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The Effect of Bodyweight Support and Incline Running on Triceps Surae Electromyographic Activity

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Abstract: Body weight support (BWS) and incline running (IR) are commonly used either during rehabilitation or during training separately, with many positive effects on athletes' performance and rehabilitation. The aim of the present study was to investigate the interaction between bodyweight support and incline running on the electromyographic activity of the triceps surae and compare it to flat running. In eighteen healthy men (age: 20.3 ± 1.2 years, body weight: 70.2 ± 4.8 kg, body height: 179.6 ± 5.4 cm), the changes in electromyographic activity (EMGA) during a 10 min run with BWS (15% or 30% of body weight; in different occasions) and IR at 7%, as well as jumping performance and gait spatiotemporal parameters, were evaluated. A lower Rating of Perceived Exertion and a significant decrease in the size of the Vastus Lateralis (VL) (33.4%), Soleus (SOL) (17%), and Gastrocnemius Lateralis (GL) EMGA (28.5%, $p < 0.05$) but not in Gastrocnemius Medialis (GM) (10.5%, $p > 0.05$), was observed during BWS30% at 7% slope compared to flat running. Also, low-frequency fatigue of the quadriceps was induced only after running without BWS on a 7% slope ($p = 0.011$). No changes were found in jumping performance ($p = 0.246$) and gait spatiotemporal parameters ($p > 0.05$) except for flight time ($p < 0.006$). In conclusion, running with a slope of 7% and 30% of BWS can result in EMG activity comparable to that observed during level running. This method can also be used in prevention and rehabilitation training programs without creating fatigue.

Keywords: injury prevention; body weight support; electromyography; fatigue; slope; uphill running

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1. Introduction

The lower body is an essential component in performance in most sports; however, the calf is the most injured part of the lower body [1,2], and Achilles Tendon rupture cases seem to keep increasing despite enhancements in knowledge and research [3]. Based on injury prevention and rehabilitation recommendations, the training load should be increased progressively while working with longer contractions to lead to better tendinous adaptations [4].

Along with rehabilitation recommendations, IR allows the longer contraction of the triceps surae due to an increased amplitude of movement. In addition, IR leads to a lesser reduction in the ankle range of motion compared to level running and can reduce the risk of tendinopathy [5,6]. At the same time, as the passive eccentric and active concentric phases of the muscle are amplified during IR, with the increases in the slope, muscle work is increased [7,8]. Finally, as EMGA depends on contraction intensity, increasing IR increases EMGA [9]. EMGA is increased by greater motor drive and motor unit recruitment. As a result, it optimizes contractions by creating more tension on the muscle fiber and can, therefore, improve the rehabilitation process. However, tendinopathy can also occur with repeated overloading on the tendinous–muscular system [5]. As IR increases the intensity of contraction, noticeable by the increase in EMGA of the lower limb, it could potentially cause repetitive overload. Nevertheless, IR is not easily accessible at an early stage of rehabilitation, and it is well established that early mobilization of the injured limb is crucial for a quick and successful rehabilitation program [10,11]. It is necessary to find a way to allow injured athletes to run on an incline slope as soon as possible. Therefore, the use of BWS in IR is a way to prevent injury.

