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Posted Date: 23 May 2024

doi: 10.20944/preprints202405.1523.v1

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Article

Nordic Exercise Effects on the Explosive and Absolute Strength of Lower Limbs in Different Sports Modalities

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Abstract: Nordic exercises aim to improve physical abilities and prevent injuries; However, it is not clear in what type of sports modalities to use it, so this study arises from the interest of analyzing its effect in different sports modalities. Objective: To analyze Nordic exercises effects on the lower limbs, and their relationship with the explosive and absolute strength inherent to demands of different sports modalities (football, athletics, basketball, sport climbing, cycling and taekwondo). Method: quasi-experimental research, identifying 122 athletes (18±3 years old) from: football (n=24), athletics/speed (n=20), sport climbing (n=20), basketball (n=24), taekwondo (n=14) and cycling (n=20); classified into a control group CG (n=57) and an experimental group EG (n=65). Results: dominant absolute strength of the initial (12.4±0.51) and final (14.5±0.98) EG, in greater proportion in basketball ($P < 0.05$); explosive strength of the initial (42.4±1.2) and final (45.8±1.5) EG, with a significant difference in all modalities between before and after ($p \leq 0.05$), except in cycling and taekwondo; no major changes were found in the GC. Conclusion: Nordic exercises are recommended as part of training to improve levels of explosive strength with emphasis on the modalities of football, basketball, athletics/speed and sport climbing, being applicable to increase absolute strength in basketball.

Keywords: Nordic training; hamstrings; explosive strength; absolute strength

1. Introduction

One of the main objectives within the area of sports training, physical preparation and physiotherapy, is to look for work strategies, models, training guides and optimal periodizations, which allow improving physical condition, and general and specific sports performance. [1,2] The existing literature mentions the need to develop absolute and explosive strength in different sports modalities; Possible interventions with specific physical stimuli with a variety of positive and negative results are currently being discussed in the search to improve the aforementioned capabilities, the most studied focus on addressing muscle deficits, muscle strengthening, preventing injuries and return to play; the last-mentioned area studied mainly in football. [3,4]

Taking into account the physical demands of each sport modality, strength and conditioning training programs are specifically included, [5] understanding that numerous sports have specific gestures that include jumps, kicks, sprints, and changes of direction. It should be considered that both strength training and other physical abilities will be appropriate for the programming and training of the elite athlete; In the same way, the evidence emphasizes good planning such as the duration and periodization of these training, finding variants in the time of completion of the motor task, the way of applying them, and even whether it is appropriate to physically stimulate, considering the biological principles of training required for optimal preparation. [6–8]

Fast and sudden movements are part of the daily training of high-performance athletes, and also of those who practice it recreationally. Several authors have been studied and they emphasize the need to intervene in muscle groups with greater tension, eccentric load, level of activity, and injury levels after high sporting demand. [9–11] One of these muscle groups is the hamstrings, for which

several programs have been generated that seek to intervene with a specialized or specific protocol, among the most outstanding are: Nordic exercise, the FIFA 11+ program, and Core stability exercises, each of these applied over a period of time and with positive results at a clinical and sporting level. [12–14]

Eccentric activation induces greater muscle tension, strengthening the muscle and reducing the injuries incidence, the length of its fascicles and asymmetry in the lower limbs. [15] Research describes that the greater risk of suffering a hamstring injury is related to a greater age range in athletes, or in athletes who have a previous hamstring injury. [16–18]

Hamstring injuries primarily occur when players perform running training, this muscle group is susceptible to injuries due to its anatomical arrangement and its correlation of strength with the quadriceps, considering its biomechanical functioning in which its mechanism of action on the joints (knee and hip) occur together (Lombard's paradox), with opposite effects on the length of the hamstrings and quadriceps generating a greater risk of injury; Finally, adding to the functions of this muscle group, the function in deceleration when walking, running and making sudden changes in direction at high speed should be highlighted, although further research is recommended in terms of correlation. [19,20]

This study focuses on analyzing several sports modalities of which we highlight the need to carry out studies and analyzes that can help to understand and improve the bibliography base for future research. For example, in Taekwondo the trained skills depend on kicking techniques, so the vast majority of injuries are located in the lower limbs, [21] and to improve and prevent these injuries, it is recommended to carry out an adequate dosage program of physical exercises, which includes as one of the objectives the improvement of strength in the lower limbs. [22]

