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STUDY ON THE IMPORTANCE OF MOTOR QUALITIES AND ENERGETIC SUBSTRATE IN THE PREPARATORY STAGE, IN HIGH-PERFORMANCE ICE HOCKEY

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Abstract: *An ice hockey team needs a rationally designed physical training, based on which the technical-tactical actions will be performed in accordance with the requirements of the contemporary game. This is all the more necessary in the case of a team where the average age is increased. The objective of our research consists in highlighting the weight of the basic and combined motor qualities and of the energetic substrates that we have implemented during the preparatory stage (on dry land and on ice) over a span of 13 weeks, at the level of the hockey players in the CSM "Dunărea Galati" team. Their results show that the designed methodology was positively reflected both in terms of improving the general and specific motor skills of the athletes, as well as in the transfer of this component of the training in the technical-tactical behavior, which manifested more efficiently and constantly. This fact led to the achievement of the proposed performance objective, namely winning the National Senior Championship.*

Key words: *ice hockey, physical training, sports performance*

1. Introduction

McGuigan, M., quoted by Joyce, D. and Lewindon, D., [8] considers that two key goals must be achieved in order to attain sports performance: improving physical, technical, psychological abilities and developing a rigorously controlled program to guarantee maximum performance at the time of the competitive season and at each major moment of a competition.

Platonov, V.N., [12] defines sports training as "the process of attaining the sports mastery, the central part of which is sports training, completed by various external factors, which increase its efficiency (means of stimulating functional capacity, accelerating the recovery processes, optimizing the mental state) and participating in competitions". Mijaică, R. et al. [10] considers that any collective physical activity, continuous and correctly directed, develops the

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responsibility of the trainees materialized by their full involvement with the achievement of the common objective. The same author [11] found that teamwork, carried out over a longer period, increases the cohesion of the group correlating positively with the performance targeted by this group.

1.1. Physical training in the Ice Hockey game

Physical training is the essential factor of the entire sports training, stimulating the increase of functional and morphological indices (joint and ligament strengthening, muscle growth), development of motor qualities (eg: strength (F), speed (V), coordination (C), endurance(R), suppleness(S)), determining the improvement of the body's overall effort capacity; and thus, the technical-tactical requirements provided in the competition rules of the discipline the athlete specializes in [2]. The physical training also ensures the harmonious and multilateral coordination of all the systems and apparatus of the body [5] and supports the recovery and rehabilitation processes [3].

The general physical training aims at: improving the effort capacity and, implicitly, the value of the resulting mechanical work, necessary to execute the motor activities with a high degree of difficulty; helping the body adapt to sustained efforts; raising the level of training and keeping fit for as long as possible [5], [12].

The auxiliary (semi-specific) physical training has an intermediate position between the general and the specific physical training, it "favors a rational use of the results of the fundamental training in the specific training process" and it is achieved in the absence of the specific training conditions, such as summer training of hockey players outside the ice rink [12].

On the other hand, the specific physical training ensures the training of the physical skills, of the motor qualities specific to a sporting discipline, preserving the previously acquired motor capacities and amplifying those functional body capacities considered to be factors of the sport performance, respectively those correlated with the specificity of the competitive activity and with the targeted result [2], [5], [12].

1.2. Dominant motor skills in the Hockey game

In case of demands for quality, the physical effort of a sportsman is limited by the level of the dominant motor skills, respectively by the levels of strength, speed and endurance, and the efficiency of the means used. It depends on the degree of automation of the motor skills learned during the training sessions. [1]
In the case of ice hockey, Flamaropol observes the relationship between strength, dexterousness and endurance, which determines the speed of execution and the speed of movement of the player [5]. The speed in the hockey game is defined as a "set of functional properties of a sportsman's body" [12], and the skating speed is defined, according to Kostka, as "the cohesion between the speed of movement and the skating technique" and the demand for this quality is determined by the position of the player, being different, but not essentially, for attackers and defenders [9].

As to endurance, for high performance hockey players it is important to have

endurance while having speed too, in close relation with the strength, considering the intensity of the game, which requires a combined energy genesis (aerobic and anaerobic), due to the long-term effort (60 minutes), but in stages, with interruptions planned for short breaks [6].

