

Efficacy of Nordic Hamstring Exercises on Jump Performance in Athletes: A Review Article

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Abstract:-

Background and Need: High-intensity intermittent team sports consist of frequent explosive actions including jumping which can provide significant improvements in the success graph of the athlete. Nordic Hamstring Exercise (NHE) has been shown to increase eccentric hamstring strength more effectively than traditional hamstring exercises. Many researchers attempted to determine whether the improvements in muscle architecture and decreased muscle injury rate using NHE have an impact on jump performance in athletic individuals.

Objective: To review the available evidence to determine the efficacy of NHE in improving jump performance in athletes.

Methods: A comprehensive search of Pubmed, Science Direct, and Google scholar were conducted for clinical trials published between the years 2013 and 2023 that evaluated the effect of NHE on jump performance in the athletic population only. In particular, Countermovement Jump (CMJ) height was the variable examined. The PEDro scale was used to examine the methodological quality of the studies.

Results: Overall, 6 clinical trials were included in the review and the results showed a moderately positive impact of the NHE on CMJ, especially in soccer and handball players. In accordance with the PEDro scale, the average methodological quality of the studies was 6.05/10.

Conclusion: NHE is an easy-to-administer, time-efficient minimal equipment training method that showed improved jump performance in athletes. Further high-quality studies on a larger scale are required to confirm these results.

Keywords:- NHE, nordic hamstring exercise, jump height, jump performance, athletes.

I. INTRODUCTION

Physical performance plays a crucial role in determining an athlete's success.¹ The strength of the lower body plays a vital role in the performance of athletes involved in sports such as soccer, handball, rugby, and basketball, which require efficient sprinting and heading performance.^{2,3} The vertical jump, one of the many explosive game dynamics, is an important component in winning or changing the pitch score and demands motor coordination between the upper and lower regions of the

body. Dowling and Vamos in their study postulated that jump height highly correlates with maximum power in healthy athletes.⁴

The hamstring muscle is most susceptible to injury and represents a significant portion of lower extremity musculotendinous injuries in athletic competitions. It accounts for more than 12% of all sports injuries.⁵ Hamstring muscle injury is a complex problem for athletes, physicians, physical therapists, and athletic trainers as these injuries tend to recur and limit participation in athletic competition.⁶ However, researchers have shown that strengthening the hamstrings can be crucial in decreasing the risk of strain or injury.⁷

Various muscle contractions may be required to improve the strength of the hamstrings. Though eccentric motions during maximal voluntary isokinetic exercise generally result in lower muscle activity than concentric motions, the maximum strength of the former is significantly higher.⁸ Eccentric contractions not only allow the conversion of kinetic energy into elastic energy of tendons but also facilitate the dissipation of mechanical energy during body deceleration.⁹

Nordic hamstring exercise (NHE) is gaining popularity recently as a training method to increase eccentric strength of the hamstring muscle, which does not require any specialised equipment and can be easily performed on the field. The exercise is performed on the knees while the ankles are strapped or held by the physical trainer and the athlete lowers the upper body as slowly as possible in a prone position.¹⁰ While the effects of this exercise are well established in improving hamstring muscle strength, its specific effects on explosive measures such as jump performance are not well established. Hence, the aim of this review was to summarise the effect of the NHE on jump performance in athletes.

II. METHODOLOGY

- **Search strategy:** Databases used for this review were PubMed, Science Direct, and Google Scholar. The following keywords were used: 'NHE', 'nordic hamstring exercise', 'jump height', 'jump performance', and 'athletes'.
- **Study selection:** Studies were considered for inclusion if they met the following criteria: (a) articles in the English language (b) articles having NHE as the implemented protocol (c) articles published from 2013 to 2023 (d) articles that describe jumping performance as their

outcome measure and (e) studies done on athletic population irrespective of the sport. Studies whose full text was not available and did not meet the inclusion criteria were excluded from the review.

- **Search of Literature:** The literature search through the database showed 2049 articles, out of which 1431

duplicates were ruled out. After initial screening, 560 were excluded for varied reasons and 58 were included for full-text review (Figure 1); 6 studies met all the inclusion criteria and were finally evaluated with the PEDro scale.

