

Investigating the Effect of Rebound Therapy Practical Program on the Explosive Power of Bottom Extremity in Hearing-Impaired Students

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Abstract

Objective: The purpose of this study was to examine the effect of rebound therapy practical program on explosive power of bottom extremity in hearing-impaired students.

Methods: 32 hearing-impaired female students voluntarily participated in this study and they were randomly divided into two experimental and control groups. Explosive power of bottom extremity in pre-test and post-test was measured using Sargent Jump Test. Experimental group performed rebound practical program for 8 weeks and 3 sessions per week for 30 to 45 minutes. SPSS version 18 software was used for statistical analysis.

Results: The mean and standard deviation of age (16.22 ± 1.641 year), weight (52.88 ± 10.070 Kg) and height (158.09 ± 7.239 cm) of subjects were measured. The mean of Sargent jump test record in pre-test were 2517.28 and 3474.65 in the two groups and these values got to 2167.8 and 2910.08 in post-test. The findings suggested positive effect of rebound therapy practical program on explosive power of bottom organ ($p = 0.839$) in the hearing-impaired students.

Conclusion: According to the obtained results, rebound therapy practical program is effective in rehabilitation of hearing-impaired students and this method can be used in physical rehabilitation in hearing-impaired children and teenagers.

Keywords

Rebound Therapy Practical Program, Explosive Power, Bottom Extremity, Hearing-Impaired

Introduction

Often, the problems of hearing-impaired people are only concerned in terms of communication. However, the communication problem is the main defect caused by hearing-impairment may be this is associated with other physical problems. In this regard, balance deficit with damage to sensory integration and motor development is often seen in hearing-impaired people (1). According to general systems theory, sensory system including vestibular of the inner ear, vision, and sense of somatosensory plays an important role in physical stability and

balance. Damage to parts of the vestibular-cochlear nerve not only impairs the sensory-neural hearing, but also, it may cause damage to the vestibular branches of the nerve and lead to problems with balance and this is the reason that 40 percent of deaf people face the balance problems (2).

In various studies, the balance deficit in hearing-impaired people has been compared with normal people. Morsh (1963) compared the vestibular performance in normal and hearing-impaired people in the high school. He observed weaker performance in hearing-impaired people than that of the normal people. (3) Balance is one of the inseparable components of all daily activities and a key part to the performance of athletes (4). For postural control, the person should maintain his/her body position in space and produce appropriate force to correct or maintain the body position and this needs a complex communication between sensory, nervous, and skeletal-muscular systems. (5)

To stand up, the central and peripheral nervous system should act well together and the neuromuscular system processes the inner data and selects the most appropriate response of muscle to postural control (6). Balance in closed kinetic chain has been maintained and each of the lower extremity joints or structures is impaired by afferent sensory disorder or disruption of power transmission and mechanical strength. (7) the lowest part of this chain is leg that provides a small area to maintain the balance. Therefore, it is reasonable that small biomechanical changes affect the balance control (8). Maintaining postural body is essential during daily activities and the right exercise; therefore, measurement of postural body in vitro and clinical measurements is used as a tool to assess the sustainability and neuromuscular control in healthy and damaged individuals. (9)

The most important point that has been emphasized in the process of rehabilitation programs is the implementation of closed Kinematic chain exercises and these practices should be gradually expanded as soon as possible according to the patient's condition. It is believed that by create more compressive force,

the closed chain exercises facilitate postural and dynamics stability, increase joint coordination, and retrain proprioceptors. Hence, some of these exercises are primarily suggested for retraining joints sense (10). According to Gahery and Bouet (2000), these exercises reduce proprioceptive error by improving neuromuscular exercises. Closed chain exercises are vital for the restoration of neuromuscular system. Integrity, balance and harmony of the body is impossible without performing such exercises. Thus, especially professional athletes should be under control for a longer time to justify the importance of this exercise (11).

Tests and measurements are essential prerequisites for the development of rehabilitation and training programs (12). A suitable test measures a person's ability well (13). Since in everyday life and sports activities, the body acts as a dynamic unit, clinical evaluation of muscle strength and joint mobility cannot provide the information needed to evaluate the performance and efficiency of ability (14).

