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Original Article

Efficacy of using isometric exercises to prevent basketball injuries

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Abstract:
This article concerns the efficacy of using isometric exercises to prevent basketball injuries. The proposed technology optimises the improvement of basketball players' general physical preparation by using isometric exercises. To define the key factors that contribute to a considerable reduction of injury rate in basketball, a dedicated survey among coaches, athletes and basketball experts has been conducted. Those were suggested to rank injury rate reduction key factors according to their significance. In general, 52 people participated as respondents in the survey. To achieve the goals set in the study, the following methods of research were used: a questionnaire, an interview, a survey; a study of the dynamics of basketball players' physical fitness and performance during competitions; an assessment of student team basketball players' physical characteristics; psychological testing of basketball players; educational experiment; statistical processing of the obtained data. Basketball players who regularly did isometric exercises, considering their individual characteristics, had better indices of their physical fitness and lower injury rates. The greatest difference ($p < 0.01$) was between injury rates for those who did not do these exercises and athletes who regularly did isometric exercises. This study's research on the use of isometric exercises in the system of general physical preparation of basketball players to prevent injury has demonstrated the high efficiency of isometric exercises.
Key words: basketball players, isometric exercises, injury prevention, general fitness, general physical preparation, educational technology, competitive activities.

Introduction

Practising basketball is always fraught with the probability of injury. This is primarily due to the presence of scrambling, collisions, increased muscular tension and physiological stresses during competitions. An injury is tissue or body organ damage resulting from any external impact. An injury can be caused by either a single strong or insignificant impact or a repeated impact on a particular muscle group [9, 10].

In modern basketball, there are new trends in improving the techniques of general physical preparation of athletes and players' injury prevention. During general physical training, the basis of basketball players' endurance is formed, ligaments and muscles are strengthened and the mechanisms for preventing injuries during competitions are formed. However, in this study, the analysis of injuries in student basketball teams revealed a number of unsolved problems related to injury prevention. The level of physical fitness of athletes on student basketball teams prevents the use of many game tactics. Due to the high number of injuries to basketball starting-lineup players, substitutes, whose fitness level is much lower than that of the starters, very often play for the team. It was found that the student basketball team of Peter the Great St. Petersburg Polytechnic University failed to solve the task of injury prevention in the 2014 season. The team with the best player selection finished only fourth in the Russian student championship due to the high injury rate in its basketball starters. This fact points to the unsolved problem of injury prevention among team players.

Studies conducted in recent years by the leading Russian and foreign experts in the field of basketball found that isometric exercises, properly used in the system of general physical preparation, significantly strengthens athletes' ligaments and reduces the risk of injury [3]. However, there is a lack of research that examines the integration of isometric exercises in the system of general physical preparation of student team basketball players to prevent injuries.

Materials and methods

To achieve the goals set in the study, the following methods of research were used: a questionnaire, an interview, a survey; a study of the dynamics of basketball players' physical fitness and performance during competitions; an assessment of student team basketball players' physical characteristics (physical fitness, functional state of the body and physical development); psychological testing of basketball players; educational experiment; statistical processing of the obtained data.

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All subjects understood the purpose of this study and provided written informed consent prior to participation in the study in accordance with the ethical standard of the Declaration of Helsinki.

Questionnaires, interviews and surveys were used to study the training programs and sports activities of basketball players, the characteristics of the general physical training organisation, the dynamics of players' performance and the structure of general physical preparation management in the student basketball team of Peter the Great St. Petersburg Polytechnic University.

Basketball players' physical fitness and performance were studied by special control tests, observation, timing, paired comparison and analysis of the current results of the team in St. Petersburg championship and other competitions.

Physical fitness tests were carried out to assess the level of physical fitness and special qualities development, as well as to analyse the impact of methods and means of general physical preparation on basketball players' motor skills to reduce injuries.

To assess basketball players' functional status, rapid assessment and the criteria for functional state assessment were used. In addition, the results of the samples, using a breath-holding test (Stange-Genchi samples), were determined; fatigue index was calculated; tapping test and tremorography were carried out.

Evaluation of breath-holding test sample results was carried out in accordance with current generally accepted criteria.

Fatigue index (FI) was calculated according to the following formula:

$$FI = \frac{SP}{\sum P},$$

where SP the summarised data of is systolic pressure measurements at the first, second and third minutes of rest after 15 full squats.

$\sum P$ is the summarised data of pulse measurements.