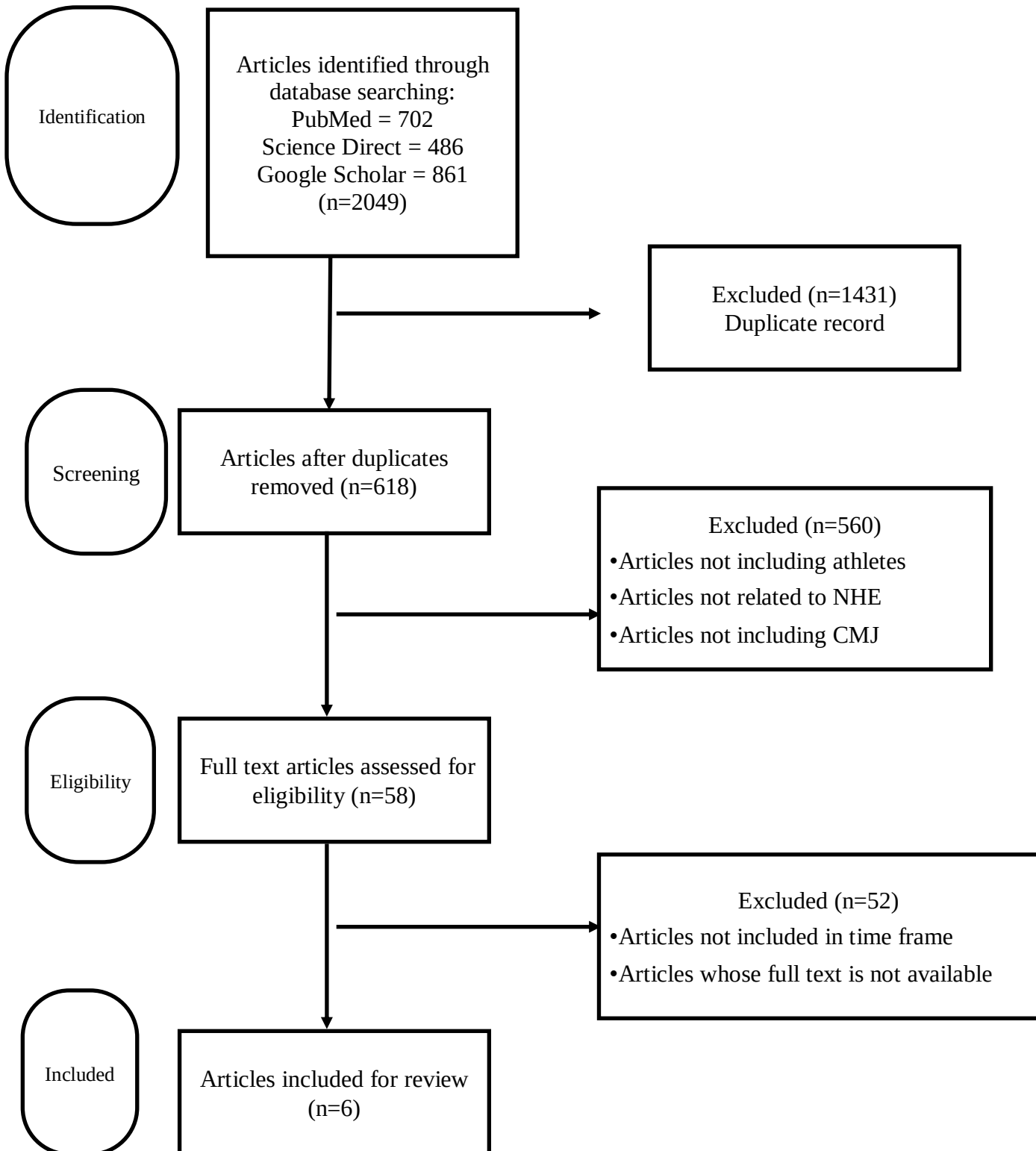


Fig. 1: The PRISMA flow diagram, illustrating each step in the selection of studies to be reviewed

III. RESULTS

- **Sample:** The articles reviewed in this included handball or soccer players as their sample population.
- **Methodological quality of trials:** In accordance with the selection and rejection criteria, only 6 studies were finally accepted for the present study (Figure 1). The PEDro scale was used to assess the quality of the trial methodology. The average methodological quality of the studies was 6.05/10 (Table 1). In particular, there were 4 studies of moderate methodological quality^{2,11,14,15} and 2 studies of high methodological quality^{12,15}.
- **Intervention:** The NHE was a therapeutic exercise administered to the athletes in conjunction with their regular sports-specific training (Table 2). The exercise protocol of NHE has been described by various researchers such as the protocols developed by Mjølunes et al. and Presland et al. was used in the studies included in this review.^{10,16} The duration of the program differed from study to study and ranged from 8 to 20 weeks. The exercises were administered at varying intensities and are summed up in Table 2. The NHE program usually

involved warm-up exercises and either performed with the help of a therapist or the feet were strapped to stabilise the lower limbs as the athlete attempted to resist a forward-falling motion using the hamstrings to maximise loading in the eccentric phase.