Muscles in the central region act as a bridge between the upper and lower extremity and through the force produced in the central region and transferred to the extremity. Primarily, stability requires neutral position maintenance of the spine, of course in circumstances where the backbone of the country's neutral status also exists (15). According to the theory of the closed kinetic chain, hip muscle strength is necessary for controlling lower segment and preventing from the other joints to be affected in case that one of the lower extremity joints does not work well (16 and 17). Thigh muscle activity is important in the performance of the lower extremity and the closed chain activities (18).

According to a study, increased core stability can cause power generation in the lower extremity during bike ride; and muscle fatigue alters the biomechanics of cycling and probably a greater risk of injury in the knee joint (17). In addition, increasing the strength of hip abductors enhance the abilities of female athletes in the control of lower extremity alignment and reduce the loads on the knee joint during movement of the trunk when increasing sport activities (20 & 19). In another study, it was found that athletes with stronger external hip abductors and rotators have not experienced the damage of lower extremities after the seasonal plays. (16)

It was also stated that, Swiss ball exercises can have a positive effect on core stabilization, but they do not necessarily improve athletic performance (21). In addition, the central stability is relatively associated with the power and performance and it increases the central power, but it does not dramatically improve the strength of lower extremity (22).

Regarding to the execution of each exercise, and to achieve the proper preparation, specific training is necessary. In physics, power is to do something in a specific time unit. In other words, power is the speed of doing the work. According to this definition, anaerobic power, maximum muscle power, and explosive power are similar concepts of the power (23). Strength, endurance, power, flexibility, speed or a combination of them is needed in any of the sport depending on the type of exercise.

For this purpose, high speed, power and appropriate explosive strength are essential principles of physical fitness for movement. Trampoline exercise (plyometric) is one of the traditional training methods that are of great importance in strengthening the explosive power with the right combination of speed and muscle power (24). In recent years, the increasing development of sports science has been very impressive and fitness has been developed as an important part of this science.

By perusing the different sports, in most of them, we find that some skills and movements need physical fitness, strength and speed (Explosive power). For example, in a jump shot in basketball, cut spike in volleyball, head in football, drive shoot in table tennis and mutation movement in four-jump, the athletes need to strengthen the mentioned factors (25). Exercise increases the ability of human movement, but what should be done if we want to maximize and continue this ability?

In this case, the importance of exercise science and practice principles fit the motion and exercise physiology is highlighted. The speed and power of the jump are important and effective factors in many athletic skills. In competition and tournaments, athletes are permanently in then condition of fighting and competing the stronger, faster and more physically trained opponents; hence, using the special training methods are necessary for athletes to participate and be prepared in domestic and international competitions versus rivals (26).

Now a days, rebound therapy practical programs (Trampoline) are suggested to increase skills training and ability of individuals by researchers and experts in exercise science field.

Several studies have been done on the rebound therapy as a training method that its main component is rebounder (mini trampoline) (27). Many studies have reported the positive effects of rebound therapy on the human body in physiotherapy and medical environments. Rebound therapy program is a type of plyometric exercises including up and down bounce, landing on two feet, a foot and various movements of the shoulders, arms, hands, torso, thighs, knees and leg (27).

Although, Trampoline has been used in various trainings form 1950, but the concept of rebound

therapy has been defined and used for the first time by Anderson et al. in 1970 while involving with children with physical and learning disabilities (28 – 29). Lawrence (2004) have introduced mini trampoline as a safe and useful means to practice all parts of the body by combining the principles of practice bounces, jumps and plyometric training that provide the framework of health and safety for all ages and with all levels of ability to achieve health benefits by bounce.

They believe that by using rebound therapy practices and simple gestures jump on trampolines, the body fat is reduced, legs, thighs, abdomen, arms, and hips are tight, agility is increased and muscles will be strong (30 – 31). In the rehabilitation, rebound therapy is used in rehabilitation training programs, because it has a positive effect on increasing the muscle strength, vertical jump, balance, bone mechanical ability, bone mineral density, as well as raising levels of health and even injury recovery (32 – 33).

Smith and Cook (2007) noted the benefits of this method including changed muscle stretching, relaxation, stimulation reaction equilibrium, situation mechanism and facility in the movement and believed this type of exercise triggers cardiovascular and respiratory-related performance. Therefore, the use of trampoline in rebound therapy increases the awareness of patients with neurological disorders as well as increasing the cardiovascular and respiratory performance and activating movements during stimulation of sensory system (28 – 34).