Among the methods/types of equipment that are commonly used among physiotherapists and rehabilitation trainers during a rehabilitation program for the lower limbs are BWS treadmills, which are capable of reducing the active body weight of the patients during a rehabilitation program; thus, they help to unload lower extremities while the patient is walking or running on a treadmill. This type of training is mainly used in non-healthy populations, like Spastic Paretic [12] or Post-Stroke patients [13–15], or in patients with Spinal Cord Injury [16,17] or even with Parkinson's disease [18]. However, BWS seems to favor rehabilitation, even in athletic populations. Indeed, even if walking and running are essential stimuli during athletes' rehabilitation programs, they can also traumatize joints and muscles because injured athletes show greater vertical impact and impact loading, with the latter being one of the principal components that may affect the success or failure of a lower-limb rehabilitation program [19]. Thus, BWS reduces the ground forces the injured athlete produces during running and avoids exacerbating the injury [20]. However, until now, the data about the effectiveness of BWS have been controversial. It seems that BWS does not reduce the total rehabilitation time significantly but allowed patients to run 2 weeks before a control group in Achilles tendon rehabilitation [21]. Also, for anterior cruciate ligament reconstruction rehabilitation, using BWS is significantly more efficient than standard rehabilitation at 12 weeks follow-up but not at 24 weeks [22]. Moreover, after a 6-week speed-training program, no differences were found between standard training and BWS training; only a decrease in injury was found for BWS training (66% against 8%) [23]. Furthermore, during a BWS running training program, EMGA decreased [17,24]. With body support ranging between 10% and 40% of the patient's body weight, a decreased EMGA of the triceps surae was observed [24], a reduction which seemed to be more pronounced in the GM and GL than SOL [25], which may lead to the variable effectiveness of BWS.

According to the above, it seems that BWS and IR, separately, can significantly affect the success of a rehabilitation program for the lower extremities, with each one providing different and necessary physiological stimuli to the injured athlete. However, neither can provide all the needed neuromuscular stimuli. On a cardiorespiratory level, it has been shown that a 7% incline with 30% BWS caused similar oxygen consumption and heart rate to the unsupported, level condition. However, the perceived intensity of this incline with BWS was greater than the unsupported condition [26]. Athletes can maintain training intensity while running on a bodyweight-supporting treadmill by introducing an incline. So, is it possible to combine the benefit of BWS and IR on the triceps surae? In theory, the simultaneous use of BWS and IR during a rehabilitation program could allow the benefits of longer muscle contraction (and a better tendinous adaptation) and earlier access to running. These two factors combined may lead to a faster time to return to sport.

However, at least to our knowledge, this has never been investigated until now. Thus, the aim of the present study was to investigate the interaction between BWS and IR on the EMGA of the triceps surae and compare it to flat running. It was hypothesized that running with a positive slope and 30% of BWS could result in EMGA comparable to level running.

2. Materials and Methods

2.1. Experimental Design

All participants performed all four experimental conditions on different days, with 7-day rest intervals between them. The order of the four training sessions was randomized: (1) level running and without BWS (IR0BWS0), (2) incline running at 7% and 0% of BWS (IR7BWS0), (3) incline running at 7% and 15% of BWS (IR7BWS15), and (4) incline running at 7% and 30% of BWS (IR7BWS30). During each trial, the electromyographic activity of the VL, GL, GM, and SOL was evaluated. At the same time, before and after 2 min, first the jumping performance and then the low-frequency fatigue of the right quadriceps muscles were assessed. All procedures were in accordance with the Declaration of Helsinki and approved by the local university ethics committee (CERUBFC-2021-11-23-041), while all participants signed a written informed consent before entering the research procedure.

2.2. Subjects

Eighteen healthy men participated in this study (age: 20.3 ± 1.2 years old, body weight: 70.2 ± 4.8 kg, size: 179.6 ± 5.4 cm). Participants were recruited from the Sports Department of the University of Dijon. Each participant had exercised an average of 6 h of sport/week for a year. For inclusion, the participant needed to be clear of any lower-limb injury within 6 months before the experiment. Subjects were asked to have similar activity levels the day before each session.