- **Outcome Measure:** The current review focussed on studying the effect of the NHE on jump performance which was measured by the Countermovement Jump (CMJ) height in all the reviewed articles. It measures the vertical jump height on a force plate in which the athlete is instructed to stand in an upright position and then does a countermovement jump by performing a rapid downward movement by flexing the knees and hips, followed by immediately extending the knees and hips to jump as high as possible. Jumping height is determined by integrating vertical ground reaction force and body mass. However, the force plates used in the reviewed articles differed (Table 2) and slight variations were observed in the methods of CMJ calculation.

No	Studies	Criteria of the PEDro scale										Total Score
		1	2	3	4	5	6	7	8	9	10	
1	Vácz M et al. [11]	1	0	1	0	0	0	1	1	1	1	6/10
2	Porrati-Paladino G et al. [12]	1	1	1	1	0	1	1	1	1	1	9/10
3	Ripley NJ et al. [13]	1	0	1	0	0	0	1	1	1	1	6/10
4	Mellor L et al. [2]	0	0	1	0	0	0	1	1	1	1	5/10
5	Chaabene H et al. [14]	0	0	1	0	0	0	1	1	1	1	5/10
6	Krommes K et al. [15]	1	1	1	1	0	0	1	1	1	1	8/10

Table 1: PEDro scale scoring of the analysed studies

No	Author & Year	Population & Sample size	Intervention	Duration, Frequency, Intensity of Intervention	Dependent variables	Evaluation/ re-assessment	Results
1	Vácz M et al. [11]	Female handball players (N = 23) EG = 13 CG = 10	EG: NHE and regular handball training drill CG: Regular handball training drill only	20 weeks Two times a week for 10 weeks, then reduced to once per week for additional 10 weeks Starting with 5 repetitions which progressed to 15 repetitions at the end of 20 weeks	CMJ height (Chronojump Bosco system), muscle contractile properties	Pre-training (0 week), mid-training (10th week), post-training (20th week)	In the EG group, CMJ height was significantly greater at 20th week and 10th week compared to pre-training. CMJ height at 10th week was significantly greater than 20th week
2	Porrati-Paladino G et al.	Female soccer players	EG: NHE, eccentric exercises &	3 weekly sessions over 4 weeks; EG:	CMJ height (MyJump 2.0) and	Pre-treatment, post-	No changes in jump performance

	[12]	(N=17) EG: 9 CG: 8	plyometric exercises CG: eccentric exercises & plyometric exercises	20mins/session; CG: 12mins/session	lower limb stability	treatment and 4 weeks follow up	were observed in either groups
3	Ripley NJ et al. [13]	Male and female collegiate athletes (N=38) NHE group: 15 Sprint group: 13	Nordic group: NHE and resistance training program Sprint group: Sprint training and resistance training program CG: resistance training program	7 weeks; Resistance training- twice/week with varying intensity across weeks; Nordic & sprint- intensity of training varied across weeks	CMJ height (Kistler force platform), sprinting performance, muscle contractile properties	Pre and post training	Increase in CMJ take-off velocity was observed for all training groups
4	Mellor L et al. [2]	Academy soccer players (N=16)	Control period: soccer-specific training programme Intervention period: soccer-specific training programme and assisted NHE	8 weeks each period with eight weeks gap in between each period	CMJ height (Optojump photocell system) and sprint performance, muscle contractile properties	Pre and post treatment after each training period	Significant changes were observed in CMJ performance
5	Chaabene H et al. [14]	Female handball players (N=19) EG: 10 CG: 9	EG: NHE subsequent to handball specific training CG: Handball specific training	Total 8 weeks; 1-3 sessions/week, 2-3 sets/session, 5-12 repetitions/set	CMJ height (Optojump photoelectric system), speed, change of direction, repeated sprint ability	Pre and post treatment	Moderate CMJ performance improvement in EG and small to trivial CMJ performance improvement in CG
6	Krommes K et al. [15]	Male soccer players (N=19) EG: 9 CG: 10	EG: NHE with regular training CG: regular training	27 sessions during 10 week period	CMJ height (Accugait force plate) and sprint performance	Before mid-seasonal break and after 10 weeks at the end of pre-season	CMJ height improved in both groups

Table 2: Brief description of the included articles

CMJ: Countermovement Jump; CG: Control group; EG: Experimental group;

IV. DISCUSSION

The effectiveness of eccentric training in the form of NHE in improving athletic performance has been established in recent years through a number of clinical trials. The purpose of this review was to summarise the effect of NHE on jump performance in athletes. Overall, 6 studies were examined in the present study with the PEDro scale and revealed that NHE had a moderately positive effect on the jump performance in athletes participating in sports viz. soccer and handball.