In athletics, however, the volume and strength of the hamstrings are related to an improvement in sprint power, [23] It should also be noted that strength training in the lower limbs turns out to be long-term, for a program to be effective in reducing the risk of injuries. [24]

In climbers, physical characteristics are predominantly marked in the upper limbs; However, with a lower prevalence in the lower limb, practitioners of this sport are required to have good hip flexibility, high aerobic resistance, strength in the hamstrings and back, to execute the impulses that could depend on and vary depending on the sporting subdiscipline. [25] For this, it is taken into account that the flexibility capacity, although it is not proportional to strength higher levels, research mentions that a good state of joint mobility improves ROM (Range of Motion), and thus achieves effective mobility. [26]

In basketball, it is known that maximum eccentric strength is an important factor for rapid and successful deceleration, and according to a cross-sectional study analyzed, the authors consider that those athletes with higher levels of strength in Nordic exercise had a greater skill for deceleration and jump. [27]

Finally, in cycling, repetitive knee movement requires simultaneous activation of the hamstrings and quadriceps in an agonist and antagonist manner, making it necessary to focus on prevention and strengthening of the lower area, involving strength phases in the entire lower limb to prevent muscle imbalance situations. [28]

Musculoskeletal damage to the hamstrings is common in different sports modalities, [16] highly studied in footballers according to current reference reviews, [17,29] although there is insufficient information on the incidence of these injuries in other sports modalities. [30,31]

Currently, Nordic exercises are part of physiotherapy and training treatments, in order to gain strength and prevent hamstring injuries in athletes. In its application, great benefits and recommendations have been found, [8,32,33] Despite being a training considered "Gold Standard", its effectiveness in other sports modalities other than football is not clear.

This study analyzes the effects of Nordic exercises on lower limbs and its relationship with the variables of explosive and absolute strength, achieving an understanding of the exercise effect, according to the demands of the modalities of football, athletics/speed, basketball, sport climbing, cycling and taekwondo.

2. Materials and Methods

It is a quasi-experimental pre- and post-test study, [34] to evaluate the effects of stimuli with Nordic exercises on the explosive and absolute strength of athletes. The Nordic-type physical stimuli were distributed in an intervention of 9 total weeks, which includes 1 week of initial evaluation (pre-test), 7 weeks of training, and 1 week of final evaluation (post-test).

2.1. Participants

A call was made during 2022 to the gyms and federations of the different sports modalities mentioned, which met the following inclusion criteria: a) Athletes who are registered in federations, gyms and sports clubs in the Imbabura province, Republic of Ecuador ; b) That they have systematic experience in the sports discipline for at least 12 months; c) That they have an age range between 16 and 28 years; d) Athletes or legal representatives who sign the informed consent; e) That they are not in the competitive stage according to their training macrocycle for each sporting modality; f) That they do not present pathologies, respiratory or musculoskeletal injuries; g) They have not completed a Nordic or similar protocol for at least 6 months prior to the intervention; h) They have a similar explosive and absolute strength index in the lower limbs.

166 eligible athletes were registered through simple random sampling (5% error and 95% confidence level), reaching a sample of 122 subjects, whose graphic protocol is described in Figure 1. The sample was classified into two groups independent, a control group that performed their usual training for each sport (G.C), and an experimental group (G.E), which added Nordic exercises to their usual training. Both independent groups must have homogeneity in the dominant and non-dominant explosive and absolute strength variables to avoid false results.

