intensity was also randomized (60% or 75% of 1RM). The participant was asked to perform 5 repetitions on the first machine and at the first intensity percentage, with a constant speed throughout [11]. A rest of 1 min was given between each of the repetitions to avoid the effect of fatigue. After 15 min, the same protocol was performed on the same machine, but with the other intensity percentage. After finishing the entire protocol with the first machine, a 15 min rest was provided, after which the protocol was started with the second machine, following the same procedure described above [11]. In the OFE-SLP case, 1 set of 5 repetitions was performed following the procedure previously described with the participant's self-weight, as the participant's intensity of the exercise could not be adjusted [25]. Resting times were set following previous methodologies, so that fatigue would not affect the results [22]. For the analysis of the data, the methodology of a previous study was followed [11]; the first and last repetitions were discarded, and the repetition with the highest root mean square (RMS) of the main muscle group of the movement, the rectus femoris, was selected, provided that it had been performed correctly, with a recording performed in each of the muscles involved [14,37,38].

All measurement sessions were separated by 72 h to avoid possible fatigue effects [37]. All subjects were summoned to all sessions at 8:00 a.m. The measurements were performed in the same room, with a standardized temperature of 20 °C and constant humidity conditions (60%).

2.6. Statistical Analysis

All data were analyzed using the Musclelab v10.5.67 software (MuscleLab Ergotest Innovation AS, Stathelle, Norway) by passing the raw amplified EMG signal to RMS [14,38]. Thus, the RMS of the peak EMG activity variable was taken in the complete repetition, and in its concentric and eccentric phases, for each muscle group, for the subsequent comparison between machines, as in previous studies [39]. The statistical analysis of the data was performed using SPSS software (Version 25; IBM Corporation, Armonk, NY, USA). The Kolmogorov–Smirnov test and Mauchly's W test were used to evaluate the normality of the data. The mean and standard deviation were calculated. A repeated-measures ANOVA and Bonferroni's correction were used to compare the different muscle activations between machines. To protect against a Type I error, Bonferroni's correction was used to achieve $p = 0.005$ for statistical significance. The effect size was calculated using partial eta-squared (η^2p) for analysis of variance and will be defined as small: ES $\geq$ 0.10; moderate: ES $\geq$ 0.30; large: ES $\geq$ 1.2; or very large: ES $\geq$ 2.0. An error of $p < 0.05$ was established.

3. Results

Table 1 shows the 1RM strength test results for the traditional SLP and BIOFIT-LP machines.

Table 1. Results of the 1RM strength test.

	1RM	60% 1RM	75% 1RM
SLP (kg)	201.51 ± 35.35	120.91 ± 21.21	151.14 ± 26.51
BIOFIT-LP (kg)	56.31 ± 13.72	31.85 ± 11.27	39.82 ± 14.09

1RM = one-repetition maximum; BIOFIT-LP = BIOFIT leg press; SLP = traditional seated leg press.

Table 2 and Figure 4 show the mean and standard deviation of the root mean square recorded in each of the muscles analyzed during the use of the SLP at 60 and 75% of 1RM, the BIOFIT-LP at 60 and 75% of 1RM, and the OFE-SLP with self-weight as intensity of the exercise. In all cases, it was found that the vastus lateralis was the muscle group that attained the greatest activation, followed by the rectus femoris, and thirdly by the tibialis anterior. After these, in the case of SLP and BIOFIT-LP, the next muscle groups with the highest activation were the biceps femoris and gastocnemius, in that order; while with the OFE-SLP machine, the order of the latter was reversed.

Table 2. Root mean square (μV) recording of the electromyographic signal in the different machines with different 1RM intensities.