2.3. Procedures and Running Trials

Each training session started with a 4 min warm-up at their preferred pace on a bicycle (CMVC20; Laroq, La-Roque, PACA, France) followed by a 3 min run on the Harness Base Body Weight Support Treadmill (Airwalk ap; H/P/Cosmos, Nussdorf, BE, Germany) at 8 km/h and 0% incline with the BWS Treadmill harness on them. Then, each participant was equipped on the right leg with an EMG captor device. The running sessions lasted 10 min, and the spatiotemporal gait parameters collected using two 1 m OptoJump strips (Optojump; Microgate, Bolzano, Italy) (1000 Hz) consisting of a single transmitting bar and receiving bar positioned on the side bars of a treadmill, which were flush with the treadmill belt (Figure 1). Contact time, flight time, and step frequency were taken during 30 s intervals at 1, 5, and 9 min. A Borg CR10 scale was used to evaluate the rate of perceived exertion (RPE) at the 5th, 7th, and 10th minute of each running trial. Before each trial, participants' body weights were evaluated. Two types of BWS protocols are commonly used, a 15% and 30% body weight reduction. Indeed, the running pattern and EMGA of the trunk are altered by 40% of the BWS [27], which is irrelevant to this study. On the other hand, 15% to 30% of BWS seemed sufficient for a rehabilitation program [28,29]. The IR was set at 7% of the slope; the internal work was increased after more than 5% [30], and the EMGA of the triceps surae was increased at 7% of slope [9]. Furthermore, it is recommended not to run beyond 7 to 10% slope without modifying the running pattern [31,32].

2.4. Evaluations of Jumping Performance

Before and 2 min after each running trial, participants performed 2 Counter Movement Jumps (CMJs) on two force platforms (Kforce Plates, Kinvent, Montpellier, France, 600 kg weighting plateform, 320 × 160 × 30 mm, sampling frequency 2.4 Ghz) with 30 s rest between trials. Maximum jump height was assessed using Kforce software, by measuring flight time and then calculating maximum height. Analysis was made with the best jump height.

Figure 1. Harness Base Body Weight Support Treadmill (Airwalk ap; H/P/Cosmos, Nussdorf, BE, Germany) with (Optojump; Microgate, Bolzano, Italy).

2.5. Evaluation of Low-Frequency Fatigue

Low-Frequency Fatigue (LFF) was assessed using the recommendation of Myocène®, as demonstrated in a recent study [33]. The right leg is set in a force sensor (recording rate at 4 kHz). Evoked forces were assessed with muscle electrical stimulation (width of 400 µs, three series of stimuli; 1—a single pulse, 2—low-frequency train at 20 Hz, and 3—high-frequency train 120 Hz) and applied with three electrodes (MyoPro-1-electrodes, Myocene, Liège, Belgium). Within 2 min, 16 sets of pulses were performed with 5 s interval in-between, with the stimulation intensity increased each set by 1 mA (From 25 mA to 40 mA). Anodes (5 × 5 cm) were placed over the vastus lateralis and medialis. In addition, a cathode (5 × 10 cm) was placed on the proximal portion of the rectus femoris (transversely). The Myocène® system integrates an algorithm instantaneously calculating the LFF. Calculations were made at each set, and the median values of all ratios were given by the software and, therefore, used in our analysis.

2.6. Electromyographic Activity

The EMGA of the VL, Gastrocnemius Lateralis (GL), Gastrocnemius Medialis (GM), and SOL were taken on the right leg. The participant's skin was prepared following Seniam recommendations (i.e., shave the skin, clean with alcohol, and waiting for dry skin). Surface electrodes were placed as recommended by Barbero et al. [34]. Muscle activities were recorded with BioNomadix 2CH Wireless EMG transmitter system from Biopac system inc. (BN-EMG2-T) and rectangular-surface Ag/AgCl electrodes (3M Health Care). The raw EMG of the four steps from a participant during IR0BWS0 is shown in Figure 2.