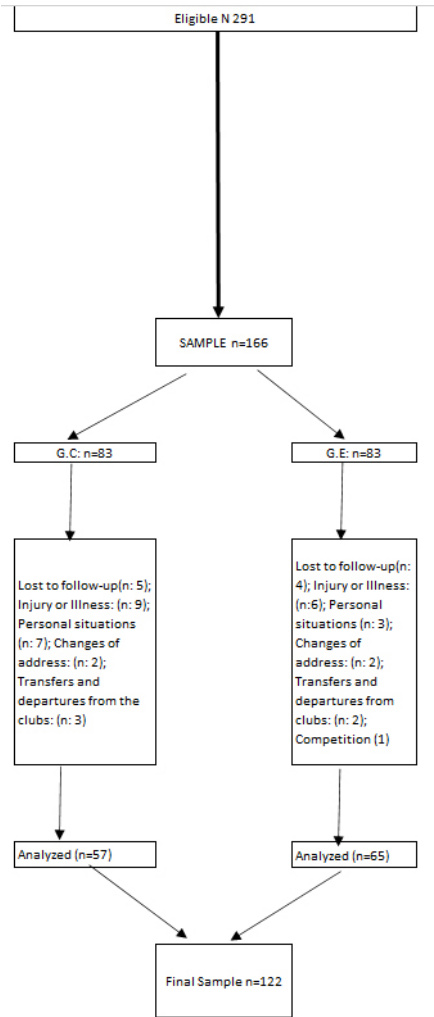


Figure 1. Participation flowchart.

To assign the groups, a draw was carried out through an automated spreadsheet in Microsoft Excel 2021, where each participant was assigned a number, which was kept hidden until after the draw ended; identifying it at the time of assignment, where they were randomly subdivided into two independent groups: G.C (n=83) and G.E (n=83).

During the evaluation and intervention process, some athletes were excluded due to the causes explained in Figure 1. Therefore, finally, the G.C was made up of 57 athletes and the G.E by 65 athletes (18±3 years), of different modalities: football (n=24), athletics/speed-100 and 200m (n=20), sport climbing (n=20), basketball (n=24), taekwondo (14 athletes) and cycling (n=20), describing their particularities in Table 1.

Table 1. Initial characteristics of the athletes.

Variable	G. Experimental	G. Control	T value	P
Age	18,15 ±3,18	18,59 ±3,4	0,44	0,6
Gender				
Female	23,0%	22,1%	-	-
Male	30,3%	24,6%	-	-
Experience (years)	3,6 ±4,11	3,7 ±3,89	0,1	0,5
Dominant Absolute Strength I	12,4 ± 0,51	12,5 ± 0,48	1,19	0,5
Non-dominant absolute strength I	11, 1 ±0,42	11, 5 ±0,48	0,56	0,7
Explosive strength	42,4±1,02	40,5±1,36	-1,1	0,7

Mean values ± standard error of the mean /
P= <0,05

2.2. Instrumentos

- 1) Instrument 1: Explosive strength: vertical jump test, reliability of 0.97; VERT vertical jump device with G Windth of Nickel technology, to determine the jump distance in cm. [35]
- 2) Instrument 2: Absolute strength: lower limb dynamometer; strength levels, CRANE SCAL brand electronic leg scale, expresses values in kilograms and newtons. [36]

2.3. Procedures

Before starting the research, potential participants were called, they were informed about the process, they signed the informed consent for their participation; highlighting that not all athletes coincided in time, since we are looking for those who are not in the stages close to their championships, from that point onwards to begin the intervention.

The research was carried out in accordance with the Declaration of Helsinki and respect for the anonymity of personal data. The project was approved by the Research Commission of the Faculty of Health Sciences of the Universidad Técnica del Norte-Ibarra, Republic of Ecuador, with resolution of the Directors Board: N° 325-CD 2021

7 physiotherapists were trained for the initial and final evaluation, who were already part of a pilot study where 60 athletes of different modalities were analyzed in the report published by Gómez, & Moya. [8] The coaches of each sports discipline were also trained for the intervention and application of the protocol in conjunction with the aforementioned physiotherapists.

The research is classified into three phases:

- 1) Pre-test: a) The participants were gathered by sports discipline in the training places, the study and informed consent were socialized; b) After this process, a draw was held to define the G.C and G.E.; c) Pre-test evaluations were carried out in the training places, prior to an agreement with the athletes and their coaches, establishing 2 previous days where they did not do any training, and came from a weekend of rest; d) The estimated evaluation time according to the pilot test carried out was 13 minutes per athlete.
- 2) Training with Nordic exercises

3) Posttest: After seven weeks of training, the corresponding evaluations were carried out on each athlete in each independent group. The same procedure was carried out as in the pretest, except for phase b, since the athletes had already been drawn.

For the pretest and posttest evaluations, a 20-minute warm-up was previously performed that included: general and specific joint mobility, upper and lower limb from proximal to distal, jogging on the ground, stretching of quadriceps and hamstrings, squats, weight dead and bridge-type exercises, with 10s of tension and 10s of rest, three series each.

Three evaluations were carried out, the average for the record was determined, the first day was evaluated with the vertical jump test, and on the second day the evaluations were carried out with the dynamometer.