	VL (M ± SD)	RF (M ± SD)	BF (M ± SD)	TA (M ± SD)	GN (M ± SD)
Complete					
SLP 60%	199.17 ± 61.46	134.96 ± 50.57	64.77 ± 38.23	68.29 ± 37.92	61.43 ± 32.66
SLP 75%	241.01 ± 70.83	176.98 ± 72.18	82.17 ± 39.51	88.08 ± 37.27	77.65 ± 37.31
BIOFIT-LP 60%	219.09 ± 69.23	149.25 ± 64.14	57.51 ± 33.48	133.69 ± 63.86	39.48 ± 20.78
BIOFIT-LP 75%	235.99 ± 75.52	162.60 ± 67.85	67.91 ± 36.25	140.83 ± 80.50	43.11 ± 19.41
OFE-SLP	66.89 ± 26.28	30.00 ± 17.76	21.22 ± 10.04	58.18 ± 55.18	40.18 ± 26.93
Concentric					
SLP 60%	224.98 ± 66.44	149.84 ± 60.63	77.11 ± 38.01	81.63 ± 46.72	75.83 ± 41.86
SLP 75%	274.71 ± 80.92	206.55 ± 88.28	95.83 ± 43.83	100.44 ± 49.77	90.85 ± 40.21
BIOFIT-LP 60%	251.12 ± 80.71	157.21 ± 74.59	69.14 ± 30.52	104.11 ± 51.47	48.86 ± 26.96
BIOFIT-LP 75%	271.15 ± 91.27	175.80 ± 74.10	82.08 ± 38.36	120.86 ± 67.79	50.45 ± 22.55
OFE-SLP	75.26 ± 32.99	28.09 ± 13.92	25.92 ± 12.39	38.52 ± 31.77	49.11 ± 32.26
Eccentric					
SLP 60%	168.86 ± 66.04	114.56 ± 56.17	39.28 ± 26.53	49.32 ± 31.60	41.51 ± 23.71
SLP 75%	196.34 ± 70.17	138.85 ± 60.05	50.26 ± 27.46	68.47 ± 30.36	53.89 ± 27.49
BIOFIT-LP 60%	179.06 ± 59.44	138.64 ± 63.56	26.94 ± 11.79	151.36 ± 89.07	24.41 ± 13.89
BIOFIT-LP 75%	187.59 ± 60.51	146.03 ± 68.19	32.87 ± 15.79	153.58 ± 104.76	30.84 ± 18.44
OFE-SLP	57.08 ± 27.61	28.70 ± 19.35	16.00 ± 9.36	64.52 ± 70.84	30.65 ± 23.68

BF = biceps femoris; BIOFIT-LP = BIOFIT leg press; GN = gastrocnemius; OFE-SLP = classic OFE; RF = rectus femoris; SLP = traditional seated leg press; TA = tibialis anterior; VL = vastus lateralis.

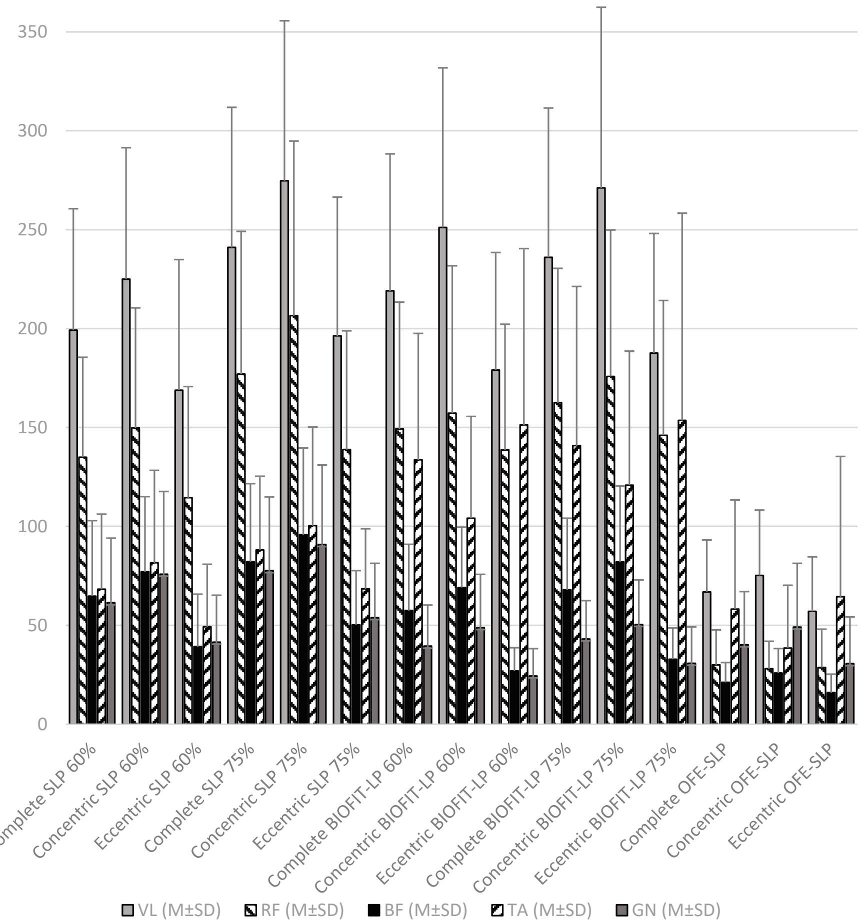

Figure 4. Root mean square (μV) representation of the electromyographic signal in the different machines with different 1RM intensities.