2. Research Objectives

It is known that an ice hockey team, in order to cope with the effort during competitions and especially to win a major importance match, needs a well-consolidated physical training, based on which the technical-tactical elements can be executed at a fast and efficient pace, throughout the matches [7]. Thus, physical training, besides technical, tactical, theoretical and psychological training, has an important role in the training strategy of hockey teams, an aspect confirmed by the results of the world famous teams (Russia, Canada, USA, Finland, etc.), as well as by the teams in the Romanian internal championship.

The starting premise of our research was that in order to be effective, physical training must be achieved through two rather distinct training stages: general physical training and specific physical training. We also considered the fact that, at the level of the top teams, the specific physical training covers a wider range of elements, to the detriment of the general physical training, because at this level the athletes already have a strong basis of physical / motor development consolidated over the years of sports training. In the case of the senior ice hockey team CSM "Dunărea Galati", the players are athletes with a long competitive experience (over 20 years), but the team average age is 35, which determines their poor motivation as to improving their physical fitness. At the same time, in the context of our training strategy, we considered that the methods and the means of action on the physical factor of sports training must be varied during the period of adaptation, of the resumption of physical exercise, and then they will be oriented more and more to the requirements of the game, during the period of specific physical training. An important aspect that we considered was the choice, dosage and frequency of using the ways of action, as this allows the stimulation of the energetic substrates and implicitly the adaptation to the competitive effort. Additionally, in order to have a reference at the beginning of the training period, we used tools to evaluate the motor potential (control tests), with the simultaneous verification of indices of the main functions, that is important reference of the state of the body, and if correctly manipulated, it contributes to the achievement of sports performance.

The main purpose of the research is to highlight, by using the example of the ice hockey team CSM "Dunărea Galati" (senior level), the impact of a rational physical training, as well as the proper orientation of the energetic substrate of the training, in achieving the proposed performance objective (winning the National Championship of Romania). In accordance with this purpose, the main objective of the study is to evaluate the level of physical training of the team members, after a reasonable use of the training microcycles, judiciously establishing the share of the motor qualities and of the specific energetic substrates for this stage, so that through a

correct management of the sport training process, a maximum competitive efficiency will be achieved.

3. Material and Methods

The study was conducted using the following research methods: specialized literature analysis, observation, experiment, evaluation of motor performance, statistical method of data processing. The materials used were those specific to the optimal application of the acting systems subordinated to the objectives regarding the general and specific physical training of hockey players, and the research location was the Galati Dunărea Artificial Rink.

3.1. The methodological framework of the research

The experiment was conducted with the senior ice hockey team of Dunărea Municipal Sports Club in Galați, during the preparatory stage of the 2015-2016 competitive year. We mention that, the 2015-2016 Season brought together 6 senior teams that entered the National Championship: CSM “Dunărea Galati”, CSA Steaua Bucharest, CS Progym Gheorgheni, ASC Corona 2010 Brasov, Sport Club Miercurea Ciuc and Sportul Studentesc Bucharest. The 6 participant teams played a regular season in the division system, each one against each one, according to the competition calendar posted on the FRHG website [14]. After the regular season matches, according to the ranking, the first four teams (among which the CSM “Dunărea Galati”) qualified for the semifinals. The teams qualified for the semifinals played in the play-off system "the best out of five matches", following the formula Semifinal 1 (1 against 4), Semifinal 2 (2 against 3). The teams qualified for the Grand Finale play in the play-off system "the best of seven games", and the teams defeated in the small final, in the play-off system "the best out of five matches" [14].

In our approach with the CSM “Dunărea Galati”, according to the main objective of the present study, we evaluated the motor capacity of the athletes through control tests on land and on ice. In this case, we established 11 dry land control tests for all subjects (23), regardless of their position on the field and 5 ice control tests for 12 attackers, 8 defenders and 2 (two) special control tests for the 3 goalkeepers of the team (average age of the team was 35).

After the initial assessment of the players by supporting the set of control tests (TI), the independent variable of the research was applied, which materialized through the contents of the training microcycles, during the physical training stage (8 weeks of physical training on land and 5 weeks of physical training on ice).