2.4. Training with Nordic Exercises (Table 2)

- 1) For 7 weeks, we worked with the G.E prior to the usual training sessions.
- 2) A 15-minute warm-up similar to the pre-test was performed and a 5-minute cool-down period.

For training with Nordic exercises, the following planning was developed (Table 2): a) During week 2 to week 4, it began with 2 series, and from week 5 to 8 with 3 series; b) For repetitions, it was considered to increase two repetitions per week or microcycle until week six, where it was maintained until week 7 and 8; c) It was ensured that the athletes maintain tension peaks in the 2s position initially, and gradually increase it to 5s; d) The breaks between series and series were 2min; with a total duration of 23 to 25 minutes.

The trained physiotherapists worked together with the training staff of each sporting discipline, monitoring each athlete in their individual progression, both in the G.E and the G.C, this was done in the same way in the G.C, who continued with their usual training, without any significant change.

Table 2. Nordic curl training protocol.

Weeks	1	2	3	4	5	6	7	8	9
Warm up in minutes	PRE-TEST	15	15	15	15	15	15	15	POST-TEST
Series		2	2	2	3	3	3	3	
Repetitions		5	6	8	10	12	12	10	
Voltage peaks in seconds		2	2	3	3	5	5	3	
Pause in minutes		2	2	2	1	1	1	1	
Back to calm in minutes		5	5	5	5	5	5	5	
Total time in minutes		23	23	23	24	25	25	24	

2.5. Statistic analysis

A database was developed, which was processed through the SPSS V.28 statistical package. The qualitative gender variable is presented in frequencies (f) and percentages (%); the quantitative variables, age, strength of the initial and final dominant side, strength of the initial and final non-dominant side, initial and final explosive strength, in mean values and standard error of the mean ($\pm$)

For inferential statistics, the Kolmogorov-Smirnov test was previously applied, identifying parametric data as there was a normal distribution, using the Student t test for related samples (t

value) in intergroup comparisons, and the Student t test for independent samples to compare independent groups, with a significance value $p = < 0.05$.

3. Results

The strength values of the initial dominant side (I) or before implementing the intervention process with Nordic exercises, between the G.C and G.E groups, do not register significant differences between the two, and present an average of 12 kg; The strength of the non-dominant side also lacks significant differences with an average strength of 11 kg, and the explosive strength is between 40.5 and 42 cm, without significant differences between the G.C and G.E (Table 3), which shows homogeneity of the independent samples in the study variables.

Table 3. Initial characteristics of strength in athletes by independent groups.

Initial characteristics	G. C	G. E	Valor t	P
Dominant Absolute Strength I	12,5 ± 0,48	12,4 ± 0,51	1,19	0,5
Non-dominant absolute strength I	11, 5 ±0,48	11, 1 ±0,42	0,56	0,7
Explosive strength	40,5±1,36	42,4±1,02	-1,1	0,7

Absolute strength (F.A), I (initial), F (final), Explosive strength (F.E), ± (standard error of the mean), T (t student), P= * (<0.05) **(< 0.01).

The G.E received the intervention for 7 weeks, generating significant differences between the initial and final values: The absolute strength of the dominant side initially registered averages of 12.4kg, and at the end of the intervention there was an increase of 14.5kg, with significant differences ($p < 0.01$). The absolute strength of the non-dominant side presented mean values of 11.1kg, and after the intervention time it increased to 13.8kg, likewise with significant differences between means ($p < 0.01$). The explosive strength was initially 42.4cm, and at the end 45.8cm was recorded, between the final and initial value, with a significant difference between means ($p < 0.01$) as described in Table 4. In intergroup comparison of the G.C (Table 4) no significant differences were evident between the pretest and posttest data in the three variables studied.

Table 4. Comparison of initial and final intergroup strength.

Group	Experimental				Control			
Characteristics	Pretest	Posttest	Valor t	p	Pretest	Posttest	Valor t	p
Dominant Absolute Strength I	12,4 ±0,51	14,5±0,98	-3,47	0,001**	12,5 ±0,48	12,52±0,48	-0,18	0,85
Non-dominant Absolute Strength	11,1±0,42	13,8±0,81	-2,8	0,007**	11, 5±0,48	11,61±0,44	-0,33	0,74
Explosive strength	42,4±1,02	45,8±1,5	-4,5	0,00002**	40,5±1,36	39,84±1,21	-1,3	0,17

Absolute strength (F.A), I (initial), Explosive force (F.E), ± (standard error of the mean), T (t student), P= * (<0.05) **(<0.01)

An important mean difference is evident between the explosive strength and the absolute strength of the final dominant and non-dominant side, when comparing the results between independent groups ($p < 0.05$), as described in Table 5.