Table 3 shows the differences between machines and between intensity percentages in the complete run, Table 4 shows the concentric phase, and Table 5 shows the eccentric phase. No significant differences were found in the activation of any muscle group when comparing the SLP and BIOFIT-LP machines at the same intensity (60% 1RM vs. 60% 1RM or 75% 1RM vs. 75% 1RM), neither in the complete run, in the concentric phase, nor in the eccentric phase ($p > 0.05$), except for the biceps femoris in the eccentric phase at 75% 1RM, which showed a greater significant activation in SLP as compared to BIOFIT-LP (ES = 0.60; moderate effect size; $p < 0.01$); in the tibialis anterior, where there was a greater activation at both intensities in the BIOFIT-LP machine in the full stroke (ES = 0.53–0.86; moderate effect size; $p < 0.01$–0.001) and eccentric phase (ES = 0.69–0.89; moderate effect size; $p < 0.001$), but not in the concentric phase (ES = 0.3–0.5; moderate effect size; $p > 0.05$); and gastrocnemius, which showed a greater activation in SLP than in BIOFIT-LP at both intensities and all phases (ES = 0.68–0.91; moderate effect size; $p < 0.05$–0.001).

Table 3. Differentiation of peak electromyographic activity (µV) between different machines and intensities of 1RM during a full execution.

Complete Repetition		SLP 60%	SLP 75%	BIOFIT-LP 60%	BIOFIT-LP 75%	OFE-SLP
Vastus Lateralis	SLP 60%	-	−41.84 ± 4.48 †	−19.92 ± 8.38	−36.82 ± 9.80 **	132.285 ± 8.82 †
	SLP 75%	41.84 ± 4.48 †	-	21.91 ± 8.16	5.01 ± 9.93	174.12 ± 10.91 †
	BIOFIT-LP 60%	19.92 ± 8.38	−21.91 ± 8.16	-	−16.90 ± 5.03 *	152.21 ± 9.76 †
	BIOFIT-LP 75%	36.82 ± 9.80 **	−5.01 ± 9.93	16.90 ± 5.03 *	-	169.11 ± 10.82 †
	OFE-SLP	−132.29 ± 8.82 †	−174.12 ± 10.91 †	−152.21 ± 9.76 †	−169.11 ± 10.82 †	-
Rectus Femoris	SLP 60%	-	−42.02 ± 5.84 †	−14.30 ± 8.89	−27.64 ± 10.59	104.96 ± 8.03 †
	SLP 75%	42.02 ± 5.84 †	-	27.73 ± 10.74	14.38 ± 13.28	146.98 ± 11.84 †
	BIOFIT-LP 60%	14.30 ± 8.89	−27.73 ± 10.74	-	−13.34 ± 6.40	119.26 ± 10.04 †
	BIOFIT-LP 75%	27.64 ± 10.59	−14.38 ± 13.28	13.34 ± 6.40	-	132.60 ± 10.86 †
	OFE-SLP	−104.96 ± 8.03 †	−146.98 ± 11.84 †	−119.26 ± 10.04 †	−132.60 ± 10.86 †	-
Biceps Femoris	SLP 60%	-	−17.40 ± 3.41 †	7.25 ± 5.70	−3.14 ± 6.75	43.55 ± 6.82 †
	SLP 75%	17.40 ± 3.41 †	-	24.65 ± 5.99 **	14.26 ± 6.80	60.94 ± 6.75 †
	BIOFIT-LP 60%	−7.25 ± 5.70	−24.65 ± 5.99 **	-	−10.39 ± 2.83 *	36.29 ± 6.11 †
	BIOFIT-LP 75%	3.14 ± 6.75	−14.26 ± 6.80	10.39 ± 2.83 *	-	46.68 ± 6.44 †
	OFE-SLP	−43.55 ± 6.82 †	−60.94 ± 6.75 †	−36.29 ± 6.11 †	−46.68 ± 6.44 †	-
Tibialis Anterior	SLP 60%	-	−19.78 ± 3.35 †	−65.39 ± 10.69 †	−72.54 ± 13.67 †	10.12 ± 9.63
	SLP 75%	19.78 ± 3.35 †	-	−45.61 ± 10.58 **	−52.75 ± 12.87 **	29.90 ± 10.28
	BIOFIT-LP 60%	65.39 ± 10.69 †	45.61 ± 10.58 **	-	−7.14 ± 8.37	75.51 ± 10.48 †
	BIOFIT-LP 75%	72.54 ± 13.67 †	52.75 ± 12.87 **	7.14 ± 8.37	-	82.65 ± 14.59 †
	OFE-SLP	−10.12 ± 9.63	−29.90 ± 10.28	−75.51 ± 10.48 †	−82.65 ± 14.59 †	-
Gastrocn-emius	SLP 60%	-	−16.22 ± 3.80 **	21.96 ± 5.64 **	18.32 ± 5.72 *	21.25 ± 5.78 **
	SLP 75%	16.22 ± 3.80 **	-	38.17 ± 5.93 †	34.54 ± 6.42 †	37.46 ± 6.87 †
	BIOFIT-LP 60%	−21.96 ± 5.64 **	−38.17 ± 5.93 †	-	−6.63 ± 2.40	−0.71 ± 5.56
	BIOFIT-LP 75%	−18.32 ± 5.72 *	−34.54 ± 6.42 †	6.63 ± 2.40	-	2.93 ± 5.28
	OFE-SLP	−21.25 ± 5.78 **	−37.46 ± 6.87 †	0.71 ± 5.56	−2.93 ± 5.28	-