It has been experimentally proved that the gravity of jumping in rebound therapy helps lymph flow, it also is useful in any physical activity, especially low-impact activities such as jumping in a rebound therapy, because the lymphatic system needs the muscular contraction of lymph fluid throughout the body (31). According to Smith and Cook (1990), rebound therapy can improve balance and coordination (34).

According to the above discussions, balance assessment in hearing-impaired people is very important to understand the potential severity and type of disorder and advising them and their families in terms of environmental and recreational experiences. Therefore, the objective of this study was to examine the effects of 8 weeks of rebound

therapy practical programs on explosive power of lower extremity in hearing-impaired students.

Methodology

This is a quasi-experimental study in which the effect of exercise rebound therapy on explosive power of lower extremity was measured through a pre-test - post-test. In this study, 32 hearing-impaired female students of below 30 dB with the mean and standard deviation (Age: 1.641 ± 16.22 years, weight: 10.070 ± 52.88 kg, height: 7.239 ± 158.09 cm) were selected. In all sports, body balance and stability are important to maintain the body posture in a state of balance, especially in sports such as basketball, gymnastics, martial arts etc. Maintaining body posture without body motions is a big point and earns a much-needed balance (35 – 36). Hence, the students enrolled in Mir high school in Isfahan city were selected and randomly divided into two groups: control ($n = 16$) and experimental ($n = 16$).

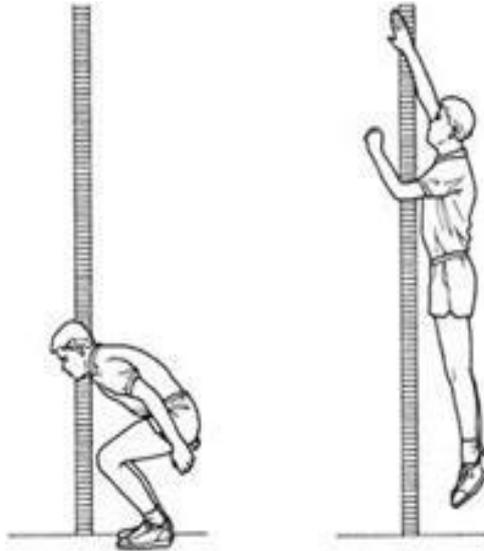
Sargent jump test that is an accepted index by researchers is widely used to assess the strength and explosive power (37). Sargent vertical jump test in our country is the most common test to measure anaerobic power and vertical jump (38). Age, height, and weight in this measure will have a little effect. Vertical jump test has acceptable reliability and validity (39).

Procedure is in the way that we measured subjects' weight then, while the subject stands in one side against the linearized wall and the other in the back part of the waist, fingerprints are drawn on the wall. To do this, one hand is located next to the wall and it vertically goes up and is turned pronation and it sticks on the wall with open fingers. Hands can be dipped in plaster (40). To do the test subject should stand on a foot and stretch body as far as she can and mark on the wall with her middle finger. Then, she takes the mode of jump and in an optimum state of balance jumps up as much as possible, draws her hand and touches the wall in peak or maximum height again with her fingers and leaves another sign higher than the first mark. His record is the distance between the two fingers (Fig. 1). This test is repeated three times and the best obtained record will be considered as the individual's score (40).

Method of obtaining the Sargent mean:

$$43.8 \times \text{height of jump (cm)} + 32.7 \times \text{body weight (kg)} - 16.8 \times \text{Height (cm)} + 431$$