In the content planning methodology, we envisaged the use - in different proportions - of all types of request for energy sources (aerobic, alactacid anaerobic, lactacid anaerobic), which would ensure the efficiency of the technical-tactical behavior of the players in the targeted competitive season [13]. In designing the strategy, we also focused on engaging athletes in actions performed against a mixed effort background, which represents the type of effort specific to the ice hockey game. In the 13 training microcycles we addressed all the basic motor qualities and their combinations, complying with the progression and the graduality of the specific effort

parameters for the training stage in question, by an appropriate dosage of the volume and intensity indicators [2], [7].

4. Results and Discussions

Following the training carried out during the 8 weeks dedicated to general physical training (PFG - period I), we calculated the shares of the motor qualities and of the energetic substrates that were used during this period. Thus, figure 1 illustrates the weight of the basic and combined motor qualities of dry land physical training, during the training stage I.

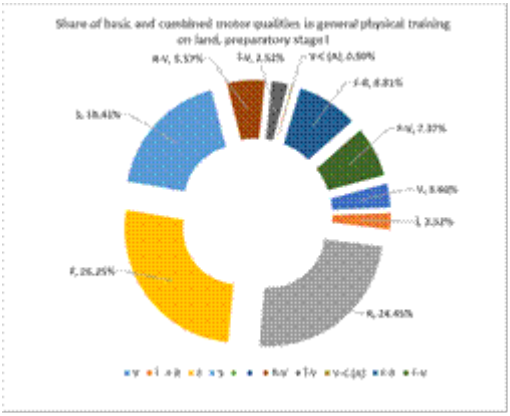

Fig. 1. *Share of basic and combined motor qualities in the general physical training on land, preparatory stage I*

Generally speaking, 75.23% of the physical dry land training program is represented by the basic motor qualities and 24.77% by the combined motor qualities. As it can be seen, in the preparatory stage I, the emphasis was particularly on the development of strength and endurance. Thus, 26.25% of the total hours of physical training were dedicated to the development of strength motor quality and 24.45% to the development of endurance. Among the other basic motor qualities, speed and skill were approached in a lower proportion (3.60% and 2.52% respectively). Considering that the suppleness develops at every training in this stage, it occupies 18.41% of the total hours of physical training. The combined motor qualities occupy a smaller proportion of the dry land physical training program, as follows: 8.81% strength in endurance, 7.37% strength in speed, 5.57% endurance in speed, 2.52% skilfulness in speed and 0.5% reaction time (agility).

The energetic substrate required during the physical training on dry land is shown in figure 2. Thus, 42.86% of the general physical training on dry land is represented by the type of aerobic effort; 35.06% of mixed effort and 22.08% of anaerobic effort.

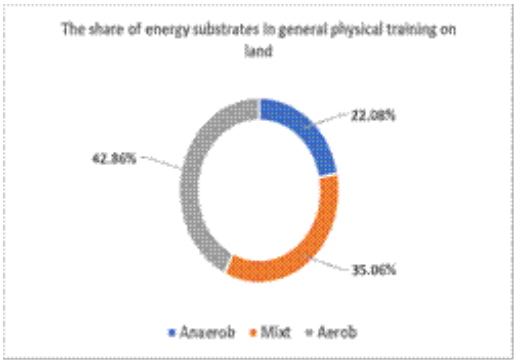

Fig. 2. *Share of energetic substrates in general physical training on dry land*

As to the period of specific physical training on ice, which took place over 5 weeks (PFS - preparatory stage II), the data obtained (figure 3) following the application of the proposed methodology are presented as follows: emphasis has been oriented towards the development of combined motor qualities; 57.33% of the specific physical training program on

ice is represented by these contents and only 42.67% by basic motor qualities.