BIOFIT-LP = BIOFIT leg press; OFE-SLP = classic OFE; SLP = seated leg press; * = p value < 0.05; ** = p value < 0.01; † = p value < 0.001.

Table 4. Differentiation of peak electromyographic activity (µV) between different machines and 1RM intensities during the concentric phase.

	Concentric Phase	SLP 60%	SLP 75%	BIOFIT-LP 60%	BIOFIT-LP 75%	OFE-SLP
Vastus Lateralis	SLP 60%	-	−49.73 ± 7.90 †	−26.14 ± 11.69	−46.17 ± 14.00 *	149.72 ± 10.35 †
	SLP 75%	49.73 ± 7.90 †	-	23.59 ± 10.00	3.56 ± 13.40	199.45 ± 13.69 †
	BIOFIT-LP 60%	26.14 ± 11.69	−23.59 ± 10.00	-	−20.03 ± 6.41 *	175.86 ± 13.00 †
	BIOFIT-LP 75%	46.17 ± 14.00 *	−3.56 ± 13.40	20.03 ± 6.41 *	-	195.89 ± 14.67 †
	OFE-SLP	−149.72 ± 10.35 †	−199.45 ± 13.69 †	−175.86 ± 13.00 †	−195.89 ± 14.67 †	-
Rectus Femoris	SLP 60%	-	−56.72 ± 8.37 †	−7.37 ± 11.84	−25.96 ± 14.09	121.75 ± 10.01 †
	SLP 75%	56.72 ± 8.37 †	-	49.35 ± 14.86 *	30.76 ± 17.70	178.46 ± 15.09 †
	BIOFIT-LP 60%	7.37 ± 11.84	−49.35 ± 14.86 *	-	−18.59 ± 8.61	129.11 ± 12.32 †
	BIOFIT-LP 75%	25.96 ± 14.09	−30.76 ± 17.70	18.59 ± 8.61	-	147.71 ± 12.19 †
	OFE-SLP	−121.75 ± 10.01 †	−178.46 ± 15.09 †	−129.11 ± 12.32 †	−147.71 ± 12.19 †	-
Biceps Femoris	SLP 60%	-	−18.72 ± 4.68 **	7.97 ± 7.31	−4.98 ± 8.76	51.19 ± 7.05 †
	SLP 75%	18.72 ± 4.68 **	-	26.69 ± 7.99 *	13.75 ± 8.90	69.91 ± 7.75 †
	BIOFIT-LP 60%	−7.97 ± 7.31	−26.69 ± 7.99 *	-	−12.94 ± 3.82 *	43.22 ± 5.72 †
	BIOFIT-LP 75%	4.98 ± 8.76	−13.75 ± 8.90	12.94 ± 3.82 *	-	56.17 ± 7.00 †
	OFE-SLP	−51.19 ± 7.05 †	−69.91 ± 7.75 †	−43.22 ± 5.72 †	−56.17 ± 7.00 †	-
Tibialis Anterior	SLP 60%	-	−18.82 ± 3.91 †	−22.49 ± 9.25	−39.24 ± 13.60	43.11 ± 8.65 †
	SLP 75%	18.82 ± 3.91 †	-	−3.67 ± 8.61	−20.42 ± 12.53	61.92 ± 9.58 †
	BIOFIT-LP 60%	22.49 ± 9.25	3.67 ± 8.61	-	−16.75 ± 9.42	68.59 ± 9.80 †
	BIOFIT-LP 75%	39.24 ± 13.60	20.42 ± 12.53	16.75 ± 9.42	-	82.34 ± 13.03 †
	OFE-SLP	−43.11 ± 8.65 †	−61.92 ± 9.58 †	−68.59 ± 9.80 †	−82.34 ± 13.03 †	-
Gastrocn-emius	SLP 60%	-	−15.02 ± 4.80 *	26.96 ± 7.39 *	25.38 ± 7.21 *	26.72 ± 7.11 **
	SLP 75%	15.02 ± 4.80 *	-	41.98 ± 6.56 †	40.40 ± 6.91 †	41.74 ± 6.85 †
	BIOFIT-LP 60%	−26.96 ± 7.39 *	−41.98 ± 6.56 †	-	−1.59 ± 3.29	−0.24 ± 6.95
	BIOFIT-LP 75%	−25.38 ± 7.21 *	−40.40 ± 6.91 †	1.59 ± 3.29	-	1.35 ± 6.40
	OFE-SLP	−26.72 ± 7.11 **	−41.74 ± 6.85 †	0.24 ± 6.95	−1.35 ± 6.40	-

