Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2022 Jun 23; 10(A):1023-1027.
https://doi.org/10.3889/oamjms.2022.9122
eISSN: 1857-9655
Category: *A - Basic Sciences*
Section: *Sports Medicine*

Since 2002

OPEN ACCESS

The Influence of Ballistic Exercises on Growth, Somatomedin Hormones for Soccer Players

Wael Ramadan[1]*, Ahmed Elsayed[1], Mariam Abu Alim[2], Ellie Abdi[3], Medhat Kasem Abdel Razek[4]

[1]Department of Sports Training, Faculty of Physical Education, Mansoura University, Mansoura, Egypt; [2]Department of Sports Biomechanics, Yarmouk University, Irbid, Jordan; [3]Center of Pedagogy, Montclair State University, Montclair, USA; [4]Department of Physical Education, Umm Al Qura University, Mecca, The Kingdom of Saudi Arabia

Edited by: Slavica Hristomanova-Mitkovska
Citation: Ramadan W, Elsayed A, Alim MA, Abdi E, Razek MKA. The Influence of Ballistic Exercises on Growth, Somatomedin Hormones for Soccer Players. OpenAccessMacedJMedSci.2022Jun23;10(A):1023-1027. https://doi.org/10.3889/oamjms.2022.9122
Keywords: Growth hormone; Somatomedin hormone; Ballistic training; Muscular ability
***Correspondence:** Wael Ramadan, Department of Sports Training, Faculty of Physical Education, Mansoura University, Egypt. E-mail: dr.wael2050@gmail.com
Received: 25-Feb-2022
Revised: 10-Jun-2022
Accepted: 13-Jun-2022
Copyright: © 2022 Wael Ramadan, Ahmed Elsayed, Mariam Abu Alim, Ellie Abdi, Medhat Kasem Abdel Razek
Funding: This research did not receive any financial support
Competing Interests: The authors have declared that no competing interests exist
Open Access: This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0)

Abstract

BACKGROUND: The sequence of exercise-induced hormonal changes demonstrates the quantification of training and competition loads and developing a sport-specific conditioning program.

AIM: The present study investigates the impact of ballistic exercises on biochemical variables and the muscular ability of soccer players.

METHODS: Participants were assigned randomly to two groups, including ten participants in each group, and underwent a pre- post-intervention test, including growth hormone, somatomedin hormone, triple jump, and wide jump.

RESULTS: The experimental group showed a significant increase in Growth by 43.56%, somatomedin by 6.99%, Triple jumps by 18.65%, and Wide jump by 15.68% compared to the control group.

CONCLUSION: In conclusion, ballistic exercises improved growth and somatomedin hormone, triple jump, and wide jump and thus enhancing biochemical variables and muscular ability.

Introduction

High-demand sports such as football, where sudden turnovers and acute accelerations are essential, and the athletic ability to reach relatively high levels of strength and maximize its transfer to performance are the critical elements [1], [2]. Training to enhance a high acceleration power output increases the risk of injuries and fatigue; many sports scientists and trainers have focused on developing effective and healthy Conditioning Programmers (CP). Ballistic Training is a well-debated and developed CP (BT) that aims to improve explosiveness by recruiting the maximal motor units in the fastest possible velocity focusing on the acceleration of the mass throughout the entire exercise range of motion without the use of heavy training weights and oversized equipment [3], [4]. BT differs from traditional strength exercises in that it has a concentric acceleration phase, an eccentric deceleration phase, and an amortization phase [5]. For instance, BT occurs at the end of the task range of motion, such as when the athlete throws the training object (e.g., a weighted ball or a bar) in the space. Whereas literature has concluded that exercise maximal power output development is higher, when the propel training object into the air incorporates traditional resistance training techniques.

Newton *et al*. were the first to investigate the differences between traditional strength training programs and BT. They reported that the BT bench throws significantly affected averaged force-velocity performance and peak velocity. Moreover, the bar accelerated up to 96% of the task range of motion during ballistic training, resulting in greater peak bar velocities and muscle recruitment to produce tension over a significantly longer concentric phase. In addition to the necessary enhanced peak power and averaged power production compared to traditional resistance training exercises Newton *et al*. [6], Fleck and Kraemer [7] demonstrated that muscle fibers contract forcefully and quickly in ballistic training due to muscle adaptation to work at high speed in a short period of time before the movement stops whereas, traditional strength training is required to perform with weight and decelerate the tendency to return to the initial position. Consequently, the action of the muscle fibers slows, and muscle volume increases more than the performance speed [7]. The dynamic interaction of mechanical, hormonal, and metabolic stimuli is an assessment and reference point for evaluating the acute development of strength and power [8], [9], [10].