The difference between the performance index and recovery index (after full recovery) expresses the degree of fatigue (FI). We distinguish three basic levels of fatigue (in standard units): an average level of fatigue: 1.1–2.0; a significant level of fatigue: 2.1–3.0; over-fatigue: 3.1 or more.

The application of a tapping test and tremorography allowed, first, evaluation of the pace, rhythm and stability of motor skills and, second, determination of the ability to define sensory–motor coordination of movements by hand tremor recording. In addition, pulse rate measured during 15 seconds was used to assess basketball players' functional state during competitive activities.

Heart rate and blood pressure indicators were used to calculate vegetative indices: Kérdö index reflected the relationship between the activity of the sympathetic and parasympathetic nervous systems; Quaas index characterised the level of fatigue.

Basketball players' state of anxiety was evaluated using C. Spielberger's inventory (1982) before and after the games.

To assess basketball players' higher nervous activity, the SAN (well-being, activity, mood) inventory, recording the subjective evaluation of well-being, activity, and mood, was used. These indicators were determined immediately before the game and two hours after its completion, using a special scale. Self-assessment indicators were evaluated by averaging 10 answers to the questions, from individuals as well as from groups. When processing the SAN test data, the absolute values of well-being, activity, and mood, as well as the correlation of these indicators, were taken into account. In particular, the fact that during intense competitive activities a significant deterioration in well-being and activity is usually accompanied by less-prominent mood deterioration was taken into account.

An increase in the difference between these indicators by more than 0.6 points in comparison with the original data may indicate a decrease in basketball players' performance.

An educational experiment was arranged and carried out during the 2014–2015 competition season of the Peter the Great St. Petersburg Polytechnic University student basketball team.

The research data were subjected to mathematical processing. The following statistical parameters were identified:

x is the calculation of the arithmetic mean;

δ is the calculation of the standard deviation;

m is the calculation of the arithmetic mean error;

t is the evaluation of the difference according to Student's t-test.

When analysing mathematical parameters, the confidence level was considered significant at $p = 0.05$.

Results

Improvement of the efficiency of basketball players' general physical fitness training is one of the most urgent problems of the training process. The solution to this problem provides a significant reduction in injuries. The following adaptive changes take place in the body of a basketball player as a result of general physical training:

• improvement of the ability of the central nervous system to create adequate stimulus for the peripheral nervous system (muscles) and ensure proper movement coordination;
• fine morphofunctional specialisation of the neuromuscular system to perform its work;
• increase of the number of electrical stimuli to ensure intense muscular activity;
• improvement of the functional capacity of all physiological systems that provide motor activity;
• development of intersystem relations in the body to facilitate high performance.

An important part of the improvement of general physical preparation to prevent basketball players' injuries is a balance between isometric exercises and jumping and power training ones. There are high requirements of the muscular–ligamentous apparatus of basketball players, especially to their legs. Huge jumping and power loads, which basketball players experience during games as well as in training sessions, which are held two and sometimes three times a day, increase protein degradation in muscle structures: myofibrils, elements of different muscle membranes and ligaments. Two to three days are necessary for the recovery of these structures. Basketball players' active sport schedule does not allow muscular–ligamentous apparatus to recover fully. Therefore, using isometric exercises as an effective means of strengthening muscular–ligamentous apparatus is a necessity to prevent injuries in basketball players. Proper selection and optimum combination of isometric exercises along with the generally accepted techniques of physical training is a major problem to be solved to prevent injuries in basketball players.

Thus, it can be noted that basketball players' sports activities require a high level of physical fitness. One of the promising directions towards increasing the efficiency of general physical preparation to prevent injuries is the rational use of isometric exercises.

A special analysis of players' injuries received on the student basketball team of Peter the Great St. Petersburg Polytechnic University in the 2014 season was conducted to discover what caused injuries that resulted in athletes' temporary disability. Due to the high injury rate in the starting-lineup players, the team placed only fifth in the St. Petersburg championship. The team failed to win other tournaments, although it was one of the strongest in Russia in terms of the players selected. On average, the injury rate in starting-lineup players of the team was 38.6% in the 2014 season.

The data on the types of injuries of basketball players on the Peter the Great St. Petersburg Polytechnic University student basketball team in the 2014 season are given in Table 1. The obtained data analysis shows that ankle joint injuries are the most common. In our opinion, the frequency of these injuries in basketball players is explained by high loads on the joints during competitions as well as by the lack of training that targets these joints. It was found that the basketball players who had a lower level of general physical fitness and those who did mostly dynamic work are at higher risk of injuries.