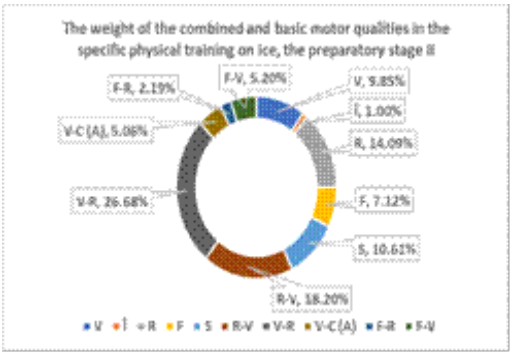

Fig. 3 *The weight of the combined and basic motor qualities in the specific physical training on ice, preparatory stage II*

Dividing the data on the various combinations (figure 4), 26.68% of the total hours of physical training were dedicated to the development of speed in endurance and 18.20% for the development of endurance in speed. The other combined motor qualities occupied a smaller proportion, as follows: 2.19% strength in endurance, 5.20% strength in speed, 5.06% speed in coordination (agility).

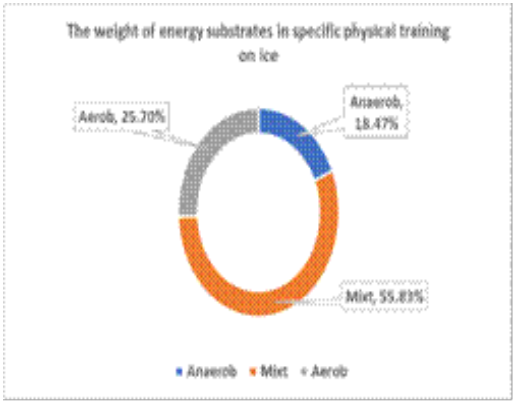

Fig. 4. *The weight of energetic substrates in specific physical training on ice*

Compared to the request for basic motor qualities (figure 3) during the previous stage, the action on the strength development came down to 7% of the total hours of specific physical training; an important weight in the training program is still developed by the resistance (14.09%), the suppleness (11.61%) and the speed (9.85%).

Regarding the percentage distribution of energetic substrates from the preparatory stage II (specific physical training on ice - PFS), it is presented in figure 4. As it can be seen, 55.83% of the total time allocated within the specific physical training on ice is represented by the mixed effort type, dominant in the high performance hockey game, 25.70% is covered by the aerobic effort and 18.47% by the anaerobic type effort.

For the entire duration of the physical training period (I and II) the development of the basic motor qualities was our major objective, in a proportion of 53.96%, while for the development of the combined motor qualities, there was a weight of 46.04 %. This fact actually reflects the larger time period programmed for the general physical training (8 weeks), compared to 5 weeks, as planned for the specific physical training. The cumulative distribution of the energetic substrates, during this entire interval, allocated to the physical training, reveals the following data: 49.27% of the actions were made on a joint effort background; 31.04% on aerobic effort and 19.69% on anaerobic effort.

The time allocated to physical training (PFG and PFS) in the 2015 – 2016 season is presented in table 1.

Table 1

Number of general and specific physical preparation hours during the preparatory stage

No.	Preparatory stage/acting orientation	Number of training hours
1	I/General physical training (PFG)	71h 06’
2	II/Specific physical training (PFS)	97h 17’
3	Total number of hours (PFG+PFS)	168h 23’

After applying the independent variable of the micro cycles for performing the physical training on land (PFG - 8 weeks) and the specific physical training on ice (PFS - 5 weeks), considering also the weights presented previously and, after the final test (TF), the statistical calculation was carried out to highlight the differences in the motor performance evaluated initially and at the end of the preparatory phase. Thus, in order to analyze the results obtained before and after applying the independent variable, we applied the Student t test, establishing a critical significance threshold $\alpha = 0.05_{2tail}$ and a 95% confidence interval. Through statistical processing of the data, in order to show the progression of the performances in the tests of general motility applied to the 23 athletes, the resulting values are presented in table 2.

The initial average of the results obtained at the control tests on land by the 23 athletes in the sample group is 727.2174, and after completing the first period of general physical training, it is 843.7065, noticing an obvious improvement of the targeted performance.

