

A systematic review of the influence of rapid telescopic compound training on the explosive power of ball players' lower limbs

Qin Songlin*

School of Physical Education and Taijiquan, Henan Polytechnic University, Jiaozuo, China

*Corresponding author: 364642992@qq.com

Abstract: By combing the origin, concept definition and development status at home and abroad, this paper systematically summarizes the influence of rapid telescopic compound training on the explosive power of ball players' lower limbs. Relevant literatures were retrieved from multiple literature databases, and the included literatures were finally determined through screening. Data were extracted and summarized, and data were compared and analyzed. After screening, 20 articles were finally included. By combing and analyzing the literature, it is known that the training period is 6-8 weeks and the training times are 2-3 times per week, which can improve the maximum strength of lower limbs to a certain extent and is not affected by age and gender. Rapid stretching combined training can cause muscle hypertrophy effect of lower limbs and change muscle morphology; The effect of rapid contraction combined training on improving muscle strength and muscle shape is not as good as that of traditional resistance strength training; PT can be inserted into physical training or functional training to develop athletes' lower limb sports ability.

Keywords: Rapid telescopic compound training, ball players, lower limbs, explosive force

1. Introduction

As a new strength training method, the compound training of rapid expansion and contraction is developed on the basis of rapid expansion and contraction (RM) and traditional compound training, which can also be called "super-isometric exercise", "enhanced training" and "impact training". The working principle of the compound training of rapid expansion and contraction is that when the muscles are elongated, they contract centrifugally, and at the same time, they contract centripetally through training, thus activating the "lengthening-shortening cycle" or centrifugal-centripetal coupling stage of human muscles. Studies have shown that rapid stretching compound training can obviously stimulate post-activation potentiation (PAP). Studies have shown that muscles stretch quickly before contraction, and contraction will be more powerful and rapid, thus positively adapting to strength, explosiveness and speed. Most ball games have a strong dependence on the explosive power of the lower limbs. The stronger the explosive power of the lower limbs, the higher the reaction and sensitivity of the ball players, which is important for completing some short-term maximum and close to the maximum physical ability limit in the game, such as sprinting, jumping and changing direction (COD), to compete with opponents and win the ball rights^[1]. These physical abilities are important factors that determine the performance potential of players in football, and these abilities are related to the strength and explosive power of lower limbs. In order to improve the strength and explosive force of ball players' lower limbs, resistance training, rapid expansion and contraction compound training and explosive force training plan are widely used in ball games. The above-mentioned training methods will induce neuromuscular adaptability, such as enhancing the stretching-shortening cycle function, recruiting sports units, excitation frequency, intra-muscle and inter-muscle coordination and morphological changes (such as fiber type or emergence angle), thus improving the overall performance. As a physical training method, rapid stretching compound training is widely used in many sports. Numerous studies have shown that rapid stretching compound training can effectively improve the explosive power, jumping ability, sprint ability and sensitivity of lower limbs. However, there are few systematic and comprehensive articles on the influence of rapid telescopic compound training on the explosive power of ball players' lower limbs, and its influencing mechanism needs further study. The purpose of this paper is to systematically evaluate the influence of rapid telescopic compound training on the explosive power of ball players' lower limbs, provide reference for the subsequent

related research of rapid telescopic compound training, and promote the scientific physical training level to some extent.

2. An overview of rapid telescopic compound training

2.1. The origin of rapid telescopic compound training

The word "Plyometrics" can be traced back to the jump training in the Olympic Games at the earliest, and was later used by the famous Russian track and field coach Verkhoshanski^[1] put forward the use, when he explained the word "Plyometrics" by shock method or jump training. In training, coach Verkhoshanski requires athletes to jump at a certain height, bear the "impact" at the moment of landing, and jump immediately after landing. Because at the moment of body impact, muscles are centrifugally contracted, and when athletes jump, the centrifugal contraction of muscles will be transformed into centripetal contraction in a very short time, so as to achieve the purpose of exercising the explosive force of athletes' lower limb muscles. Lloyd B. Winter, a famous American track and field coach, used Plyometrics to train athletes for explosive power of lower limbs. Radcliffe and Farentinos proposed in their research literature that Plyometrics was first used as "jumping training" and was used by Soviet coaches in the early 1970s. At present, the most commonly used term "plyometrics" was formerly "pleythyein", and the word "plyometrics" first appeared in the sports literature of the former Soviet Union written by V. M. Zaciorskij in 1966, but he did not give a corresponding explanation^[2]. The explanation for "plyometrics" was given in 1975 by Fred Wilt, an American track and field researcher. The professional name of Plyometrics was created by Fred Wilt, who is an excellent long-distance runner himself. After a long-term follow-up investigation, he found that rapid telescopic compound training played a key role in the training of athletes in the former Soviet Union. He studied and analyzed the training methods of Soviet coaches, and brought this training method to the United States. Then Plyometrics training methods rose in the United States. The training principle of Shock Method is the same as Plyometrics. Chinese scholars Wei Bing, Li Shuhong and others have their own views on the source of this training method. They think that Snyder, the coach of sprinter Jesse Owens, began to apply his training method similar to Plyometrics training principle when he trained Jesse Owens in the early 1930s^[3].