Training-induced metabolic stimulus changes result in elevated anabolic hormones release [11], [12]. Addressing a better understanding of these responses on and BT interventions may provide an enhanced experience of the stimuli process of the exercise adaptations [13], [14], thus enabling the specialized description of BT required for the Motor task. It has been proven that the greater engagement of muscles unites and groups to perform a task, the higher the anabolic hormones released can be dedicated in the blood [15], [16], [17]. In contrast, training adaptation and the muscle's mechanical output can be indicated by the dynamic interaction of the mechanical, metabolic stimuli, and hormonal responses. Through the analysis of selected growth and somatomedin hormones, this study aims to optimize the effect of BT in score players' participants' strength and power development.

Materials and Methods

Participants

Twenty volunteers were recruited in the current study (age, 16.50 ± 0.53 y, body mass, 68.80 ±4.58 kg, height, 174.50 ±5.38 cm, and training age 4.20 ± 4.00 kg/m^2). Participants were excluded if they suffered from metabolic disease or renal, pulmonary, or cardiovascular problems. Before initiating any testing or training session, written informed consent was obtained from 20 players, who were then divided equally into two groups, ten persons in each group of the experimental and control groups. The Institutional Review Board approved the study. Table 1 depicts the physical characteristics of the two groups.

Table 1: Physical characteristics of subjects

Variables	Age (years)	Body mass (kg)	Height (m)	Training age (years)
Mean	16.50	68.80	174.50	4.20
SD	0.53	4.58	5.38	4.00

The biochemical responses testing

A complete physical examination was performed, and blood was drawn for routine biochemistry, serum growth hormone, and somatomedin hormone. Participants should not exercise or eat anything for 10 h before the test (unless specifically instructed to do so for some of the dynamic tests); water is permitted. Subjects may be asked to sit quietly for 30 min before the test.

Training program

Participants were randomly categorized into two groups, including ten participants in each group. Before the onset of the study, none of the participants had participated in any training for two months. For 10 weeks, the groups followed a training program of four sessions per week, lasting 2 h after lunch. The foundation period depends on body weight and weight machines for 2 weeks and ballistic training for 8 weeks. The duration of the training unit is from 90 to 120 min. Ballistic exercise time in training units ranges from 20 to 30 min, depending on the number of repetitions (8–12), groups (3–4), and rest intervals between sets (2–3) min. Ballistic training intensity ranges between 40: 55% of the player's maximum intensity; the training program is used at the Intermediate (low-high) intensity. Experienced physical education instructors supervised each lab training session. Each subject's repetition maximum (1RM) was determined using existing references. Twelve subjects had to perform a warm-up set of 8–10 repetitions at 50% of their estimated 1RM, and they had to move to a warm-up set of 3–5 repetitions at 85% of their estimated 1RM. In addition, they performed 1RM attempts over 4–5 trials separated by 3 min rest intervals to determine squat 1RM. After 4 weeks of resistance training, 1RM was measured again, and intensity was re-established.

Performance variables tests

The athletic performance of the participants was measured by two field tests: The triple jump and Wide jump test of each participant [18]. Devices and tools: Tape - Cones/Dishes, Barriers, Swedish Seats, Rubber, Gaiters, Rastametar, and Stopwatch.

Statistical analysis

Statistical analysis was carried out via the Statistical Package for the Social Sciences (SPSS) program 15.0. The data were expressed as mean ± standard deviation (SD) and "T" values. The significance level was at 0.05.

Results

The descriptive characteristics of participants are displayed in Table 1 (age, 16.50 ± 0.53 years, body mass, 68.80 ± 4.58 kg, height, 174.50 ± 5.38 cm).