BIOFIT-LP = BIOFIT leg press; OFE-SLP = classic OFE; SLP = seated leg press; * = p value < 0.05; ** = p value < 0.01; † = p value < 0.001.

When comparing the OFE-SLP with SLP and the OFE-SLP with BIOFIT-LP, a significantly lower activation was found in the OFE-SLP for all muscle groups, in the full stroke, concentric, and eccentric phases (ES = 0.69–1.08; moderate effect size; $p < 0.01$–0.001), except for the tibialis anterior as compared to SLP for the full stroke and eccentric phase (ES = 0.09–0.42; effect size between small and moderate; $p > 0.05$); for the gastrocnemius as compared to BIOFIT-LP for the full stroke, concentric phase, and eccentric phase (ES = 0.09–0.2; small effect size; $p > 0.05$); and for the gastrocnemius as compared to SLP at 60% 1RM in the eccentric phase (ES = 0.25; small effect size; $p > 0.05$).

When comparing the OFE-SLP with SLP and the OFE-SLP with BIOFIT-LP, a significantly lower activation was found in the OFE-SLP for all muscle groups, in the full stroke, concentric, and eccentric phases (ES = 0.2–0.5 effect size between small and moderate; $p < 0.01$–0.001), except for the tibialis anterior, as compared to SLP for the full stroke and eccentric phase (ES = 0.14–0.5; effect size between small and moderate; $p > 0.05$); for the gastrocnemius, as compared to BIOFIT-LP for the full stroke, concentric phase, and eccentric phase (ES = 0.2–0.9; effect size between small and moderate; $p > 0.05$); and for the gastrocnemius as compared to SLP at 60% 1RM in the eccentric phase (ES = 0.25; small effect size; $p > 0.05$).

Table 5. Differentiation of peak electromyographic activity (µV) between different machines and 1RM intensities during the eccentric phase.