2.2. The Definition Of Rapid Telescopic Compound Training

The connotation of "National Students' Physical Health Standard" is the evaluation standard for measuring students' physical health status and exercise effect, the basic requirements of the state for students of different ages in physical health, and the individual evaluation standard for students' physical health. The concept of health includes physical health, mental health and social adjustment. The National Students' Physical Health Standard covers the category of students' physical health which is closely related to school sports. In order to define its connotation and avoid being confused with the three-dimensional concept of health, "physique" is taken as the attribute of "health" to show its connotation.

2.3. The development of rapid telescopic compound training in foreign countries

The concept of rapid contraction compound training was first put forward by relevant researchers in European countries. to develop and improve the explosive power of athletes. Yuri Verkhoshanski first used the word "plyometrics", which he interpreted as impact training, and improved athletes' muscle explosive power by using plyometrics training. Gregory John Renfro, in the study of plyometric training, tested the sensitivity test of T-run and the 40-yard sprint ability of young football players, and found that the speed and sensitivity of football players who were trained at the same time with rapid expansion and contraction training and weightlifting training were more obvious than those who were only trained in a single exercise. Salonikids K divided tennis players into experimental group, control group A and control group B in his research. The experimental group was trained with plyometric, while The experimental group and the control group were trained by control variable method, general and special training respectively, and then the experimental data were collected and it was found that the athletes trained with rapid telescopic compound training method were better than the control group in rapid acceleration, lateral movement and direction-changing movement. Rapid telescopic compound training is favored by coaches in the United States because of its obvious effect on improving some sports abilities of athletes, and it has aroused the research of relevant scholars.

2.4. The development of rapid telescopic compound training in China

At first, "plyometrics" training was translated into "super-isometric training" in China. With the in-depth study of its physiological mechanism and biomechanical characteristics by domestic scholars, it is translated into "rapid stretching compound training" according to its muscle contraction form and exercise characteristics. In his research, Wei Shuo pointed out that the rapid expansion and contraction compound training plays an irreplaceable role in developing athletes' sensitive quality, but it is necessary to use the rapid expansion and contraction compound training scientifically and reasonably, and at the same time, to control the influencing factors of the rapid expansion and contraction compound training reasonably according to the actual situation^[5]. Yang Xuekun divided 30 male athletes in senior high school physical education class into two groups according to the research needs in the study of the influence of joining rapid telescopic compound training on the training effect of college entrance examination. After the experiment, the research shows that the explosive power of athletes is improved, the time to complete technical movements is shortened and the sports performance is improved after the rapid telescopic compound training. The research results of scholars such as Sun Zhijian show that the rapid expansion and contraction compound training method can greatly improve the athletes' hurdle performance, and at the same time, it is also helpful for athletes to develop rapid explosive power^[8]. Hu Chengye's research shows that compared with the traditional resistance strength training, the compound training of rapid expansion and contraction has obvious effect on improving the jumping ability of college basketball players, especially the vertical jumping ability of athletes^[9]. Lu Changqing pointed out in his research that the combination training of rapid expansion and contraction is better than resistance training in improving the explosive force, speed, flying height, special achievements and developing the maximum strength of basketball players^[10]. In his research, Cheng Yahua pointed out that it is better to improve the sensitive quality of tennis players by using rapid expansion and contraction compound training, and at the same time, the athletes' short-distance accelerated sprint ability has been improved correspondingly by using this training method, and the effect is remarkable. In his thesis experiment, Liu Ye intervened the athletes in the experimental group with compound training of rapid expansion and contraction, while the control group trained with basic strength training^[11]. After 6 weeks' experiment, it is found that the compound training of rapid expansion and contraction can improve the stability of athletes' lower limbs and improve their sports ability^[6].

3. Materials and methods

3.1. Literature Screening

3.1.1. Retrieval Strategy

Search was conducted on China HowNet, Wikipedia, Wanfang, sci-hub, Web of Science and other websites. The search period was from 2013 to 2023, and the period ended in June 2023. The search terms included rapid telescopic compound training, enhanced training, jumping training, impact training, plyometrics and so on. A total of 362 documents were retrieved, among which 20 were journals based on the core of Peking University and limited by Cscsi.