Bautista IJ et al. in their meta-analysis revealed that training programs involving the NHE could be beneficial in enhancing sprint performance and eccentric strength of knee flexors team sport players.¹⁹ On the other hand, Cuthbert M et al. also found positive effects in the eccentric strength and muscle architecture following both high and low volumes of NHE interventions.¹⁸ Similarly, a systematic review by Al attar et al. demonstrated that injury prevention programs that include NHE may alleviate the risk of hamstring injuries among soccer players.¹⁹

An important difference in the NHE intervention observed in these studies is the volume and workload of the intervention. Traditionally NHE interventions have had large volumes with many totaling over 400-700 repetitions as seen in studies conducted by Bourne et al. and Ishoi et al.^{20,21} The study conducted by Váczi M et al.¹¹ were of 20 weeks and all the remaining studies only had a timeframe of 10 weeks or lesser. Feedback from the players in the study showed that NHE with a smaller dosage (1-2 training sessions a week), a small volume (5-15 repetitions of 1-2 sets), a small time frame (4– 5 weeks), or as part of additional strength training was a sufficient stimulus in improving jumping performance. But at the same time, CMJ height in the NHE group decreased from 10 to 20 weeks. At 20 weeks, however, it was still significantly higher than at pre-intervention. These results showed that the training volume had an important effect on CMJ height, as the participants executed two eccentric training weekly in the first training period, which decreased to one in the second training period.

Likewise, Cuthbert M et al. proposed that reducing NHE volume prescription does not negatively affect adaptations in eccentric strength and muscle architecture when compared with high-dose interventions. These findings suggested that lower volumes of NHE may be more appropriate for athletes, with an aim to increase intervention compliance, potentially reducing the risk of hamstring strain injuries. In contrast, Bautista IJ et al found that for well-trained team sport players, the improvements in eccentric strength were less consistent, suggesting a higher training intensity of NHE may be required to induce adaptations.¹⁷

Except for the study conducted by Chaabene H et al.¹⁴, all the players were non-elite athletes who have rarely taken part in a structured strength and conditioning program and therefore more likely to benefit from this intervention due to a possibly lower starting point compared to elite athletes with longer training history. Another limitation that all the studies faced were the small sample size. It is recommendable to have a larger sample size of players and multicenter recruitment. Conducting medium and long-term studies and implementing a longer follow-up period could give a more clear idea of the suitability of these exercise programs for jump performance in athletes.

NHE was performed at the beginning of the training session except in the study conducted by Chaabene H et al.¹⁴ where it was performed subsequently to the regular handball training routine. Mellor L et al.² found that performing the NHE after exercise when the hamstrings are already fatigued has more hypertrophic adaptations, whereas performing the NHE before exercise when the hamstrings are not fatigued is suggested to stimulate an injury prevention adaptation of increased fascicle length and both these changes are linked with improved jumping performances. However, more research is required to know the efficiency of this aspect.

Hence the findings of this review suggest that physical therapists can improve the use of NHE to improve jump performance in athletes involved in sports like soccer and handball. The use of NHE not only warrants an improvement in jump performance but also can improve muscle strength and performance in athletes. Future research is needed to include studies with improved research protocols with larger study populations that are more exclusive to determine the effect of NHE exclusively on CMJ. Future research should include the athletic population other than soccer and handball, including elite athletes playing at a professional level, and also examine the effects of NHE on injury prevention. Therefore, taking into account the limitation of this literature review, the researchers warrant a future scope with new experimental protocols with better methodological quality to confirm the effectiveness of NHE on jump performance in athletes.

V. CONCLUSION

High-intensity intermittent team sports consisting of frequent high-intensity actions include explosive actions like that of jumping. The conclusion derived from this review is that the addition of progressive NHE training of the hamstring muscles as part of a regular training protocol positively influenced jump performance in soccer and handball players. The NHE training intervention lasted no more than 10 minutes, making it a time-efficient training method that can be routinely carried out in a sporting environment with few resources required. This exercise is also an easy-to-administer, minimal equipment exercise that has been shown to create high levels of hamstring muscle activation and a higher eccentric hamstring activation than most other commonly used hamstring exercises.

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