Eccentric Phase		SLP 60%	SLP 75%	BIOFIT-LP 60%	BIOFIT-LP 75%	OFE-SLP
Vastus Lateralis	SLP 60%	-	−27.48 ± 3.49 †	−10.20 ± 7.63	−18.73 ± 7.11	111.79 ± 8.78 †
	SLP 75%	27.48 ± 3.49 †	-	17.28 ± 8.74	8.75 ± 8.02	139.27 ± 9.61 †
	BIOFIT-LP 60%	10.20 ± 7.63	−17.28 ± 8.74	-	−8.53 ± 4.09	121.99 ± 7.41 †
	BIOFIT-LP 75%	18.73 ± 7.11	−8.75 ± 8.02	8.53 ± 4.09	-	130.52 ± 7.55 †
	OFE-SLP	−111.79 ± 8.78 †	−139.27 ± 9.61 †	−121.99 ± 7.41 †	−130.52 ± 7.55 †	-
Rectus Femoris	SLP 60%	-	−24.29 ± 6.01 **	−24.08 ± 11.08	−31.47 ± 11.64	85.86 ± 8.64 †
	SLP 75%	24.29 ± 6.01 **	-	0.21 ± 10.15	−7.18 ± 11.48	110.15 ± 9.63 †
	BIOFIT-LP 60%	24.08 ± 11.08	−0.21 ± 10.15	-	−7.39 ± 6.28	109.94 ± 9.10 †
	BIOFIT-LP 75%	31.47 ± 11.64	7.18 ± 11.48	7.39 ± 6.28	-	117.33 ± 10.15 †
	OFE-SLP	−85.86 ± 8.64 †	−110.15 ± 9.63 †	−109.94 ± 9.10 †	−117.33 ± 10.15 †	-
Biceps Femoris	SLP 60%	-	−10.97 ± 2.70 **	12.35 ± 4.19	6.41 ± 4.27	23.28 ± 4.46 †
	SLP 75%	10.97 ± 2.70 **	-	23.32 ± 4.43 †	17.38 ± 4.58 **	34.25 ± 4.15 †
	BIOFIT-LP 60%	−12.35 ± 4.19	−23.32 ± 4.43 †	-	−5.94 ± 1.51 **	10.94 ± 2.41 **
	BIOFIT-LP 75%	−6.41 ± 4.27	−17.38 ± 4.58 **	5.94 ± 1.51 **	-	16.87 ± 2.92 †
	OFE-SLP	−23.28 ± 4.46 †	−34.25 ± 4.15 †	−10.94 ± 2.41 **	−16.87 ± 2.92 †	-
Tibialis Anterior	SLP 60%	-	−19.16 ± 3.49 †	−102.04 ± 14.40 †	−104.26 ± 16.56 †	−15.20 ± 11.15
	SLP 75%	19.16 ± 3.49 †	-	−82.89 ± 15.02 †	−85.11 ± 16.76 †	3.95 ± 11.70
	BIOFIT-LP 60%	102.04 ± 14.40 †	82.89 ± 15.02 †	-	−2.22 ± 9.75	86.84 ± 13.62 †
	BIOFIT-LP 75%	104.26 ± 16.56 †	85.11 ± 16.76 †	2.22 ± 9.75	-	89.06 ± 17.86 †
	OFE-SLP	15.20 ± 11.15	−3.95 ± 11.70	−86.84 ± 13.62 †	−89.06 ± 17.86 †	-
Gastrocnemius	SLP 60%	-	−12.38 ± 2.44 †	17.11 ± 4.54 **	10.67 ± 4.70	10.86 ± 4.30
	SLP 75%	12.38 ± 2.44 †	-	29.48 ± 5.20 †	23.04 ± 5.32 **	23.24 ± 4.90 **
	BIOFIT-LP 60%	−17.11 ± 4.54 **	−29.48 ± 5.20 †	-	−6.44 ± 1.73 **	−6.25 ± 3.94
	BIOFIT-LP 75%	−10.67 ± 4.70	−23.04 ± 5.32 **	6.44 ± 1.73 **	-	0.19 ± 4.47
	OFE-SLP	−10.86 ± 4.30	−23.24 ± 4.90 **	6.25 ± 3.94	−0.19 ± 4.47	-

BIOFIT-LP = BIOFIT leg press; OFE-SLP = classic OFE; SLP = seated leg press ** = p value < 0.01; † = p value < 0.001.

4. Discussion

The main objective of this research was to analyze and compare the EMG activity of the muscle groups of the lower limbs produced during the execution of the leg press with a traditional SLP machine, and OFE-SLP and BIOFIT-LP machines. The results showed that in all three machines, the most activated muscle group was the vastus lateralis, followed by the rectus femoris and tibialis anterior. These results coincide with those found in a similar study, in which a high activation of the vastus lateralis, as well as the rectus femoris and tibialis anterior, was observed during the use of an SLP [22,27,40]. In light of these results, the performance of exercises involving simultaneous ankle and knee extension, regardless of the small biomechanical differences between exercises, involves the same major muscle groups [11]. This corroborates the findings of recent studies, in which muscle electrical activity was analyzed in exercises such as the SLP, the leg press at 45°, and the squat, finding that they all activate the same major muscle groups, despite their differences in execution, as they are all lower limb press exercises [1,11,14]. Furthermore, as all exercises are performed on stable, guided machines, the core musculature may be more involved, as they rely less on the stabilizing musculature, as compared to exercises with free weights [41] Therefore, it is possible to proceed to the comparison of the machines with each other.

In this regard, an outstanding result of the present investigation was that when comparing machines with the same percentage of intensity, more specifically the EMG activities measured in the SLP and the BIOFIT-LP, similar percentages of activation were found both at 60% and 75% of the 1RM in the main muscle groups involved, in the full stroke, and in the concentric and eccentric phases. No previous studies have analyzed EMG activity in OFE with a selector for the intensity of the exercise, and no studies were found that compared the same model of indoor and outdoor machines, with the present study being a pioneer in this aspect. However, in other studies comparing indoor machines designed to work the same muscle group, it has been found that at similar percentages of 1RM, the EMG activity of the main muscles involved is similar [19], confirming the results of the present study. In light of these results, it can be affirmed, along the same lines as previous studies, that the amplitude of the EMG was greatly dependent on intensity rather than on the execution technique for both traditional SLP and BIOFIT-LP machines [42].