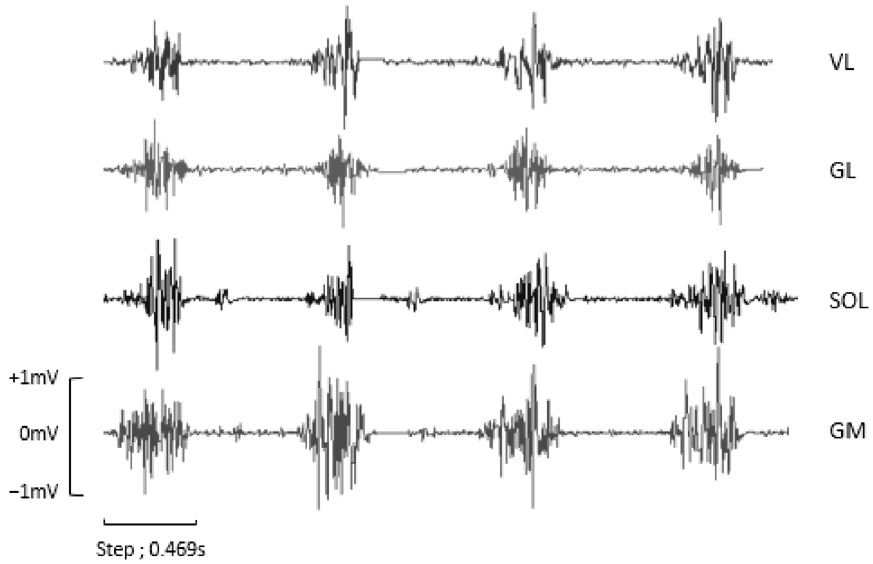

Figure 2. Raw EMG of four steps from a participant during IR0BWS0. VL: Vastus Lateralis, GL: Gastrocnemius Lateralis, SOL: Soleus, GM: Gastrocnemius Lateralis.

Each participant realized a 30 s run before the experimental run at 10 km/h and 0% IR for normalization. All EMGA data were analyzed with the mean root-mean-square (mRMS; length 200 ms, 20 samples, 1 point overlapping). The mRMSs of the experimental run were divided into 3 intervals of 200 s (total of 10 mins) and were evaluated as a percentage of the 30 s normalization run. Data were analyzed with Acqknowledge 4.2. Each recording was collected at 2 kHz, and bandlimited from 5.0 Hz to 500 Hz.

2.7. Statistical Analysis

All data are presented as the mean and standard deviation (±SD). All data followed a normal distribution (Shapiro–Wilk test), and sphericity was respected except for RPE and mRMS; a Greenhouse-Geisser (GL) correction was then applied. A two-way repeated analysis of variance (ANOVA; Bonferroni Post Hoc) was performed to analyze the results of the different variables (Condition, Time, Condition × Time). The variable Time was composed of three periods of 200 s: from the onset to 200 s (3.3 min), from 200 s to 400 s (6.6 min), and from 400 s to the end (10 min). Also, group-sized effects were calculated with Cohen's d (0.2–0.5, small; 0.5–0.8, medium; >0.8, large effect). Statistical analyses were performed with JASP (JASP Team, 2021—Version 0.16). $p \leq 0.05$ was used as a level of significance.

3. Results

Muscle Activity. The mean mRMS of each condition is represented in Figure 3, and the percentage of EMG compared to the normalized run is shown in Table 1.

For GL, the ANOVA has showed significative differences between conditions (F (1.573, 12.580) = 4.114, $p = 0.015$, ηp2 = 0.340), represented in Figure 3. A large effect size was found between IR0BWS0 and IR7BWS0 ($p = 0.085$, d = −0.882). Significant differences in Time were found between each three moments (F (1.690, 13.523) = 28.532, $p < 0.001$, ηp2 = 0.781). EMGA keeps decreasing with time; EMGA from the last 200 s is inferior to the second one ($p < 0.022$), and both are inferior to the first 200 s ($p < 0.001$). No interaction was found (F (6, 48) = 0.985, $p = 0.446$, ηp2 = 0.110).

For SOL, significant differences between conditions were found (F (3, 21) = 5.131, $p = 0.008$, ηp2 = 0.423), presented in Figure 3. A group effect size was shown between IR0BWS0 and IR7BWS0 ($p = 0.103$, Large, d = 0.916) and between IR7BWS0 and IR7BWS15 ($p = 0.303$, Medium, d = 0.734). Significant differences in Time were found (F (2, 14) = 58.71, $p < 0.001$, ηp2 = 0.893); for the GL, the EMGA from the last 200 s was inferior to the second one ($p < 0.007$), and both were inferior to the first 200 s ($p < 0.001$). No interaction was found between Condition and Time (F (6, 42) = 0.852, $p = 0.538$, ηp2 = 0.109).