Our studies have shown that in basketball, dynamic (jumping) activities cause primarily rupture of ligaments at their ends attached to bones and tears of muscles in the places of their origin.

Table 1. Types and rates of injuries of basketball players on the student team in the 2014 season

Ranking	Types of injuries	Rate (%)
1	Contusions	38.2
2	Ankle joint injuries	21.8
3	Knee joint injuries	14.5
4	Lumbar spine injuries	11.5
5	Groin, thigh-muscle strains	6.9
6	Finger sprains	4.0
7	Other injuries	3.1

The analysis of the injury rate shows that dynamic activities cause tissue destruction, but static isometric activities are constructive, because the strength range increases.

Basketball imposes many requirements on athletes, in a variety of sporting conditions. Such a combination of requirements and conditions presupposes a vast range of injury prevention means. All these facts lead to a number of insights.

First, just being 'an athlete' does not reflect the specific health status, physical fitness and functional state of an athlete's systems and organs necessary for his or her sporting activity. Therefore, it is very important for a basketball player to strengthen those ligaments and joints which are at risk of injury. Second, certain training has a very particular effect on the body of an athlete, specifically modifying both its morphology and mode of functioning. This insight leads directly to the third insight, which is that the present-day mode and level of training for basketball does not presume that basketball may result in injuries of all kinds. With the increasing training load and intensity, as well as the growing focus on specificity, the most frequent injuries are all basketball-specific. That is to say, an evenly developed musculoskeletal system is not characteristic of a high-level professional athlete.

Thus, it is irrelevant to evaluate the functional state and injury rate for athletes in different sports by the same criteria, because their bodies differ not only morphologically but also functionally. Studying the types of

injuries in basketball players without associating them with the specific character of training, involving the same patterns, often results in false conclusions or generalisations, which hampers or misleads the scientific development of effective training.

Fourth, concerning pathological conditions and diseases that typically occur in basketball players, morphological and functional particularities of an athlete's body, which are formed under sport-specific training, condition individual susceptibility to and course of common diseases in any basketball player. They are mainly responsible for the sport-specific internal pathology and injury patterns as well.

Thus, by defining basketball-specific injury patterns, it is possible to ensure more objectivity in selecting injury prevention exercises and, therefore, to control general physical preparation most effectively. Management of general physical preparation involves evaluation of the current level of physical fitness. The evaluation results are translated into stimulus inputs, which should be efficacious, prompt and unfailingly attainable within a set time limit.

One of the challenges of present-day sport science is to enhance the effect of training management through integrated control of the physical fitness of an athlete. This problem is highly pertinent to the tasks associated with fitness training to prevent injuries. A high level of performance in scheduled competitions with zero injury rate is one of the essential criteria by which to judge how successfully and correctly the course of training has been organised. Consequently, identifying the factors that reduce the risk of injury in basketball is a significant aspect of scientific investigation.

To define the key factors that contribute to a considerable reduction of injury rate in basketball, a dedicated survey among coaches, athletes and basketball experts has been conducted. Those were suggested to rank injury rate reduction key factors according to their significance. In general, 52 people participated as respondents in the survey. The ranking results are presented in Table 2.

The top position was given to the selection of most appropriate isometric and other types of prevention exercises to reduce injury rate in basketball and volleyball players. [13]. Experience has shown that appropriate isometric exercises considerably reduce injury risks as they benefit strengthening muscles and ligaments of different joints.

Table 2. Ranking of key factors that contribute to a considerable reduction in injury rate (n = 52)

Significance (rank)	Main determinant factors to reduce injury rate and severity in basketball players	Rank index (%)
1	Selection of most efficacious isometric and other types of prevention exercises to reduce injury rate and severity	21.3
2	Selection of most effective training techniques corresponding to the level of athlete's physical fitness	18.7
3	Executing integrated control of different components of an athlete's physical fitness	15.2
4	Identifying the exactly optimal training load in accordance with the level of fitness of basketball players	12.8
5	Implementing preventive measures for athletes who have had illnesses and for those who complain of general malaise before beginning exercise	12.2
6	The level of coaching technique and competency of coaches for injury prevention training	9.8
7	Motivating basketball players in injury prevention exercises	6.3
8	Considering individual differences in musculoskeletal and musculoarticular morphology	3.7

The selection of the most effective training techniques corresponding to the level of athletes' physical fitness is ranked second. Throughout the annual training cycle, the physical fitness of a basketball player changes. Thus, it is necessary to select optimal sets of training exercises, taking into account the actual level of fitness to avoid overexertion.