Table 5. Final characteristics of explosive and absolute strength between independent groups.

Characteristics	Control Group	Experimental Group	Valor t	P
Dominant Absolute Strength I	12,52±0,48	14,5±0,98	-2,22	0,04**
Non-dominant Absolute Strength	11,61±0,44	13,8±0,81	-1,7	0,03**
Explosive strength	39,84±1,21	45,8±1,5	-3,59	0,0004**
Absolute strength (F.A), I (initial), F (final), Explosive strength (F.E), ± (standard error of the mean), T (t student), P= * (<0.05) **(< 0.01)				

The strength values were analyzed by sports discipline (Table 6), where the absolute strength of the dominant and non-dominant side of the G.E did not undergo significant changes between the initial and final process, except in football and basketball, where there was a significant difference (p<0.05). Regarding explosive strength, it can be mentioned that Nordic exercises influence its increase significantly (p<0.05) in the experimental group, except in cycling and taekwondo, where no notable changes were generated after the intervention. (Table 6)

Table 6. Final strength characteristics by sports discipline.

	Football		Basketball		Cycling		Climbing		Taekwondo		Athletics/Speed	
N	10	14	12	12	10	10	10	9	7	7	10	11
Group	C	E	C	E	C	E	C	E	C	E	C	E
Dominant												
F. A.	10,59	14,12	13,18±	11,96±	13,49	8,19±	12,03±	13,72	14,86	13,93	12,33	12,91
I ±	±0,66	±1,01	0,954	0,89	±1,13	0,85	1,138	±1,38	±3,10	±1,83	±0,97	±1,43
F. A.	10,29	15,01	12,62±	14,406	14,39	9,54±	12,18±	17,63	13,57	14,49	12,58	16,19
F ±	±0,52	±0,79	0,827	±0,66	±1,09	0,45	1,30	±4,64	±2,44	±1,46	±1,22	±4,32
T	1,24	-0,86	1,08	-0,3114	-1,98	-1,99	-0,159	-1,119	0,932	-0,527	-0,27	-1,037
P	0,246	0,049*	0,303	0,010*	0,079	0,07	0,877	0,296	0,404	0,613	0,787	0,327
Non-Dominant												
F. A.	10,57	11,88	11,54±	11,566	12,58	8,33±	11,03±	12,01	13,78	12,32	10,93	11,26
I ±	±0,8	±0,92	0,744	±0,76	±1,05	0,29	1,009	±0,88	±3,59	±1,7	±1,05	±0,97
F. A.	10,12	14,99	11,73±	13,96±	12,89	9,54±	10,98±	16,8±	14,65	12,53	10,94	15,97
F ±	±0,6	±0,7	0,558	0,89	±1,27	0,45	0,72	3,64	±3,24	±0,84	±0,83	±3,58
T	1,74	-2,17	-0,443	-2,931	-0,68	-0,266	0,104	-1,556	-1,789	-0,121	1,45	-1,543
P	0,114	0,405	0,666	0,014*	0,514	0,035*	0,919	0,158	0,148	0,907	0,888	0,157
Explosive strength												
F. E.	41,35	45,12	40,21±	43,73±	30,67	37,16	42,65±	43,36	50,66	43,44	42,65	42,04
I. ±	±2,5	±0,88	2,39	3,24	±3,68	±2,10	1,65	±2,24	±7,9	±3,75	±1,65	±2,4
F. E.	38,25	49,62	39,82±	46,044	33,01	41,3±	41,72±	48,11	49,60	42,50	41,57	47,24
F. ±	±2,9	±127	1,7	±3,51	±3,30	3,31	1,46	±2,23	±6,9	±3,6	±1,68	±2,59
T	3,06	-5,408	0,33	-2,502	-2,129	-1,02	1,043	-3,56	0,655	0,956	1,21	-3,088

P	0,014*	0,000 01**	0,747	0,029*	0,062	0,338	0,324	0,007* *	0,548	0,387	0,257	0,000 3**
<i>C (control), E(experimental), Absolute strength (F.A), I (initial), F (final), Explosive strength (F.E), ± (standard error of the mean), T (t student), P= * (<0.05) **(<0.01)</i>												

4. Discussion

Taking into account the purpose of the research, the study analyzed the effects of Nordic exercises on lower limbs and its relationship with explosive and absolute strength, according to the demands of the modalities of football, athletics/speed, basketball, sport climbing, cycling and taekwondo.