Figure 1. Sargent Vertical Jump Test



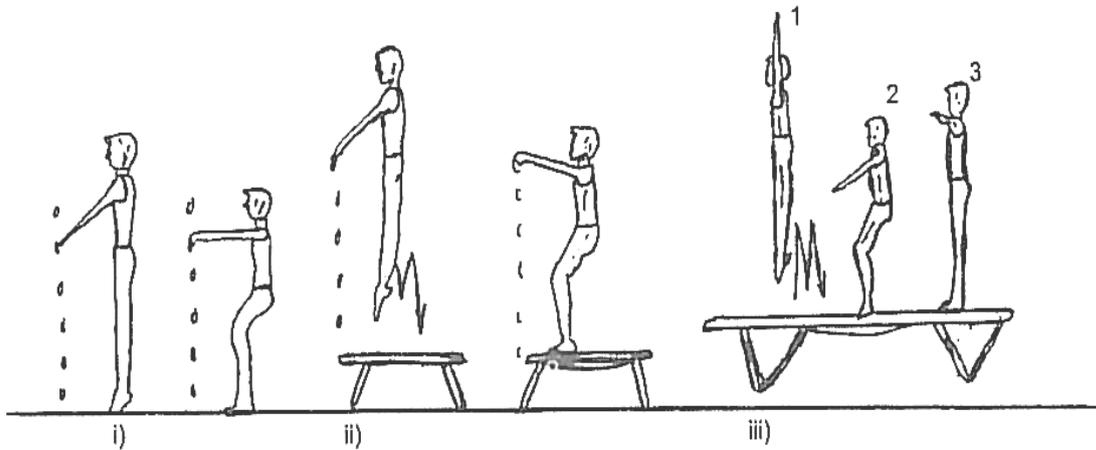
To performer bound therapy practical program, the standard protocol defined by Grubel (2006) was used. This exercise protocol includes safe jumping, jumping aerobic, strength and jumping resistance and the experimental group performed the exercises for eight weeks and three sessions per week for 30 to 45 minutes

Table 1. Rebound Programs of Experimental Groups

Sessions	Motion	Minute
The First Week	Physical Readiness (Dressing, Hygiene and Safety, Jogging, Stretch, and Station Movements)	10
	Gestures Related to Getting Familiar with The Device (Such as Standing, Walking, etc.)	25
	Recovery (Walking, Stretching, Dressing, Collecting Items)	5
The Second Week	Physical Readiness (Dressing, Hygiene and Safety, Jogging, Stretch, and Station Movements Gestures While Sitting)	10
		25
	Recovery (Walking, Stretching, Dressing, Collecting Items)	5
The Third Week	Physical Readiness (Dressing, Hygiene and Safety, Jogging, Stretch, and Station Movements in Sitting and Facultative Positions)	10
		25
	Recovery (Walking, Stretching, Dressing, Collecting Items)	5
The Fourth Week	Physical Readiness (Dressing, Hygiene and Safety, Jogging, Stretch, and Station Movements in Standing Position Primarily)	10
		25
	Recovery (Walking, Stretching, Dressing, Collecting Items)	5
The Fifth Week	Physical Readiness (Dressing, Hygiene and Safety, Jogging, Stretch, and Station Movements)	10
	Jumping Motions (Hopping, side by side, Hopscotch)	30
	Recovery (Walking, Stretching, Dressing, Collecting Items)	5
The Sixth Week	Physical Readiness (Dressing, Hygiene and Safety, Jogging, Stretch, and Station Movements)	10
	Jumping Motions with higher severity	30
	Recovery (Walking, Stretching, Dressing, Collecting Items)	5

The Seventh Week	Physical Readiness (Dressing, Hygiene and Safety, Jogging, Stretch, and Station Movements)	10
	Jumping Motions	30
	Recovery (Walking, Stretching, Dressing, Collecting Items)	5
The Eighth Week	Physical Readiness (Dressing, Hygiene and Safety, Jogging, Stretch, and Station Movements)	10
	Jumping Motions	30
	Recovery (Walking, Stretching, Dressing, Collecting Items)	5

Figure 2 . An Example of the Movements Carried Out on The Trampoline by Volunteers Participating in the Study



One day before the rebound therapy practical program, pre-test was carried out on participants in both groups after ten minutes of warm-up (slow running, stretching the hamstring, quadriceps, gluteal muscles, and gastrocnemius soleus). In the next day, the participants in the experimental group began rebounds therapy programs after 10-minute warm-up (stretching). This makes the best use of their leg bones during the program. After the end of exercises period, post-test was performed on experimental and control groups. For summarizing and classifying the data, the descriptive data was

used in the form of mean and standard deviation statistics. Analysis of variance for repeated data in SPSS version 19 and for analysis and significance level for all analyses were 0.05.

Results

Sociological information on age, height, and weight of the subjects are shown in Table 2. Demographic characteristics show no significant difference between the experimental and control groups in any of the variables. Hence, the experimental and control groups at baseline are assumed to be homogeneous.