The third position is given to the integrated control of different components of physical fitness. The system of integrated control as part of general physical preparation includes evaluating performance in competitions, measuring different fitness components and monitoring the training load [6,7,8]. General physical preparation is considered a specialised function within the integrated training program, which is intended to achieve model performance results. Physical fitness of an athlete undergoes complex structural transformations at different phases of training. Consequently, it is essential for evaluation of fitness level at every particular stage to be based on a complex diagnostic model specifically designed to evaluate real-life fitness within the given phase, or period of training. A complex diagnostic evaluation model is a minimum set of measurements, or indicators, that are based on characteristics essential for the fulfillment of a particular task assigned to an athlete and most adequately report the athlete's physical fitness level.

Defining the consistent criteria to select the informative parameters is instrumental for effective diagnosing. Those criteria must correlate strongly with fitness parameters. However, in our opinion, considerable data loss is possible because each indicator has multiple parts, and every measurement implies a number of variables. The factual material taken from the practical basketball coaching experience makes it possible to select from a variety of parameters those that provide the fairest evidence of different aspects of the physical fitness of a basketball player. It is necessary to observe the following provisions:

• It is necessary to be aware of the actual state of the fitness training system and to have its reference standards, including those essential for injury prevention.

• It is also necessary to define the most informative physical fitness parameters and the ways to monitor the measurement changes.

Effective training management requires using quantitative data to analyse qualitative changes that come about as a response to training inputs. Executing proper fitness control and management means making and implementing a proper plan for physical preparation and timely adjustment to feedback. At the same time, as part of a general injury prevention strategy, it is necessary to take preventive measures for those athletes who have had illnesses and those who complain of general malaise (position 5).

A system of integrated educational control allows the coach to solve injury prevention tasks through corrective measures during physical fitness training. Depending on the goals of specific fitness tests, the measurements of the actual fitness level can vary considerably. Implementation of the integrated training provides the basis for injury prevention in basketball. An objective evaluation of general physical fitness and its dynamics is a prerequisite for efficient management of physical fitness training to provide proper injury prevention. Integrated training procedures yield an objective evaluation of fitness when all the components of fitness within a certain period are taken into account. At the same time, such training can define the key factors that have contributed to the goal of fitness.

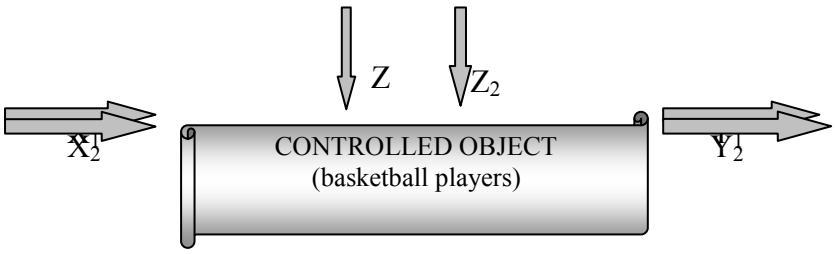
The level of coaching competence, with particular focus on the aspect of isometric injury prevention training, is given the sixth position. This factor assumes the coach has a perfect command of the mechanisms of muscular and articular responses to isometric exercises.

Identifying an optimal training load in the course of the general physical preparation in accordance with the level of fitness is ranked next by the basketball experts. This factor is closely related to the coach's competencies because the coach sets up the load. The efficacy of the whole process of training and drilling, which is intended to reduce injury risks and improve general fitness, depends on how accurately the training load is prescribed.

The next important factor addresses consideration of individual differences in morphology, musculoskeletal and muscular and articular apparatus. Individual musculoskeletal and muscular and articular apparatus morphology is genetically predetermined. The coach must consider this when prescribing isometric exercises. It contributes to strengthening the musculoskeletal system and ensures higher performance in competitions.

Thus, this study has defined the key factors to reduce injury rates.

Studying complex processes such as general physical preparation with a focus on injury prevention as part of the whole cycle of basketball training sessions inevitably involves creating a management system structure and defining its elements. According to present-day concepts, the structure of the physical fitness training process, with a focus on injury prevention (presented roughly), includes a controlled object and a control system. Their interrelationship engages direct feedback control mechanisms. Besides, as is known, the process of control implies stimulus and disturbance inputs affecting a controlled object (a basketball player). The response is evaluated on the basis of output (functional and other) parameters (Fig 1).