Table 2 compares pre-and post-testing variables in terms of Growth hormone, Somatomedin hormone, triple jumps, and wide jump between experimental and control groups. An increase in growth by 25.73%, somatomedin by 3.42%, triple jumps by 13.79%, and wide jump by 10.69% in the control group versus increases in growth by 43.56%, somatomedin by 6.99%, triple jumps by 18.65%, and wide jump by 15.68% in the experimental group. According to variables, the experimental group demonstrated better

Table 2: Pre- and post-testing variables between experimental and control groups

Variables	Group	Pre		Post		Change %	(T) Value
		Mean	SD	Mean	SD		
Growth, ng/mL	Experimental	4.210	0.674	7.460	0.650	−43.56	8.101*
	Control	3.810	0.730	5.130	0.636	−25.73	
Somatomedin, ng/mL	experimental	325.70	29.333	350.20	32.652	−6.99	1.985*
	Control	316.20	12.308	327.40	15.889	−3.42	
Triple jumps, m	experimental	4.840	0.368	5.950	0.283	−18.65	3.082*
	Control	4.750	0.362	5.510	0.351	−13.79	
Wide jump, m	experimental	1.720	0.133	2.040	0.237	−15.68	1.875*
	Control	1.670	0.137	1.870	0.160	−10.69	

improvement statistically significant difference. Values are means with $p < 0.05$ between variables for groups.

Discussion

The present study highlights the potential beneficial effect of ballistic exercises on growth, somatomedin hormone, triple jump, and wide jump for soccer players. After 10 weeks of using the ballistic training program, the experimental group outperformed the control group in terms of growth hormone (43.56%), somatomedin hormone (6.99%), triple jump (18.65%), and wide jump (15.68%) compared to the control group. A study by Fallo (1993) [19] demonstrated that resistance exercises also increased testosterone hormone and growth level. Furthermore, Mullington *et al*. (1996) [20] illustrated that training volume and maximum intensity are considered the most important factors affecting growth hormone and somatomedin secretion. These results are consistent with those of Häkkinen *et al*. (2002) [21] and Kraemer *et al*. (1992) [22], that is, physical exercise is associated with muscle growth and increased muscle strength of the arms and legs its significant impact on growth and testosterone hormone concentration [23].

Similarly, Jullien *et al*. (2008) [24] reported that strength exercises significantly affect the strength of soccer players under the age of seventeen. Bouagina *et al*. (2022) [25] reported similar findings, demonstrating the positive effect of ballistic training on the development of physical variables and the improvement of the skill level of the experimental group. Another study by Kılıc *et al*. (2019) [26] showed that the physical load resulting from sports activities led to an increase in some hormones, such as prolaktin and adrenocorticotrophin. Rosendal *et al*. (2002) [27] demonstrated that intensive physical training had a substantial influence on the IGF system and its binding proteins, affecting trained and untrained individuals differently.

These results agree with Sonksen P.H (2001) [28] hypothesis that physical training is a primary stimulant of somatomedin and growth hormones. It is noteworthy that the amount excreted depends on the age and training type, that is, when the training load increases, so does hormone secretion, and it decreases when physical effort stops. Kelly *et al*. (1990) [29] discovered a similar relationship between GH, SM-C levels, and fitness determined by maximum oxygen uptake prediction (vo2 max). There was a positive correlation between SM-C plasma levels and density of bone minerals, which was fitness-dependent. The decline in SM-C plasma levels may be related to aging-related decreased fitness. The ballistic training group outperformed the plyometric training group in terms of developing basic skills and physical components, which could be attributed to the ballistic exercises used during the experiment. They were based on accurate training bases and adhered to the standardized training load variables. These exercises put more strain on the muscles, the working joints, and tendons. Therefore, the body gradually adapted to such exercises by moving from less intense to more complex and more intense exercises. Fagan [30]. The researcher paid particular attention to the selection of exercises, skill performance, and muscular work direction. In addition, the researcher attributed that improvement to the enhanced power of leg muscles and consequently the skilled execution of the experimental group. The final outcome revealed a significant increase in variables.

Ballistic exercises improved growth and somatomedin hormone, triple jump, and wide jump for junior soccer. Therefore, coaches should focus on the type of training that enhances muscular ability through daily training units and conduct more studies on different samples according to gender, age, and athletic activity.

It is proposed that the ballistic training directed at specific muscle groups can lead to physical improvement through the high-speed performance that forces the muscle to adapt to ballistic resistance functionally. Holcomb *et al*. (1996) [31] and Christou *et al*. (2006) [32] illustrated that ballistic resistance programs improved power.

Similarly, Hong *et al*. (2014) [33] reported that the muscle shortening cycle during training should stimulate the regular muscular stretching and shortening cycle. Furthermore, it should reflect improvement in strength through adaptation of the nervous system, as most sports movements involve the stretching (extension) phase followed immediately by the contraction phase [33].