Given the above, the homogenization of the population was guaranteed thanks to the inclusion criteria and the initial tests that showed the non-existence of significant differences before the intervention process. On the other hand, differences were established between independent groups (G.C and G.E), with the wide possibility of participation in both cases, and the vast majority of those evaluated presented the right side as dominant. The results coincide with scientific evidence on the effects of Nordic exercises on muscle strength in lower limbs in injured athletes. [37]

The Danish Society of Sports Physiotherapy (DSSF) recommends the application of Nordic exercises to improve strength and prevent injuries, through a systematic review where it is advised to intervene in different sports due to the ease with which Nordic exercises can be adjusted to different sports, in terms of loads and volume; [38] Therefore, in the present study, several sports modalities were included such as basketball, soccer, athletics/speed, sports climbing, taekwondo and cycling, recommending their applicability in the sports and therapeutic field.

Several authors mention that these exercises are applicable to increase eccentric hamstring strength in men and women, [32,39,40] Therefore, in the present study we sought to apply an intervention in both genders, with equal loads, volumes and frequencies, there being a prospective need to expand the studies with representative samples according to gender in inferential terms, taking into account the possibility that An intervention process such as the one implemented may have differentiating particularities in its effects depending on gender.

The effects generated by the application of a Nordic training protocol are not affected by age according to Capaverde, et al [41] who refers to the applicability of this training type in adolescents until adulthood, without significant differences (p= 0.12), coinciding with this research, an average age of 18 years was established, with a minimum age of 16 and a maximum age of 28 years, so that it can be applicable in various age groups.

There is little literature regarding the influence of Nordic exercises on absolute strength. It is worth mentioning that the creation of new devices that help in data collection and adaptation to the application of this training protocol is also being studied, [6] In fact, two of the articles consulted evaluate healthy athletes, through dynamometry expressed in newtons; The average values of the studies fluctuated between 180 to 300 newtons (nw) represented in kg from 18 to 30 approximately as initial values, lacking significant differences between before and after the intervention; [41,42] These data are superior to those found in the athletes evaluated, since they had average values between 12kg or 118(nw) on the dominant side, without a significant difference between before and after in the control group (p=>0.05). , and 14.5 (kg) or 143 (nw) with a significant difference in the experimental group (p=<0.05).

Según Vianna, et al., [40] Nordic exercises increase absolute strength, assessed initially and after 8 weeks of intervention in female football players, where strength increased significantly (p=0.003) in the experimental group; Therefore, it is deduced that Nordic exercises could generate improvements in absolute strength at the hamstring level.

Regarding the variability of the explosive strength, de Villarreal & et al [43] mention that this capacity can increase after a plyometric training program, self-loading and changes of direction, while Rønnestad & Mujika, [44] referring to its physiology, they describe that it is due to motor improvement, an increase in the angle of registration of the peak of recruitment that affects the

stability of the knee when executing the jump, data that are similar to those achieved in the present study, where the athletes showed an increase in the jump in the G.E from 42cm to 45cm post intervention, with a significant difference $p < 0.01$.

Although it is true that absolute strength increases in sports modalities, especially in football and basketball, in the rest of the modalities it was not significant ($p > 0.05$), these data are similar to those found in Whyte's study, & et al [45] who, in their randomized clinical trial, report significant increases of up to 19%, both on the dominant and non-dominant sides. However, the interaction did not turn out to be significant, but it may have important implications for the clinic and the physiotherapy approach, [45] since when looking for a localized intervention, Nordic exercises would be a good option to consider. [46]

It should be noted that the studies consulted analyze samples associated with football, so the plus of this study is to consider applying it in other sports modalities, in this case the results determined significant changes in basketball and football. In taekwondo the change was noted in a minimal decrease in absolute strength, this may be due to the type of training used, since no significant differences were found in a pre and post, while Cardozo, & Moreno-Jiménez, [47] advise in their systematic review of strength in Taekwondo, that it should be improved and new evaluation parameters and instruments should be created that are more precise, and that help to differentiate these values.