Note: X_1, X_2 - stimulus inputs; Z_1, Z_2 - disturbance inputs; Y_1, Y_2 – response (output) parameters

Fig. 1. The structure of the system of management of general physical preparation with a focus on injury prevention

To solve the problems of managing the process of general physical preparation with a focus on injury prevention, it is necessary to follow its general principles, or basics. According to present-day concepts, the principles of management of biological systems include availability of data essential to evaluate the initial, intermediate and final functional states; and development of a general algorithm for managing, controlling and correcting the general physical preparation program [1,2,4,5].

Tasks of injury prevention are closely associated with tasks of physical health and fitness diagnosis and prognosis. In the context of the body systems' interrelation, it is obvious that this association manifests itself as logical transition from one task to another (diagnosis – prognosis – control). It is also necessary to return to previously solved tasks at different periods of training (diagnosis and prognosis of the efficiency of general physical preparation with a focus on injury prevention).

While solving the tasks of injury prevention, an athlete is considered as a system. Diagnosing generally includes determining the nature and degree of functional deviations from the norm, whereas prognosis is predicting the dynamics of physical characteristics and functional systems, including muscles, ligaments and joints. Management involves optimal balance of training means and techniques to ensure the body's recovery and expand the limits of the optimal structural and functional state of the body systems, muscles, ligaments and joints to enforce the effects of injury prevention.

Based on these theoretical statements, a technology for implementation of isometric exercises with a focus on injury prevention has been developed (Figure 2).