However, a significantly greater activation was observed in the BIOFIT-LP machine as compared to the SLP machine for the tibialis anterior at both intensities in the full stroke and concentric phase, but not the eccentric one. In contrast, the gastrocnemius showed a greater activation in the SLP as compared to the BIOFIT-LP machine at both intensities and all phases, and the biceps femoris showed greater activation in the SLP at 75% 1RM during the eccentric phase. As observed in several studies, the position of the selector of the intensity of the exercise and ergonomic and biomechanical characteristics of the equipment with respect to the joint levers condition the participation of certain muscle groups [3,43,44]. In this sense, the findings for the SLP machine are in line with what was found in previous studies, where it was shown that in this machine, an increased activation of the biceps femoris and gastrocnemius was generated, especially in the push-off phase [4], due to the co-contraction of these muscle groups, together with the extensor musculature of the knee, to improve the anteroposterior stability of the joint in the angulations of greater instability [4]. Another possible explanation is that the projection of the intensity of the exercise in the SLP falls forward with respect to the base of support and the support of the feet, so that the co-activation of the biceps femoris and gastrocnemius is vital for knee stabilization [4,45]. In contrast, in the BIOFIT-LP machine, the intensity of the exercise projection falls further back with respect to the base of support and foot support, which could favor the activation of the tibialis anterior as a stabilizer of the ankle joint [46]. For all of the above, in general terms, it can be stated that with the new BIOFIT-LP design, an EMG similar to that achieved with the traditional fitness room machines, such as the SLP, could be achieved. Therefore, this new machine design could provide an alternative for effective strength training, albeit outdoors and free of charge, with the advantages that this could have for the health of the population [8]. However, the lack of previous studies analyzing this issue with OFE, and the fact that the studies that have analyzed EMG activity with traditional SLP have included fewer muscle groups than in the present investigation [19], makes it necessary to conduct future research that contrasts the results of the present investigation.

Another relevant result of the present investigation was that when comparing the EMG of the BIOFIT-LP and SLP, with respect to the OFE-SLP, the machines with an external selector for the intensity of the exercise showed significantly higher values in all muscle groups, regardless of the intensity of the exercise, with a few exceptions. Despite the popularity of OFE in recent years [8,24,25], no previous study was found that analyzed EMG activity on this type of machine, so that its efficacy is somewhat uncertain [47]. However, previous studies have pointed out that intensity selection conditions fiber recruitment, and therefore the recorded signal [48,49]. Considering that the classic OFE line only allows working with self-weight [24], the results of the present investigation could be due to the fact that the subjects' own weight did not represent an intensity close to their 60% or 75% of the 1RM during the use of the OFE-SLP. Therefore, in light of the results of the present investigation, the OFE-SLP machine may have a limited efficacy, given the EMG activity it generates [47]. Therefore, it would have little capacity to generate adaptations, especially in terms of hypertrophy in most of the population, as it is lacking the increased muscle recruitment that can potentially provide a more anabolic stimulus [6], being able to only provide a sufficient stimulus in populations with low fitness levels, such as older detrained populations [23].

However, when comparing the EMG of the OFE-SLP with respect to the other two machines, no differences were found in the tibialis anterior as compared to the SLP for the full stroke and eccentric phase; for the gastrocnemius as compared to the BIOFIT-LP for the full stroke, and the concentric and eccentric phases; and for the gastrocnemius as compared to the SLP at 60% 1RM in the eccentric phase. The discussion of this section is limited, as only one article was found that analyzed the activity of gastrocnemius and tibialis anterior at the same time during the use of guided machines for lower limb training [40], developed on classic fitness center machinery, without including any type of OFE in the analysis. In any case, the function of the gastrocnemius and tibialis anterior muscle groups in this type of exercise is stabilization [4,19], so the lack of differences in EMG between machines may be due to the fact that the execution of these exercises, when performed with guided machines, may not be greatly dependent on these stabilizers [4].

The second objective of this work was to determine the differences in the EMG of the muscle groups of the lower limbs at 60 and 75% of the 1RM on machines that allow selection of the intensity of the exercise (SLP and BIOFIT-LP). The results showed an increase in the EMG activity of all the muscle groups analyzed when performing at an intensity of 75% of the 1RM, compared to 60% of the 1RM, both for the full stroke and for the concentric and eccentric phases in the SLP. The results are in line with those found in previous studies, in which an increase in EMG was found with an increasing intensity [22]. This is because at higher intensities, the recruitment and firing frequency of the recruited motor units increases [48,49].