Regarding explosive strength, training with Nordic exercises generated an increase in jump height in cm; in most of the modalities studied, significant changes were observed ($p < 0.05$) as mentioned by Whyte, [45] concluding that Nordic training improves the eccentric isokinetic strength of the hamstrings, being useful in developing a program to reduce the injury risk to these structures. On the other hand, no significant changes were found in cycling and taekwondo.

The current study has limitations; The Nordic exercises cannot be assumed as the only cause of the changes in strength, since both G.C and G.E continued with the planned training in each discipline, where they went through a progression of the load, it is for this reason that, although the difference is not significant in the G.C in the before and after, a slight increase in absolute and explosive strength is recorded. Caution is recommended with the dosage and distribution of the load since, although they seem like easy-to-execute exercises, in practice the implementation of these physical stimuli is complicated. On the other hand, caution is considered in the interpretation of the data, taking into account the small nature of the sample studied, recommending expanding the sample size and carrying out comparative studies by gender in the future.

The analysis of sports modalities such as taekwondo, cycling, basketball, athletics/speed and sport climbing was considered; However, there are no registered studies of the application of Nordic exercises; Therefore, we highlight in the future the importance of this study in analyzing this protocol in the aforementioned modalities, serving as a theoretical and methodological basis for other similar interventions.

5. Conclusions

The athletes have an age range between 16 and 28 years old, distributed between men and women in two independent groups, with homogeneous levels of strength in the initial stage. Applying an intervention process, it is concluded that the absolute and explosive force of the G.E showed a significant positive difference between the initial and final phase, unlike the G.C. However, when analyzing the effects of Nordic training by sports discipline, it turned out to be effective in improving explosive strength in the modalities of football, basketball, athletics and climbing, taking into account the characteristics of these sports modalities that use movements where the hamstrings produce eccentric actions. Absolute strength only improved significantly in basketball, not registering major changes in the rest of the sports modalities studied. It is advisable to include stimuli with Nordic exercises according to the periodization and planning of strength training, because despite being considered "Gold Standard" exercises for hamstrings, they do not seem to be necessary in various sports modalities.

5.1. Practical Applications

- 1) As has been described in this study, after the application of a Nordic training protocol in athletes of different modalities, it focused on the improvement of explosive and absolute strength, concluding that not all sports generate gains in this physical capacity.
- 2) In this sense, it is considered that doctors, physiotherapists or people related to the protocol can develop this strength training program in accordance with the stage of the macrocycle they are going through.
- 3) According to the results achieved, explosive strength improved in most of the modalities studied, except in cycling and taekwondo; Therefore, they can be applicable to improve the aforementioned capacity only in sports where Nordic stimulation has positive effects.
- 4) Regarding absolute strength, the implemented protocol has positive effects on absolute strength in basketball and soccer.
- 5) The scope of the 7-week Nordic training protocol has limited effects; Therefore, its improvement may be temporary or may be linked to load management within each macrocycle.

Author Contributions: Conceptualization: V.P.-M.; Methodology: V.P.-M.; S.C.-M.; Validation: R.P.-G. and V.P.-M.; Formal analysis: V.P.-M.; S.C.-M. and R.P.-G.; Investigation: V.P.-M., R.P.-G.; Resources: R.P.-G.; Data curation: V.P.-M. and R.P.-G.; Writing—original draft preparation: V.P.-M. and S.C.-M. Funding acquisition: R.P.-G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethics Committee: ID: N° 325-CD 2021; Faculty of Health Sciences of the Universidad Técnica del Norte- Ibarra- Ecuador.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to the qualitative nature of the study.

Acknowledgments: To the Research Project “Optimización del proceso de dirección del entrenamiento en deportes de cooperación-oposición (Senescyt: CEB-PROMETEO-007-2013). To the AFIDESA Research Group of the Universidad de las Fuerzas Armadas-ESPE. On the other hand, we also thank the Research Project called: “Análisis de la fuerza muscular pre y post entrenamiento Nórdico en deportistas de Imbabura período 2022” (Resolution: 325-CD), of the Universidad Técnica del Norte, Ibarra-Ecuador.

Conflicts of Interest: The authors declare that they have no interest conflict.

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