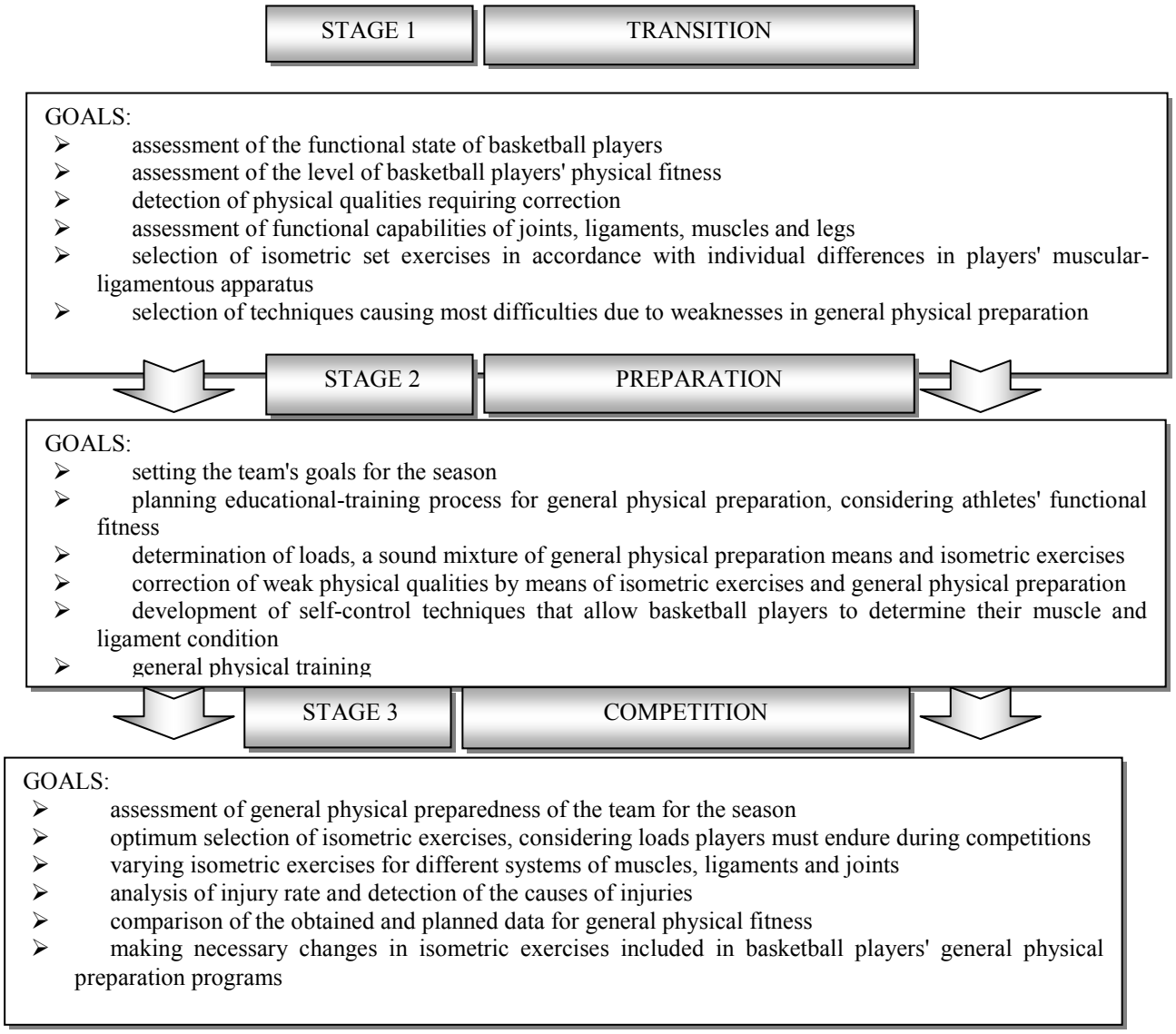


Fig. 2. Educational technology of using isometric exercise for injury prevention in basketball players

The efficiency of this technology has been checked in the course of the educational experiment. To reveal the interrelation of performance indicators and indicators of general fitness in natural conditions of competitions, a complete physical examination of the student basketball team players has been carried out, using a set of tests. A basketball team's performance depends to a large extent on the absence of injuries in starting-lineup players, efficiency of long-distance shooting, number of turnovers and defensive and offensive rebounds. The most informative parameters for players are times of 6-metre distance runs and 20-metre dribbling, tapping test and level of operational thinking. Correlation analysis allowed us to identify the interrelation of the following parameters:

• efficiency of distance throws and the times of 6-m runs (r = 0.66) and of 20 m dribbling (r = –0.65) and the level of operational thinking (r = –0.85);

• number of offensive rebounds and the optimum value of the tapping test (r = 0.76), relationship of the optimum value of the tapping test and its maximum value (r = 0.65);

• number of turnovers and players' height (r = –0.81), times of 6-m runs (r = –0.66) and the maximum and limited tapping test, respectively (r = –0.66 and r = –0.86).

Thus, the study identified peculiarities and common regularities of performance parameters and the means by which better performance is achieved. Performance depends on such constituents of general fitness as precision in movement, sprint speed, activity and diversity of motor activity in scramble under the basket. This activity requires muscular, ligament and joint strength, especially leg strength.

Analysis of basketball players' performance during competitive activities shows that modern ideas about the organisation of physiological structures and their functions can make coaches view the integration of isometric exercises with general physical preparation in a different way.

According to this approach, isometric exercises should be included in the general physical preparation to prevent injuries in basketball players.

It should be mentioned that the level of activity by players' different functional systems at the beginning of contest season is not equal and, probably, is determined by the impact of various factors during the competitive period. It is obvious that an initial excess of system shifts of players with the middle level of their physical fitness is then reduced along with their adaptation to competitive activities.

Thus, after three months of isometric exercising, players' well-being, according to their subjective assessment, improved in 98% of cases; pain syndrome in muscles and ligaments was eliminated. The mean values of players' ongoing state of anxiety (SA) were stable for the entire team both before the correction (at the beginning of the 2014 season: –48.6 ± 1.1; at the end of the 2014 season: –50.8 ± 2.3 points, $p < 0.05$) and after isometric exercising as part of the general physical preparation (–44.2 ± 2.2 points at the beginning of the 2015 season; –48.0 ± 2.1 points at the end of the season, $p < 0.05$). The level of trait anxiety (TA) as an individual peculiarity of a basketball player was high during the 2015 season.

SAN test data behaviour was similar (Table 3).

Table 3. Graded self-assessment according to the three indicators of SAN test (points) at the beginning and end of the 2014 and 2015 seasons (before and after the use of isometric exercises in GPP)

Scales	Before correction		After correction	
	At the beginning of the 2014 season	At the end of the 2014 season	At the beginning of the 2015 season	At the end of the 2015 season
Well-being	4.4 ± 0.3	4.8 ± 0.3	4.7 ± 0.3	4.7 ± 0.3
Activity	4.0 ± 0.3	4.8 ± 0.2	4.2 ± 0.1	4.9 ± 0.2
Mood	4.4 ± 0.3	4.0 ± 0.3	4.5 ± 0.3	4.9 ± 0.3

Note: For all the values in the Table 3, $p < 0.05$.