In contrast, the BIOFIT-LP machine showed significant differences with increasing intensity only in the vastus lateralis for the full stroke and concentric phase, in the biceps femoris for the full stroke and concentric and eccentric phases, and in the gastrocnemius for the eccentric phase. No differences were found in any of the EMG cases on this machine with an increasing intensity for the rectus femoris and tibialis anterior. The fact that differences were found in the posterior musculature in the eccentric phase could be due to the fact that this phase in this exercise is performed in favor of gravity, and the participants were asked to perform it at a controlled speed, so that in the face of an increase in the intensity, it is possible that there would be an increase in EMG activation responsible for slowing down the movement, i.e., posterior musculature [14,50]. In contrast, the concentric phase is performed against gravity, which might require a greater activation of the biceps femoris musculature as the main knee stabilizer [14]. Regarding the vastus lateralis and rectus femoris, the intensity could have been insufficient for the recruitment of more fibers by the rectus femoris, showing differences only in the vastus lateralis. Previous studies have indicated that at high intensity (90% of the 1RM), the vastus lateralis presents greater activations than the rectus femoris [22]. For this same reason, the signal recorded in the tibialis anterior did not present significant differences even when increasing the intensity, indicating the lack of a different stimulus in terms of joint stabilization [46]. Based on the results of the present investigation, in general terms, an increase in the intensity could imply an increase in the recruitment of fibers of the main musculature involved, and therefore, of the adaptations that will be achieved by training with such machinery [22].

The main practical application of this research is that a new line of OFE that has a series of adaptations to be able to adjust the intensity of the exercise achieves similar EMG activations to conventional gym machinery. This information is valuable for both users and trainers, as it demonstrates that this line of machines could be just as effective as conventional machinery to train lower limbs in trained young men. Most of these machines are located in free, open-access facilities, providing an opportunity for the population to do strength work in an economical way and outdoors. The present research also shows that when this type of OFE does not have a system to adjust the intensity of the exercise, a lower EMG intensity is generated, so that the use of OFE that only allows training with one's own body weight could be less effective for strength training than machines that allow an adjustment of the intensity of the exercise in trained young men. Therefore, it would be advisable for public agencies that are investing in the installation of this OFE in public spaces to consider this in order to choose models that have an adjustment of the intensity of the exercise, thus maximizing the population that will be able to train effectively in these facilities. Regarding possible future lines of research, it would be advisable to analyze other prototypes of OFE to study the effect of different design changes on the EMG presented during their use in the different muscle groups. On the other hand, in the current study, the effect of fatigue was mitigated by allowing a minute of rest between each repetition [51]. Even so, future studies should use one of the various methods of analysis of neuromuscular fatigue [52] as well as zero-crossing of EMG signal [53]. In addition, it would be recommended to replicate the study in a female population or in other age populations to analyze whether the results are replicable in other populations.

Despite the novelty of the present study with respect to previous research on the analysis of the effectiveness of OFE, the present investigation is not without limitations. First, the EMG analysis of the gluteus as a hip extensor was not included due to the location of the electrodes being incompatible with the execution of the exercise on the machines, which is performed from sedentation (SLP and BIOFIT-LP). As a second limitation, the three machines exhibited small variations in the biomechanics of execution, which are conditioned by the mechanism of each of the structures, which makes the comparison between the exercises not exact. As a third limitation, the present study did not include the maximum voluntary contraction test as a variable in the EMG analysis, nor did it record the EMG during the 1RM test, variables that could have helped to differentiate the percentage of activation of each muscle group with respect to its maximum for each of the exercises involved. However, the EMG activation tests on the different machines were performed on the same day, following a randomized order, to eliminate the effect of daily variation on this variable. As a final limitation, although an in situ goniometric analysis was used to differentiate the concentric and eccentric phase, the present study did not include a goniometric analysis of the ankle, knee, and hip joints in the data analysis, which could have helped to discern the origin of the difference in EMG activation between some of the machines.

5. Conclusions

It was observed that the EMG activity presented by the current OFE, designed to strengthen the lower limb musculature (OFE-SLP), is significantly lower than that of the SLP, a machine commonly used in strength training in fitness centers by trained young men. On the other hand, it was found that when some changes in the machine configuration are made to the OFE, and an external intensity of the exercise is included, as performed on the BIOFIT-LP machine, activations similar to those of the SLP are achieved in trained young men. Moreover, in general terms, a higher intensity implied a higher activation of the involved musculature in trained young men. In light of these results, OFE could be considered an alternative to traditional machines for strength work in trained young men.

6. Patents

This research includes data on a new machine for the outdoor fitness equipment line, which is in the process of patenting by the Spanish Patent and Trademark Office (code: ES2975897), as well as of an external intensity of the exercise selection system for this machine (code: ES2975886).

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app14167390/s1, Table S1: Research model.

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