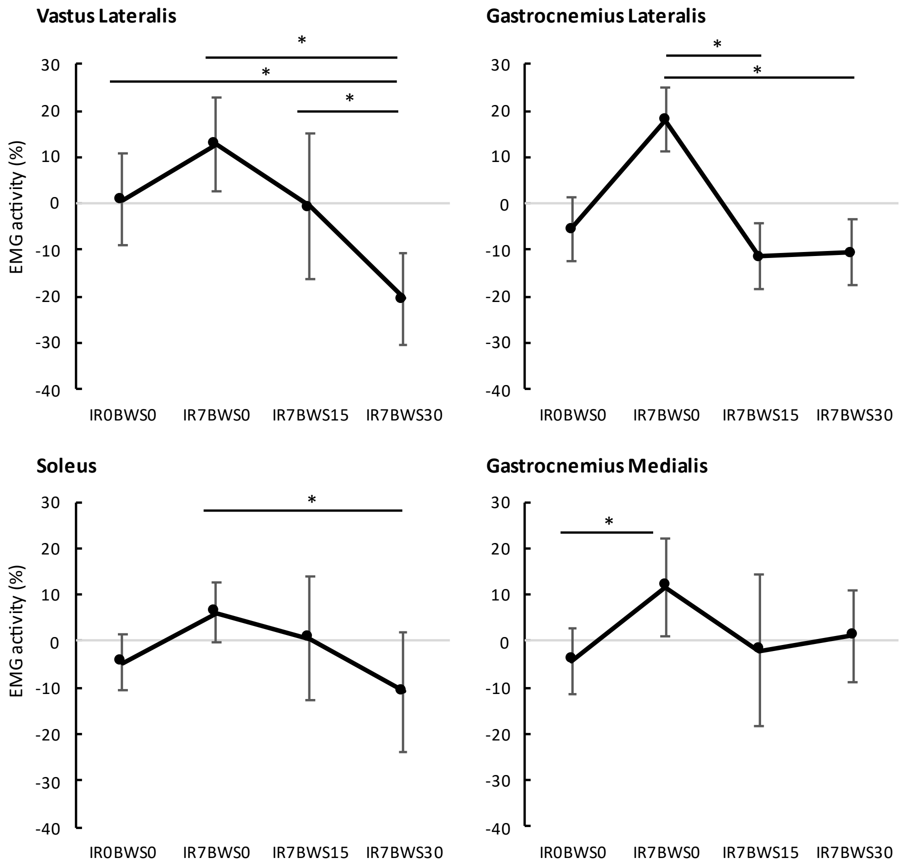

Figure 3. Modification in EMG activity in percentage of control run (level running). * Means significant difference ($p < 0.05$). Level running without BWS (IR0BWS0), incline running at 7% and 0% of BWS (IR7BWS0), incline running at 7% and 15% of BWS (IR7BWS15), incline running at 7% and 30% of BWS (IR7BWS30).

Table 1. Values of percentage of EMG activity compared to 30 s run (reference). Level running without BWS (IR0BWS0), incline running at 7% and 0% of BWS (IR7BWS0), incline running at 7% and 15% of BWS (IR7BWS15), incline running at 7% and 30% of BWS (IR7BWS30).

	$\mathbf{IR_0BWS_0}$	$\mathbf{IR_7BWS_0}$	$\mathbf{IR_7BWS_{15}}$	$\mathbf{IR_7BWS_{30}}$
VL	0.8%	12.9%	−0.6%	−20.5%
GL	−5.5%	18.1%	−11.3%	−10.5%
SOL	−4.6%	6.2%	0.6%	−10.8%
GM	−4.3%	11.7%	−2.1%	1.1%

For GM, the ANOVA showed significant differences between conditions (F (3, 24) = 4.106, $p = 0.017$, ηp2 = 0.339), as shown in Figure 3. A group effect size was found between IR7BWS0 and IR7BWS15 ($p = 0.07$, large, d = 0.849). Significant differences in Time were found (F (1.129, 9.030) = 8.956, $p = 0.013$, ηp2 = 0.528); EMGA of the first 200 s was significantly superior compared to the 2nd and 3rd periods of 200 s ($p < 0.001$). However, no significant interaction was found (F (1.401, 11.210) = 0.739, $p = 0.453$, ηp2 = 0.085).