Just as after isometric exercising, along with the fatigue increase by the end of the 2014 and 2015 seasons beside the changes of each indicator, the difference between the indicators increased due to the decrease of points for 'Well-being' and 'Activity' in comparison with more stable points for 'Mood'. Moreover, if after doing isometric exercises at the beginning of the season there was a certain tendency for all the SAN indicators to increase ($p > 0.05$), then by the end of the season they reached the values close to or equal to the values before the employment of these exercises in the general physical preparation program.

Based on this, diagnostics of physical fitness of basketball players during competition is of great importance. These diagnostics will provide early detection of disorders, injury prevention and correction of vegetative dysfunction caused by competitive activities. The system approach to training as well as the use of the provisions of the theory of functional systems enables the development of the technique, providing control over athletes' current fitness level. The main criteria for diagnosis of possible injuries and psycho-emotional stress acquired during competitions are the changes in parameters of subjective self-assessment, psychophysiological testing and the assessment of somatic-vegetative characteristics.

The research data showed that the level of physical fitness of basketball players depends directly not only on aerobic performance but also on the level of development of physical qualities (except for maximum strength).

The level of development of physical qualities above normal does not affect the level of players' physical state significantly. Moreover, the excessive increase of these parameters leads to the reduction of some of the parameters and the overall level of physical fitness due to long-lasting overexertion of the systems involved (muscles and joints) and failure of the mechanisms of adaptation to physical loads.

Analysis of the results of examination of players who regularly had been doing isometric exercises for a long time showed that the level of players' fitness depended significantly on each player's career length. The

following regularity was found: the longer the period of continuous isometric exercising, the higher the level of the athlete's physical fitness, the lower the injury rate and fatigue and, thus, the better the results.

Basketball players who regularly did isometric exercises, considering their individual characteristics, had better indices of their physical fitness and lower injury rates. The greatest difference ($p < 0.01$) was between injury rates for those who did not do these exercises and athletes who regularly did isometric exercises (Table 4).

Table 4. Comparative analysis of an injury rate for EG (experimental group) and CG (control group) (at the end of the contest season 2015)

Groups	Contusions	Injuries of muscles and ligaments	Ligament sprains	Dislocation and sprains	Brain concussion	Callosity and grazes	Other injuries
EG ($n = 14$)	2	3	5	1	-	3	2
CG ($n = 14$)	3	7	11	2	1	4	4

Three-hour weekly loads including isometric exercises were held. The intensity of the exercises was adjusted according to the formula developed for load adequacy estimation. The findings of the study are represented in Table 5.

The right combination of isometric exercises for different purposes and adequate loads has led to significant improvement in the parameters of physical state, especially after a year of such exercises.

Table 5. Comparative analysis of players' physical fitness before and after using isometric exercises ($\overline{X} \pm m$) points

Time of testing	Stages of general physical preparation		
	Transition 1	Preparation 2	Competition 3
Before the experiment	3.89 ± 0.18	6.15 ± 0.33	7.79 ± 0.15
After a year of training	4.92 ± 0.42*	7.11 ± 0.2*	8.80 ± 0.26

Note: Reliability of the differences against reference parameters is marked as –* ($p < 0.05$). The level of physical fitness was estimated according to the 9-point scale.

Loads and isometric exercises for different purposes provide not only compensation for the performance reduction during competitions but can also provide the tendency for its improvement, reducing the injury rate in basketball players significantly.

Implementation and checks of the efficiency of isometric exercises for injury prevention was the second part of the experiment. The expert assessment data indicating better performance indicators were recorded.

The findings of the experiment show its rather high efficiency. Data of the performance assessment indicate the importance and feasibility of the proposed system of general physical preparation using isometric exercises (Table 6).

Table 6. Average data of the performance efficiency before and after the experiment ($n = 21$)

Basic parameters	Performance (%) ($x \pm m$)	
	Before the experiment	After the experiment
Layups hits	58.7 ± 9.6	62.8 ± 8.7
Three-pointers	39.7 ± 5.4	47.3 ± 6.1
Free-throw hits	69.5 ± 6.5	76.7 ± 6.9
Offensive rebounds	32.1 ± 4.3	39.3 ± 5.2
Defensive rebounds	58.2 ± 5.3	68.7 ± 6.2
Turnovers	21.5 ± 4.8	31.8 ± 5.7

The data represented in Table 7 indicate the improvement of all the most important parameters of the performance. This is also proved by the level of satisfaction of the players who took part in the experiment with the content and procedure of the physical fitness training using isometric exercises.