Conclusions

Ballistic exercises improved growth and somatomedin hormone, triple jump, and wide jump for junior soccer. Therefore, coaches should pay attention to the type of training that enhances muscular ability through daily training units. Further studies should be conducted on different samples based on gender, age, and athletic activity.

References

1. Morgans R, Orme P, Anderson L, Drust B. Principles and practices of training for soccer. J Sport Health Sci. 2014;3:251-7.
2. Williams AM, Hodges NJ. Practice, instruction and skill acquisition in soccer: Challenging tradition. J Sports Sci. 2005;23(6):637-50. https://doi.org/10.1080/02640410400021328
PMid:16195012
3. Kent M. The Oxford Dictionary of Sports Science and Medicine. Oxford: Oxford University press; 1998.
4. Burk E. Ballistic Training for Explosive Eesults. Florida: Human Kinetics Publisher; 2001.
5. Deschenes MR, Tenny KA, Wilson MH. Increased and decreased activity elicits specific morphological adaptations of the neuromuscular junction. Neuroscience. 2006;137(4):1277-83. https://doi.org/10.1016/j.neuroscience.2005.10.042
PMid:16359818
6. Newton R, Kraemer W, Häkkinen K, Humphries B, Murphy A. Kinematics, kinetics, and muscle activation during explosive upper body movements. J Appl Biomech. 1996;12(1):31-43.
7. Fleck S, Kraemer W. Designing Resistance Training Programs. 3rd ed. Champaign, IL: Human Kinetics; 2004.
8. Raastad T, Bjøro T, Hallén J. Hormonal responses to high and moderate-intensity strength exercise. Eur J Appl Physiol. 2000;82(1-2):121-8. https://doi.org/10.1007/s004210050661
PMid:10879453
9. Ratamess NA, Kraemer WJ, Volek JS, Maresh CM, Vanheest JL, Sharman MJ, *et al*. Androgen receptor content following heavy resistance exercise in men. J Steroid Biochem Mol Biol. 2005;93(1):35-42. https://doi.org/10.1016/j.jsbmb.2004.10.019
PMid:15748830
10. Tremblay MS, Copeland JL, Van Helder W. Effect of training status and exercise mode on endogenous steroid hormones in men. J Appl Physiol (1985). 2004;96(2):531-9. https://doi.org/10.1152/japplphysiol.00656.2003
PMid:14514704
11. Gatti R, De Palo EF. An update: Salivary hormones and physical exercise. Scand J Med Sci Sports. 2011;21(2):157-69. https://doi.org/10.1111/j.1600-0838.2010.01252.x
PMid:21129038
12. Spiering BA, Kraemer WJ, Anderson JM, Armstrong LE, Nindl BC, Volek JS, *et al*. Effects of elevated circulating hormones on resistance exercise-induced Akt signaling. Med Sci Sports Exerc. 2008;40(6):1039-48. https://doi.org/10.1249/MSS.0b013e31816722bd
PMid:18461003
13. Mangine GT, Ratamess NA, Hoffman JR, Faigenbaum AD, Kang J, Chilakos A. The effects of combined ballistic and heavy resistance training on maximal lower and upper-body strength in recreationally trained men. J Strength Cond Res. 2008;22(1):132-9. https://doi.org/10.1519/JSC.0b013e31815f5729
PMid:18296966
14. García-Ramos A, Jaric S, Padial P, Feriche B. Force-velocity relationship of upper body muscles: Traditional versus ballistic bench press. J Appl Biomech. 2016;32(2):178-85. https://doi.org/10.1123/jab.2015-0162
PMid:26540734
15. Gilbert G, Lees A. Changes in the force development characteristics of muscle following repeated maximum force and power exercise. Ergonomics. 2005;48(11-4):1576-84. https://doi.org/10.1080/00140130500101163
PMid:16338723
16. Migiano MJ, Vingren JL, Volek JS, Maresh CM, Fragala MS, Ho JY, *et al*. Endocrine response patterns to acute unilateral and bilateral resistance exercise in men. J Strength Cond Res. 2010;24(1):128-34. https://doi.org/10.1519/JSC.0b013e3181a92dc5
PMid:19816216
17. Wilkinson SB, Tarnopolsky MA, Grant EJ, Correia CE, Phillips SM. Hypertrophy with unilateral resistance exercise occurs without increases in endogenous anabolic hormone concentration. Eur J Appl Physiol. 2006;98(6):546-55. https://doi.org/10.1007/s00421-006-0300-z