For VL, significant differences between conditions were found (F (3, 15) = 14,588, $p < 0.001$, ηp2 = 0.745), as presented in Figure 3. The ANOVA did not reveal any significant differences for Time (F (2, 10) = 2.021 $p = 0.183$, ηp2 = 0.288) and the interaction between Condition and Time (F (6, 30) = 0.735, $p = 0.626$, ηp2 = 0.128).

Rating of Perceived Exertion. All results are shown in Figure 4. Our results show significant differences between Condition (F (3, 33) = 28.738, $p < 0.001$, ηp2 = 0.723), but not between IR0BWS0 and IR7BWS30 ($p = 0.079$). Significant differences in Time (F (1.113, 22) = 32.759, $p < 0.001$, ηp2 = 0.749), and in the interaction between Condition and Time (F (3.259, 66) = 5.427, $p = 0.003$, ηp2 = 0.330) were found. The interaction between condition and Time showed no significant differences between IR0BWS0 and IR7BWS30 between the different time periods (At 5 min, $p = 1.00$; at 7 min, $p = 0.625$, and at 10 min, $p = 0.625$).

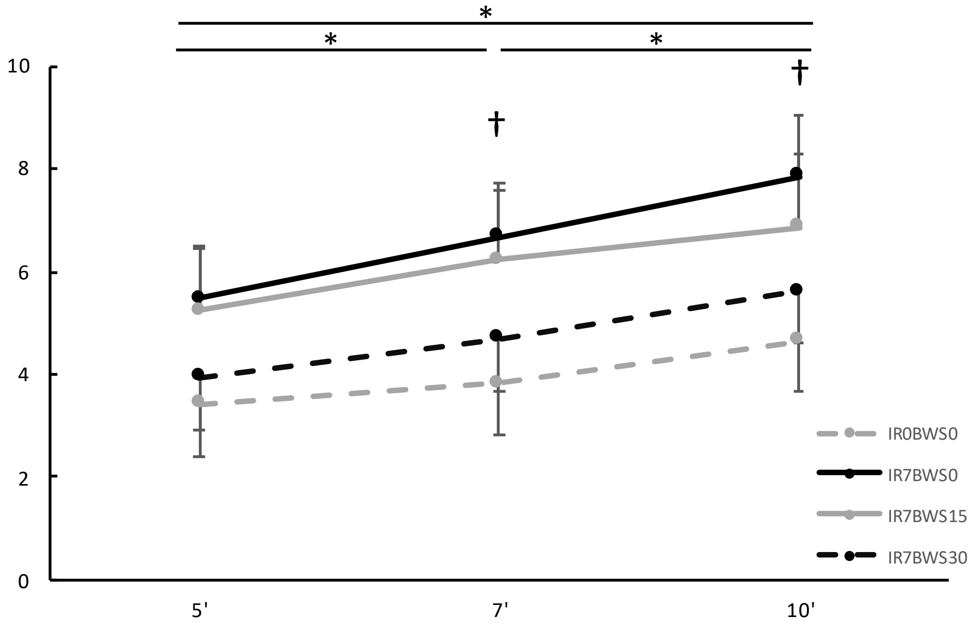

Figure 4. Effect of Time on RPE during the 10 min run. The standard deviation displayed only in the positive or negative for clarity. * Means significant difference ($p < 0.05$). † Means significant difference between IR7BWS0 and IR7BWS15. Level running without BWS (IR0BWS0), incline running at 7% and 0% of BWS (IR7BWS0), incline running at 7% and 15% of BWS (IR7BWS15), incline running at 7% and 30% of BWS (IR7BWS30).

Jumping performance. Running at 10 km/h for 10 min did not affect peak jump height for all conditions (F (3, 33) = 1.451 $p = 0.246$, ηp2 = 0.117).