3.1.2. Literature inclusion and exclusion criteria

Inclusion: the content includes rapid telescopic compound training, ball players and explosive power of lower limbs; The intervention mode of the experimental group is rapid stretching compound training, while the intervention mode of the control group is blank or other training types; Outcome measures: explosive force of lower limbs; Experimental design: All were randomized controlled experiments or self-controlled experiments.

Exclusion: non-Chinese and English literature; Non-healthy population experiment; Unable to obtain the full text of the literature; The outcome index is not expressed by mean and standard deviation; The quality of literature is low.

3.1.3. Incorporation of literature

By searching, there are 70 articles related to the compound training of rapid expansion and contraction, of which 20 articles are included in the literature standard.

3.2. Literature method

3.2.1. Visual analysis

In this paper, with the help of CiteSpace6.2.R2 visualization software, the key words, the evolution trend of research hotspots and the years of research hotspots of 362 related literatures about rapid telescopic compound training, enhanced training and impact training in China from 2013 to 2023 are presented and analyzed in the form of knowledge maps.

In this paper, with the help of CiteSpace6.2.R2 visualization software, the key words, the evolution trend of research hotspots and the years of research hotspots of 362 related literatures about rapid telescopic compound training, enhanced training and impact training in China from 2013 to 2023 are presented and analyzed in the form of knowledge maps.

Literature visualization analysis plays a vital role in the analysis of research hotspots and future trends in a certain field^[12]. It is mainly based on the theory of scientific development model, structural hole theory and knowledge unit dispersion and reorganization theory to realize the function of explaining the current situation and predicting the future of the field^[13], and has gradually become the main analysis method in the field of management. Common visual analysis softwares are Refviz, Bibexcel, Hiscite, CiteSpace, etc. Among them, CiteSpace is widely used in academic research because of its stable and reliable program, convenient adjustment of atlas and rich colors. In this paper, the CiteSpace6.2.R2 visualization software developed by Chen Chaomei is used as an analysis tool to scientifically measure the research literature of rapid contraction compound training. First, the data in Refworks format is saved from China HowNet, and then the downloaded data is converted into the standard format of the required data through "data" in the software, and then the data is re-processed. Finally, the author, institution and keywords of the article can be visually analyzed in turn. In the visualization results, the node size reflects the author's co-occurrence frequency. The bigger the nodes are, the more they have in common, the more consistent the research trends are, and the smaller the nodes are, the less the similarities and the lower the relevance of the research.; Network density describes the density of interconnected edges between nodes; Centrality is used to explain whether the node plays a key role in the whole map network, that is, the node with large centrality is more critical.

3.2.2. Literature data method

Search for key words on platforms such as China Knowledge Network (CNKI), Web Of Science database and school library resource database, such as "rapid telescopic compound training", "super-isometric training", "lower limb explosive force training", "lower limb explosive force training" for ball players, etc., and consult relevant literature to understand the research status and development trend of rapid telescopic compound training and ball players' lower limb explosive force training, so as to provide theoretical support for the research on the influence of rapid telescopic compound training on ball players' lower limb explosive force for this paper. In the library, consult books about the compound training method of rapid expansion and contraction and the training method of ball players' lower limbs, so as to provide ideas for this study.

4. Results and analysis

4.1. Hot spot analysis

The hotspot visualization of co-occurrence keywords by CiteSpace software can directly reflect the research hotspots and development trends in this field. In the knowledge map of hotspot analysis, keywords are represented by circles and labels, and their activity is positively related to the size of the circle, while the closer the distance between the two circles, the closer the relationship between them. According to the visual analysis of the research hotspots of rapid contraction compound training from 2013 to 2023 by CiteSpace software, we can know that the top ten hotspots in the field of rapid expansion compound training are: (1) explosive power; (2) Sensitive quality; (3) Teenagers; (4) resistance training; (5) rapid afterburner; (6) sports performances; 7. Strength training; 8. Basketball; (9) jumping ability; 10) Ability to change direction. The research shows that the research hotspots in this field mainly include explosive power, sensitive quality, ball games and their relationships.