PMid:16972050
18. Haff GG, Triplett NT, editors. Essentials of Strength Training and Conditioning. 4th ed. Florida: Human Kinetics; 2015.
19. Fallo F. Renin-angiotensin-aldosterone system and physical exercise. J Sports Med Phys fitness. 1993;33(3):306-12.
PMid:8107485
20. Mullington J, Hermann D, Holsboer F, Pollmächer T. Age-dependent suppression of nocturnal growth hormone levels during sleep deprivation. Neuroendocrinology. 1996;64(3):233-41. https://doi.org/10.1159/000127122
PMid:8875441
21. Häkkinen K, Pakarinen A, Hannonen P, Häkkinen A, Airaksinen O, Valkeinen H, *et al*. Effects of strength training on muscle strength, cross-sectional area, maximal electromyographic activity, and serum hormones in premenopausal women with fibromyalgia. J Rheumatol. 2002;29(6):1287-95.
PMid:12064848
22. Kraemer WJ, Fry AC, Warren BJ, Stone MH, Fleck SJ, Kearney JT, *et al*. Acute hormonal responses in elite junior weightlifters. Int J Sports Med. 2006;13(2):103-9. https://doi.org/10.1055/s-2007-1021240
23. Johansson AG, Forslund A, Hambraeus L, Blum WF, Ljunghall S. Growth hormone-dependent insulin-like growth factor binding protein is a major determinant of bone mineral density in healthy men. J Bone Mine Res. 1994;9(6):915-21. https://doi.org/10.1002/jbmr.5650090617
PMid:7521562
24. Jullien H, Bisch C, Largouët N, Manouvrier C, Carling CJ, Amiard V. Does a short period of lower limb strength training improve performance in field-based tests of running and agility in young professional soccer players? J Strength Cond Res. 2008;22(2):404-11. https://doi.org/10.1519/JSC.0b013e31816601e5
PMid:18550954
25. Bouagina R, Padulo J, Fray A, Larion A, Abidi H, Chtara M, *et al*. Short-term in-season ballistic training improves power, muscle volume and throwing velocity in junior handball players. A randomized control trial. Bio Sport. 2022;39(2):415-26. https://doi.org/10.5114/biolsport.2022.106150
PMid:35309523
26. Kilic Y, Cetin HN, Sumlu E, Pektas MB, Koca HB, Akar F. Effects of boxing matches on metabolic, hormonal, and inflammatory parameters in male elite boxers. Medicina (Kaunas). 2019;55(6):288. https://doi.org/10.3390/medicina55060288
PMid:31216765
27. Rosendal L, Langberg H, Flyvbjerg A, Frystyk J, Ørskov H, Kjaer M. Physical capacity influences the response of insulin-like growth factor and its binding proteins to training. J Appl Physiol (1985). 2002;93(5):1669-75. https://doi.org/10.1152/japplphysiol.00145.2002
PMid:12381752
28. Sonksen PH. Insulin, growth hormone and sport. J Endocrinol. 2001;170(1):13-25. https://doi.org/10.1677/joe.0.1700013
PMid:11431133

29. Kelly PJ, Eisman JA, Stuart MC, Pocock NA, Sambrook PN, Gwinn TH. Somatomedin-C, physical fitness, and bone density. J Clin Endocrinol Metab. 1990;70(3):718-23. https://doi.org/10.1210/jcem-70-3-718

PMid:2307727

30. Fagan CD. Ballistic Training: The Effectiveness of Maximal Power Training on Physical Performance (Unpublished Master's Thesis). University of Calgary, Calgary, AB; 2000. https://doi:10.11575/PRISM/21700

31. Holcomb W, Lander J, Rutland R., Wilson GD. The effectiveness of a modified plyometric program on power and the vertical jump. J Strength Cond Res. 1996;10:89-92.

32. Christou M, Smilios I, Sotiropoulos K, Volaklis K, Pilianidis T, Tokmakidis SP. Effects of resistance training on the physical capacities of adolescent soccer players. J Strength Cond Res. 2006;20(4):783-91. https://doi.org/10.1519/R-17254.1

PMid:17194231

33. Hong AR, Hong SM, Shin YA. Effects of resistance training on muscle strength, endurance, and motor unit according to ciliary neurotrophic factor polymorphism in male college students. J Sports Sci Med. 2014;13(3):680-8.

PMid: 25177199