LFF. The post values were significantly inferior to the Pre values (F (1, 8) = 8.788, $p < 0.018$, ηp2 = 0.523). Also, ANOVA revealed a significant decrease only in the LFF ratio for IR7BWS0 ($p = 0.011$). Results are shown in Table 2.

Table 2. Values of the running-induced muscle fatigue given according to Myocène®. Level running without BWS (IR0BWS0), incline running at 7% and 0% of BWS (IR7BWS0), incline running at 7% and 15% of BWS (IR7BWS15), and incline running at 7% and 30% of BWS (IR7BWS30).

	PRE	**POST**	**Difference**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**
IR_0BWS_0	75.1 ± 6.7	73.3 ± 8.8	1.8 ± 3.5
IR_7BWS_0	75.8 ± 8.0	71.6 ± 9.8	4.1 ± 3.5
IR_7BWS_{15}	73.5 ± 8.4	71.8± 8.6	1.7 ± 4.4
IR_7BWS_{30}	74.0 ± 7.1	72.8 ± 6.5	1.2 ± 1.7

Gait spatiotemporal parameters. Our results did not demonstrate differences ($p > 0.05$) in gait spatiotemporal parameters (Condition, Time, or interaction of both) except in flight time. As IR increases, the flight time decreases from 47 to 35 ms and then the addition of BWS leads to a longer flight time from 35 to 47 ms. Results are presented in Tables 3 and 4.

Table 3. *p* values with ANOVA analysis for gait spatiotemporal parameters. * Means significative difference ($p < 0.05$).

	Contact Time	Flight Duration	Step Frequency
Condition	0.306	0.001 *	0.107
Time	0.344	0.208	0.641
Interaction	0.618	0.911	0.594

Table 4. Gait parameter data between each condition. a, b and d represent significant differences between IR0BWS0, IR7BWS0 and IR7BWS30. Level running without BWS (IR0BWS0), incline running at 7% and 0% of BWS (IR7BWS0), incline running at 7% and 15% of BWS (IR7BWS15), and incline running at 7% and 30% of BWS (IR7BWS30). * Means significative difference ($p < 0.05$).

	Flight Time	Contact Time	Step Frequency
	Mean ± SD	Mean ± SD	Mean ± SD
IR_0BWS_0	47 ± 1.3 *b	338 ± 29	156 ± 9
IR_7BWS_0	35 ± 1.2 *a,d	340 ± 44	161 ± 14
IR_7BWS_{15}	38 ± 1.3	340 ± 36	159 ± 12
IR_7BWS_{30}	47 ± 1.7 *b	336 ± 27	155 ± 9
	$p < 0.006$	$p > 0.05$	$p > 0.05$

4. Discussion

The main finding of the present study was that running with a slope of 7% and 30% of BWS results in EMG activity comparable to that observed during level running, verifying our hypothesis. Furthermore, as was hypothesized, BWS can decrease running-induced muscle fatigue (LFF).

Our results correspond to previous studies that confirmed an increase in EMG for GL, SOL, and GM at 7% incline running [9], as well as in mechanical power [35]. As shown in Figure 1, the EMG of SOL seemed less impacted by the slope and a BWS of 15% than the GL and the GM. Indeed, the SOL EMG increased by 10.8% from the LR to IR7%, but that of the GL and GM increased by 23.6% and 16%, respectively. On the other hand, with a BWS of 15%, the SOL EMG decreased by 4.8%, and the GL and GM by 29.4% and 13.8%, respectively. This is mainly due to differences in the muscle insertion; the SOL is a monoarticular muscle that only participates in plantarflexion, and the gastrocnemius is a bi-articular muscle used for knee flexion. Another explanation of this phenomenon could be the different roles of the gastrocnemius and soleus. A previous study has shown that, in the single-leg-stance period, the SOL is mainly responsible for forward trunk progression and support, and the gastrocnemius for leg swing [36]. However, this study focused on walking locomotion; it could be interesting to elucidate the behavior of these two muscles while running.