4.2. Frontier analysis

Keyword pop-up analysis (including pop-up, keywords, pop-up intensity and start-stop time) and

time zone analysis can clearly present the historical evolution of this research field. Select 362 articles with relevance, whose keywords can be detected by Cite Space software, that is, based on the integration of vocabulary frequency of papers in this field, summarize the hot keywords in the research frontier of related fields by analyzing the growth rate of vocabulary. As shown in Figure 1, during 2013-2017, the field of rapid telescopic compound training focused on super-length, rapid strength, jumping, strengthening, special achievements, influence, sensitivity, physical training, strength, starting technology, etc. At this stage, China mainly studied the definition of related concepts of rapid telescopic compound training and the exploration of training methods; From 2018 to 2023, the research focus in this field is tennis, compound training, stride, vertical jump, step frequency, volleyball, experimental group, badminton, experimental research, football, physical education college entrance examination, special quality, jumping ability, sports performance, basketball, etc., which is closely related to the continuous improvement of theoretical results and the gradual integration of theory with practice. To sum up, the research focus of rapid contraction compound training is closely related to high-frequency keywords. First, from the perspective of keyword co-occurrence map, a certain content system has been formed in terms of super-length, fast strength and enhancement; Secondly, according to the keyword pop-up diagram, although the hot words such as "sports performance" and "college entrance examination for physical education" were formed late, they have become the eye-catching points in this field, while "quick strength", "special quality" and "special achievements" belong to the "strong hot spots" tracked by scholars. The research focus is gradually biased towards the combination of training and ball games. The research focus is gradually biased towards the combination of training and ball games.

Top 25 Keywords with the Strongest Citation Bursts

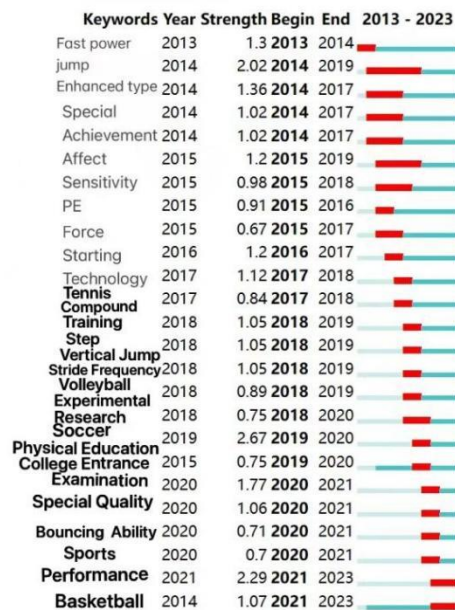


Figure 1: Top 25 keywords with the strongest citation bursts

5. The influence of rapid telescopic compound training on the explosive power of ball players' lower limbs

The conclusion of Wang Chunhui (Study on the Influence of Rapid Telescopic Compound Training on the Lower Limb Explosiveness of Young Men Basketball Players) shows that traditional lower limb strength training can improve the lower limb explosiveness level of young basketball players, which is manifested in the remarkable improvement of standing long jump and jumping with feet in situ after training ($P < 0.01$); The results of run-up and one-legged take-off and height touching were significantly improved ($P < 0.05$). Although the results of T-shaped turn-back running and 30m sprint running were improved, there was no significant difference ($P > 0.05$). The combined training of rapid expansion and contraction can improve the explosive power of young basketball players' lower limbs, which is manifested in the remarkable improvement of standing long jump, taking off with both feet in situ, taking off with one foot in run-up, T-shaped turn-back running and 30m sprint running after

training ($P < 0.01$). Compared with the traditional lower limb strength training, the rapid telescopic compound training is more effective in improving the explosive power of basketball players' lower limbs. Specifically, after the training, the basketball players' performance in standing long jump, taking off with both feet in situ, taking off with one foot on the run-up, T-shaped turn-back running and 30m sprint running are all higher than those of the traditional lower limb strength training, and the differences are very significant ($P < 0.01$). Huang Linjie et al. (A systematic review of the influence of rapid telescopic compound training on the maximum strength and muscle shape of lower limbs) showed that the rapid telescopic compound training with a training period of 6-8 weeks and a training frequency of 2-3 times per week can improve the maximum strength of lower limbs to some extent, and is not affected by age and gender, but the training effect is not as good as that of traditional resistance strength training; Rapid stretching combined training can positively affect the muscle circumference of lower limbs, but the improvement effect is not as good as that of traditional resistance strength training. Chen Liang (A Systematic Review of the Influence of Compound Training on Football Players' Sports Performance) shows that compound training can improve the sprinting ability, jumping ability and changing direction ability of male football players (aged 14-23) from amateur to professional level to some extent. Li Yizhen's research shows that the compound training of rapid expansion and contraction of lower limbs can improve the sensitivity of badminton players, increase the moving speed of footwork on the court, improve the jumping ability of badminton players, and increase the take-off height and stride jump distance on the court. Chen Canhui (Research on the Application of Rapid Telescopic Compound Training in Shot Put Training in Colleges and Universities) shows that both traditional training and rapid telescopic compound training have improved students' shot put performance. As far as the improvement range is concerned, the improvement range of rapid telescopic compound training is more significant and the effect is better than that of traditional training. Cao Xiaoxiang (Effect of Rapid Telescopic Compound Training on the Lower Limb Rapid Strength Quality of Young Javelin Athletes) The research shows that after the rapid telescopic compound training, the test scores of various test indexes reflecting the lower limb rapid strength of javelin athletes in the experimental group have improved significantly ($P < 0.01$). The results of each test index in the control group were also very significant ($P < 0.01$). After 8 weeks of rapid expansion and contraction training, the effect of rapid strength development of lower limbs was more significant than that of traditional resistance strength training. Cui Jiqing, He Fangzhou and Liu Yufei (Meta-analysis of the influence of rapid telescopic compound training on the explosive power of basketball players' lower limbs) show that rapid telescopic compound training can obviously improve the explosive power, moving speed and agility of basketball players, among which PT can improve the sensitive quality of basketball mobilization most obviously, and it can be used as an ideal training method to improve basketball players' lower limb sports ability.