Table 2. Demographic Characteristics of Subjects

Factor	T	Mean±SD	Group	Number	P
Age		15.56±1.31	Rebound	32	0.436
	-2.436	16.88±1.70	Control		

Height	-1.739	155.94±6.51 160.25±7.47	Rebound Control	32	0.432
Weight	-1.739	49.87±6.22 55.88±12.31	Rebound Control	32	0.109
Weight	-1.739	49.87±6.22 55.88±12.31	Rebound Control	32	0.109

P = Significant Level

* = Significant at 0.05 Level

According to Table 3, the mean record of Sargent jump test before the test in two experimental and control groups was respectively 2517.28 and 3474.65 seconds that in post-test, this rate reached 2910.08 and 2167.8. This difference was statistically significant in terms of mean. (P=0.839 and F=0.042). In other words, the differences between the various research groups over the two testing are matched (P<5%). It can be seen in Figure 2 that the

slope in the experimental group is more than that of the control group. This indicates a significant interaction between the two groups. (P=0.104 and F=2.813) In other words, the changes separate scores on any of the two groups, internal model of changes are significantly different between the two groups. According to the comparison within the groups, significant progress or regression is observed in total scores of the two groups (P=0.289 and F=1.167).

Figure 3. Line Chart of Changes of Explosive Power Scores in Two Times

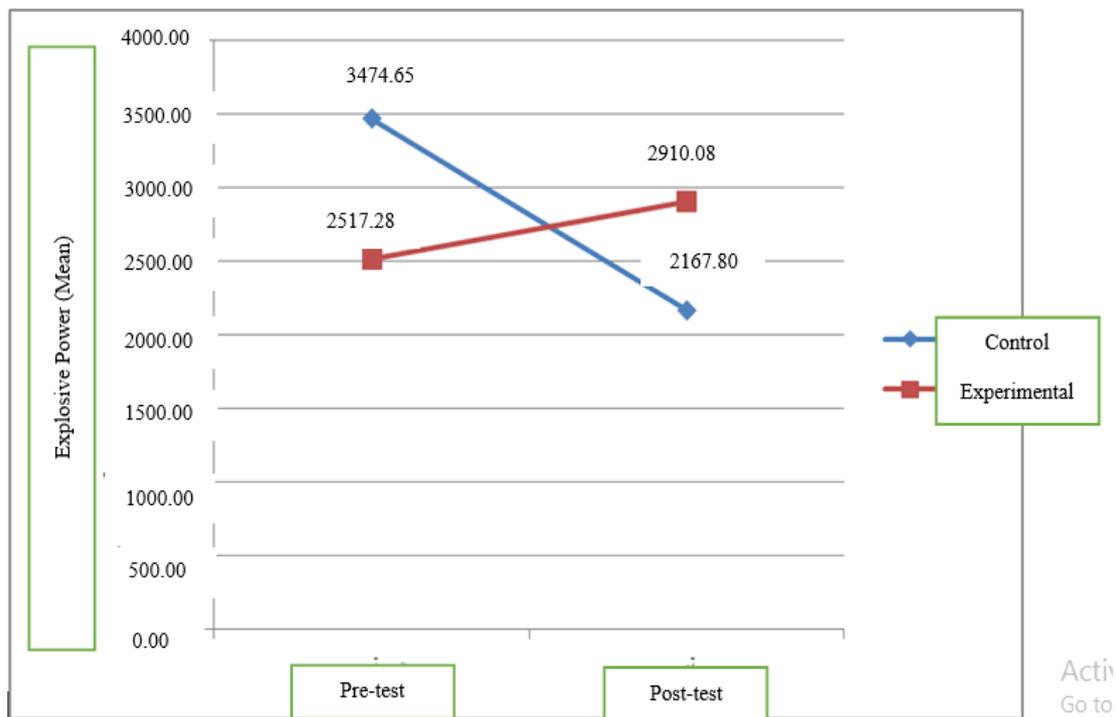


Table 3. Information of Variables in Pre-Test and Post-Test and The Results of Analysis of Variance for Repeated Data

Factor	Group	Within Group	Group Interaction	Within Group	Post-Test Mean ±SD	Pre-Test Mean ± SD
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Mean Sargent Explosive Power	Rebound	F=1.167	F=2.813	F=0.42	2910.088±327.9912	2517.288±325.6603
	Control	*P=0.289	P=0.104*	P=0.839*	2167.8±57.5603	3474.656±5056.479

P = Significant Level

* = Significant at 0.05 Level

Results and Discussion

The findings of this study showed that after eight weeks of training, a significant improvement was observed in explosive power of lower extremity in the hearing-impaired patients compared to the pre-test and this improvement was greater in the experimental group compared to the control group. In general, most studies conducted on the effect of rebound therapy have reported the significant improvement of muscular power.