After that, the EMG of the VL and triceps surae was decreased by 15% of the BWS compared to incline running and had an almost-similar muscular activity to level running (VL (−0.6%), SOL (0.6%), GM (−2.1%)). Only the GL (−11.3%) appeared more affected by unloading 15% of the body weight. Moreover, 30% BWS was effective, having an EMG activity lower than for level running: VL (−20.5%), GL (−10.5%), SOL (−10.8%), except for GM (1.1%). However, the EMG activity of the gastrocnemius muscle did not decrease while unloading from 15% to 30%. Conversely, the VL EMG significantly decreased from BWS 15% to BWS 30%. We hypothesize that as the IR from 5% to 10% modifies the running pattern (increase GM/GL EMG and mechanical work), adding more BWS could also change the running pattern. During the single-leg stance from BWS 15% to BWS 30%, it could be possible that the percentage of work from the Gastrocnemius increases, but as the weight decreases, the EMG does not change. Those results would be similar to Sainton et al. [37], who found a significant decrease in muscle activity at the push-off phase at 20% of BWS, but not at 40%, for both gastrocnemii. Our results showed a decrease in EMG activity during the 10 min run, and it is might be possible that Achilles tendon structures and properties were modified during the run, despite the warm-up protocol.

The statistical analyses show a more decreased EMG for the VL than the triceps surae muscles when BWS is active. According to previous studies, the force produced by the triceps surae is mostly created by the tendon's length change and not the fascicle length [38], even with a positive or negative slope [6]. Therefore, the main difference in our results can be explained by muscle behavior, and we can hypothesize that the subject's unloaded body weight would affect the VL's EMG activity and the stretching/shortening of the Achilles Tendon. However, the muscular activity of the VL seems less affected by incline running at 7% than the GL and GM (increased by 12.1% compared with 23.6% and 16%). These results were expected; indeed, EMG activity and the mechanical power of the VL significantly increased from 9.1% [39] and 10% of the slope [35,40,41].

Although running-induced muscle fatigue was assessed on the quadriceps, our results showed that a 10 min run at 7% of the IR can create LFF compared to the LR and BWS conditions. As the slope increases, the muscle's mechanical work increases, as does the LFF. Likewise, using BWS is efficient in decreasing muscle fatigue in IR. Thus, we supposed that muscle fatigue is not created by repetitive contractions but by the ground force reaction in IR conditions.

The statistical analysis showed two modulations in RPE; increasing the slope increases the RPE, and BWS leads to a lower RPE. As the unloading subject causes less ground force reaction, a decrease in RPE with BWS was expected. These results agree with a previous study on BWS [42,43] and assert its utility in rehabilitation. Indeed, a lower RPE may lead to a longer time of sustained exercise and, finally, an increased muscle-contraction time.

Furthermore, our study shows that 30% of BWS and 7% of IR are the right parameters to elicit a similar perceived difficulty to level running (respectively, RPE is 5.6 and 4.6). Nevertheless, 15% of BWS does not seem sufficient to reduce RPE compared to flat running, but it can reduce perceived difficulty through time (at 7 min and 10 min, RPE of 15% of BWS was lower than without).

According to our data, spatiotemporal parameters such as contact time and step frequency are not statistically affected by BWS and IR, even if IR suggests an increase in step frequency. We supposed that because BWS [37,44,45] and IR [7,46,47] have the opposite effect on step frequency, no significant differences could be found; however, flight time increased with more BWS. This is probably due to a strategy of the runner; as BWS increased, the participant let himself be supported by the mechanical system. This explanation could also justify the decreases in RPE and the modification of the EMG activity.

5. Conclusions

Our study supports the use of body weight support during inclined running as an alternative to flat running to improve a rehabilitation program, as inclined running enhances the passive eccentric and active concentric phases of the calf muscles.

This method may have two assets: progressive loading through BWS and optimizing time contraction with incline running. All of this is achieved without increasing the difficulty and offers more considerable access for all kinds of populations and injury. This method can also be used in strengthening training programs without creating a decrease in a simple performance like jumping.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest: The authors declare no conflict of interest.

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