6. Conclusion

The training cycle is 6-8 weeks, and the training frequency is 2-3 times/week, which can improve the maximum strength of lower limbs to a certain extent, and is not affected by age and gender. But the training effect is not as good as the traditional resistance strength training; The compound training of rapid expansion and contraction can make the lower limbs have muscle hypertrophy effect and change the muscle shape, but the improvement effect is not as good as that of traditional resistance strength training. The mechanism of rapid stretching combined training to improve the explosive force of lower limbs and make lower limbs have muscle hypertrophy effect needs further study. PT can be inserted into physical training or functional training to develop athletes' lower limb sports ability.

References

- [1] Wang Kaiyi, Zhang Peicheng. *Methodological factors influencing the explosive force of lower limbs by rapid stretching compound training [J]. Contemporary Sports Science and Technology, 2021,11(20):56-60+64.*
- [2] Ji Qing, He Fangzhou, Liu Yufei. *Meta-analysis of the influence of rapid stretching compound training on the explosive power of basketball players' lower limbs [J]. Bulletin of Sports Science and Technology Literature, 2023,31(01):224-228.*
- [3] Chen Canhui. *Research on the application of rapid telescopic compound training in shot put training in colleges and universities [J]. Contemporary Sports Science and Technology, 2022,12(33):50-54+108.*
- [4] Shang Xinke, Li Yichen. *Research on the influence of rapid stretching compound training on sports*

performance [J]. *Track and Field*, 2022,(09):27-28+47.

[5] Mao Peng. *Experimental study on the effect of rapid contraction compound training on the sensitive quality of primary school students aged 9-10* [J]. *Scientific Consulting (Education and Research)*, 2022,(05):227-229.

[6] Xue Liang, Li Chunman, Fang Zuoming, Jin Zherong. *Meta-analysis of the influence of rapid telescopic compound training on the speed of changing direction* [J]. *Journal of Anhui Normal University (Natural Science Edition)*, 2022,45(03):288-298.

[7] Li Liang. *A systematic review of the influence of compound training on the performance of football players* [J]. *Bulletin of Sports Science and Technology Literature*, 2022,30(03):35-36+59.

[8] Lin Jie, Yang Qun, Liang Xingyue, Zhang Zhiyong, Ji Hongshen, Li Duanying, Sun Jian. *A systematic review of the influence of rapid stretching compound training on the maximum strength and muscle shape of lower limbs* [J]. *Sports Science and Technology Literature Bulletin*, 2022, 30(03):42-47.

[9] Xiao Qian, Wu Xueping. *Effects of Compound Training on Strength and Quality of Athletes in Alpine Skiing Standing Group of Paralympic Winter Games* [J]. *Sports Research*, 2022,43(02):56-61.

[10] Chun Hui. *Research on the influence of rapid stretching compound training on the explosive force of lower limbs of young male basketball players* [J]. *liaoning sport science and technology*, 2022,44(01):135-140.

[11] Zhou Tong, Zhang Biyu. *Research progress of compound training* [J]. *Sports Science*, 2017,37(10):72-79.

[12] Hou Li, Gao Yang, Liu Lulu. *Research status and prospect of ecological compensation for heavy metal pollution in farmland in China-based on CiteSpace knowledge map analysis* [J]. *Journal of China Agricultural University*, 2020, 25 (8): 132-143.