The results of this research on explosive power are consistent with the results of Tahmasbi et al. (2013) in a study on the effect of rebound therapy on health-related physical fitness, balance, and proprioception of educable mentally retarded children and significant improvement in their explosive power of legs (41), as well as the study of Hosseini (2012) on the effect of plyometric exercises on vertical jump performance and neuromuscular adaptations in the volleyball players and a significant increase in vertical jump performance (42). In a study on the effect of elastic, plyometric and resistance exercises on anaerobic performance of elite volleyball players, Kalvandi et al. (2011) observed a significant increase in vertical jump test (43). Valipour et al. (2010) conducted a study on the effect of plyometric exercises on functional and neuromuscular adjustment and a significant increase in Sargent jump test were observed (44). Ferdowsi et al (2009) conducted a study on the effect of weight and plyometric exercises on muscle strength and power and observed increase in the value of vertical jump test after 6 weeks (45). Daneshmandi (2006) examined the effect of plyometric exercises on aerobic capacity of gymnastics and founded a significant increase in explosive power of the lower extremity of gymnastics (46). Gigazoghlu et al. (2013) examined the effect of plyometric exercises on the motor performance and balance in mentally disabled children and reported a significant increase in vertical jump test (47). Hudson et al. (1997) conducted a study to evaluate the effect of mini-trampoline on the vertical jump and observed a significant increase in vertical jump, (Hudson, 1986) (48 – 49). Simple gestures jumping and rebound therapy on trampolines, legs, thighs, abdomen, arms, and hips are strengthened as well as the muscular power (Chartered society of physiotherapy, 2007) (50).

Trampoline effect in vibration of muscle spindle improves muscle tone. So that, the vibration of muscle spindle with increased tone causes increase in length and elasticity of muscle tissue and increase in the contraction of muscle tissue in decreased muscle tone (50). On the other hand, rebound therapy practical program causes explosive activity in the lower extremity and these exercises are effective in the improvement of explosive power of the lower extremity and are evident in result of this research.

As a result, in the exercises by vibration in muscle spindle and loss of muscle tone, increased length shortened and general flexibility improved (50). Hence, significant and positive effect of rebound therapy on improving the explosive power of lower extremity is well expected.

In rebound therapy, exercises are performed on an unstable surface and for balancing and body postural against gravity, muscles are more engaged, so that these exercises are called the Cellular exercises which means engagement of all cells in body to do the exercises. Since most of these exercises are done in a standing position, the share of antigravity muscles in maintaining balance is larger and the passage of time and progress in practices increase the strength of these muscles. Moreover, since apart of the exercises of jumping movements are from the jumping moves and are like plyometric exercises, the effect of the selected exercises in improving muscle strength is doubled in the system; consequently, it causes improve in the muscles of the lower extremity. Hence, increasing the explosive power of lower extremity in extensor and flexor muscles in the knee in the rebound therapy is not strange (50).

Increase in the power after exercise may be due to cellular-molecular changes in central nervous system, motor units, neuromuscular connection plate, network systems involved in sarcoplasmic, mitochondria, or in contractile proteins (51). Therefore, different stimuli, such as hormonal changes, type, duration, and intensity of exercise can determine the original position of changes (52 – 53) so that, researchers stated the adjustment after exercise due to hormonal changes and muscle tension (54). In this case, greater motor units for a given action are engaged that will facilitate and enhance the ability of muscle contraction for power

generation. Such an increase in motor unit recruitment pattern can be caused by stopping or reducing inhibitory impulses (muscle spindle) that allow simultaneously activation of more motor units (54). Exercise can be some deterrent impulses to gradually reduce or cope with it and let the muscle achieve higher levels of power. Thus, increasing the power may be achieved by reducing neural inhibition (50).

Conclusion

According to the results of this study, rebound therapy practical programs increase the explosive power of lower extremity as well as aerobic capacity in hearing-impaired students. Accordingly, for all sports that require a high vertical jump, it is necessary to perform trampolines exercises in their fitness programs.

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