T Student Test – General Physical Training (PFG) Table 2

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 2	Total on land TF	843.7065	23	110.15783	22.96950
	Total on land TI	727.2174	23	113.06588	23.57587

a. The correlation and t cannot be computed because there are no valid pairs.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 2	Total on land TF & Total on land TI	23	.989	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 2	Total on land TF - Total on land TI	116.48913	17.00726	3.54626	109.13464	123.84362	32.848	22	.000

Comparing the value of t calculated, t_{calc} = 32.848, to the critical value for the established significance threshold (α = $0{,}05_{2\ tail}$) in the table with critical values of t Student distribution, t_{crit} = ∓2,074, for d_f = 22 degrees of freedom. We note that t_{calc} = 32.848 > t_{crit} = ∓2.074, $p_{calc} \rightarrow 0$ (Sig. (2-tailed) = 0.000), p_{calc} = 0.000 < α = $0.05_{2\ tail}$, hence we can state there is a significant difference between the two sets of data (TI – TF).

In the case of the efficiency of the specific physical training program (PFS), by applying the same calculation procedure (table no. 3), we find that the initial average of the results obtained at the ice control test by the 23 athletes is 301.3043 and at the end of the stage it is 338.7826, noting an improvement in performances. Comparing the value of t calculated, t_{calc} = 15.343, with the critical value for the established significance treshold (α = 0.052 tail) in the table with the critical values of the t Student distribution, t_{crit} = 2.074, for df = 22 degrees of freedom, we observe that t_{calc} = 15.343> t_{crit} = 2.074, p_{calc} (Sig. (2-tailed) = 0.000), p_{calc} = 0.000 <α = 0.052 tail, so there is a significant difference between the two data sets (TI - TF).

T Student Test – Specific Physical Training, on ice (PFS) Table 3

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	TOTAL TF	1182.4891	23	184.00873	38.36847
	TOTAL TI	1028.5217	23	182.15147	37.98121

a. The correlation and t cannot be computed because there are no valid pairs.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	TOTAL TF & TOTAL TI	23	.996	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	TOTAL TF - TOTAL TI	153.96739	15.96575	3.32909	147.06328	160.87150	46.249	22	.000

Based on the methodology applied in the preparatory stage, focused on the physical / motor component, the training process was continued, engaging the other factors of the sports training, too according to the training requirements specific to the pre-competitive and competitive stages. The final ranking Seniors 2015 - 2016, the National Championship of Romania presented the following ranking: 1. CSM Dunărea Galaţi; 2. Sport Club Miercurea Ciuc; 3. ASC Corona 2010 Brasov; 4. CSA Steaua Bucharest; 5. Progym Gheorgheni; 6. Sportul Studentesc Bucharest (SENIORI

NATIONAL CHAMPIONSHIP 2015 - 2016 - CSM "Dunărea Galați" wins the series 4 of 7 and it is the National Champion). [14]

5. Conclusions

To be effective, the physical training - regardless of the quota of an ice hockey team - has to be done following the two directions: general physical training and specific physical training. However, at the level of the top teams, we must emphasize that the specific physical training has a wider coverage - from the point of view of scheduling - to the detriment of the general physical training, since the athletes already have a basis for the physical development achieved and strengthened over the years of sports training and which, due to this fact, should only be maintained.

In the case of the ice hockey teams active in the National Senior Championships in Romania, the problem of scheduling physical training must be particularized for the following reasons: the level of technical-tactical acquisitions cannot be fully manifested due to the superficiality in approaching the physical factor of the training; the weight of motor qualities and energetic substrates in the preparatory stage are not, in most cases, correlated with the dominant motor expressions and with the type of effort specific to the game of ice hockey; in the preparation on dry land there is no emphasis on actions to be performed against the background of aerobic effort (as a building factor for the level of the physical fitness), and during the period of the specific physical training - on ice – neither the means of acting (with divided shares) are differentiated nor basic importance is given to improving the ability to work in a mixed effort, which basically supports the high overall performance of the hockey player.

Our research, whose didactic approach consisted in the rationalization and the correct / appropriate distribution of the factors that contribute to the improvement of the general and specific motor skills of the hockey players, has demonstrated the relation between this component of the sport training process and the competitive performances of the CSM "Dunărea Galați" hockey team, which had in the 2015/16 season, the title of National Champion of Romania.

This study also shows that a correct planning of the weights allocated to the motor qualities (basic and combined) correlated with the energetic substrates involved in supporting the specific actions of the ice hockey game has a positive and relatively long-term impact on the highly competitive results.

Acknowledgments

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