The positive effects of the experimental program involved positive changes in the parameters characterising basketball players' functional state, physical fitness and psychophysiological state (Table 7).

Table 7. Dynamics of the parameters of basketball players' fitness in the course of the experiment

Parameters	Testing time	Initial data	At the end of the contest period	*p*
100 m run (s)	Before the experiment	14.8 ± 0.2	14.9 ± 0.1	-
	After the experiment.	14.9 ± 0.2	14.7 ± 0.1	-
Squatting with weight (kg)	Before the experiment	109.3 ± 2.3	114.4 ± 5.3	-
	After the experiment	115.8 ± 2.5	120.0 ± 1.3	-
General fitness (points)	Before the experiment	6.2 ± 0.3	8.0 ± 0.2	0.05
	After the experiment	6.3 ± 0.2	9.0 ± 0.1	-

Conclusion

This study's research on the use of isometric exercises in the system of general physical preparation of basketball players to prevent injury has demonstrated the high efficiency of isometric exercises. The analysis of the obtained data from the examination of players continuously doing isometric exercises indicates that the level of their physical fitness is higher. The following regularity has been found: the longer the period of continuous isometric exercises is, the higher the physical fitness level is, the lower the injury rate and fatigue are and, consequently, the greater the improvement of performance is.

References

Bolotin A.E., Fernandes A.J-A. (2011). Model of physical training management in the Angolan army. *Proceedings of Lesgaft National State University*, 9 (79), pp.164-169.

Bolotin A.E., Fernandes A.J-A. (2011). Educational conditions required for the Angolan military physical fitness training quality improvement. *Proceedings of Lesgaft National State University*, 10 (80), pp.185-187.

Bolotin A.E., Zaitsev O.S. (2012). Educational model for developing the physical readiness of cadets studying at PVO (VKO) (Aerospace Defense) higher educational institutions for combat activities. *Proceedings of Lesgaft National State University*, 9 (91), pp.38-42.

Bolotin A.E., Zyukin A.V., Napalkov Y.A. (2014). Educational model for developing professional readiness of cadets studying at higher educational institutions affiliated with VV MVD (Interior Troops of the MIA of the Russian Federation) with the use of physical training and range practice. *Proceedings of Lesgaft National State University*, 6 (112), pp.75-79.

Bolotin A.E., Bukhanov A.V. (2013). Structural-functional model management for professional training of personnel of missile station rescue units. *Proceedings of Lesgaft National State University*, 9 (103), pp.30-34.

Bolotin A.E., Borisov A.V., Skripachev S.A. (2014). Educational model for physical training of cadets studying at PVO (Air Defense) higher educational institutions considering training load regulation. *Proceedings of Lesgaft National State University*, 9 (115), pp.11-14.

Bolotin A.E., Skripachev S.A. (2014). Factors conditioning the necessity to regulate training loads during general fitness training of cadets studying at PVO (Air defense) higher educational institutions. Proceedings of Lesgaft National State University, 5 (111), pp. 17-21.

Bolotin A.E., Borisov A.V., Skripachev S.A. (2014). Psychological and educational conditions required for efficient training load regulation during physical training of cadets studying at PVO (Air Defense) higher educational institutions. *Proceedings of Lesgaft National State University*, 8 (114), pp.39-42.

Bolotin, A. E. Bakayev V. V. (2015). Structure and content of the educational technology of managing students' healthy lifestyle. *Journal of Physical Education and Sport*, 15(3), pp.362-364.

Bolotin, A. E. (2015). Educational model for developing the professional readiness of cadets studying at higher education institutions affiliated with the GPS of the MChS with the use of physical training aids. *Journal of Physical Education and Sport*, 15(3), pp.417-425.

Bolotin, A.E., Bakayev V.V., Vazhenin S.A. (2015). Educational technology of using the system of Pilates for the prevention of spine disorders of female students. *Journal of Physical Education and Sport*, 15(4), pp. 724-729.

Curt C., Toksoz I., Dindar M.D. (2014). The effects of two different whole-body vibration frequencies on isometric strength, anaerobic performance, and rating of perceived exertion. *Journal of Physical Education and Sport*, 14(1), pp.306-314.

Jimenez-Olmedo J.M., Pueo B., Penichet-Tomas A. (2016). Defensive systems during the Men's European University Beach Volleyball Championship. *Journal of Physical Education and Sport*, 16(3), pp.945-950.