IN SEARCH FOR A MODEL OF THE CHAMPION IN THE YOUTH HANDBALL

by

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Material of this paper consists of results of research of 87 boys (including 22 – continuous) aged 11 – 14 and attending sports classes specialised in handball. In the research an attempt was made to select factors which have the greatest influence on the process of mastering the special fitness in handball at the initial phase of training. In result of factor analysis and the analysis of multiple regression it was found that effectiveness of mastering the special fitness in handball depends to a great extent on the level and development of motor coordination, and especially its elements related to the higher level of the sensorimotor coordination. Furthermore, the degree of the special fitness depends to a large extent on the development of the explosive power.

Key words: youth sport, handball.

Introduction

The proper course of recruitment (selection) as well as of all phases of selection is conditioned in a special manner by application of appropriate criteria and standards. The latter are based on so-called 'champion models'. Through analysing features typical for such a model we can define, in approximation, quality and value of all those parameters requested of a player at each phase of training and onthogenetic development which are necessary to achieve the sports championship (Raczek 1991).

Therefore it appears necessary to create, for specific sports disciplines and competitions, appropriate champion models. According to Ważny (1981), a champion model is 'an abstract (conceptual) structure aimed at imitation of selected and the most important features of the original, i.e. the present or future champion of a given sports discipline'.

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Having in mind all activities taking place during a handball play we have to agree that it is not easy to recognise, specify and a precisely describe all features determining the final sports result. The structure of features of a high-class player (in team games) consists of mental features, special motor abilities, complex and coordination motor skills and a somatic constitution (Naglak 1994).

In the Polish literature on this subject you can find attempts of creating specific handball champion models (Czerwiński 1990, Żarek 1983). However, in spite of a complex approach none of them does not cover all related problems and none of them can be considered the ultimate and not modifiable.

Study of the model allows controlling features of the best players, which leads, in consequence, to optimisation consisting in control of training at its every phase (Kuźniecow and Nowikow 1976). However, the model of an adult champion does not include precise information about the features and predispositions which are responsible for precision, speed and effectiveness of acquiring new motor acts (techniques of movement) at the earlier phases of training. Searching for those features is difficult due to the fact that depending on the dominant elements in specific types of moves the predispositions are grouped in specific complexes (often identified jointly in multidimensional statistic analyses) which are often called motor abilities (Szopa et al. 1996). Moreover, the model of a youth champion, if it exists at all, cannot be based on the adult models.

Having the above in mind, the following research goals have been adopted in this paper:

1. Finding the factorial structure of motor abilities for specific age groups of boys under research;
2. Evaluation of the extent and character of influence of variables defining structural-morphological predispositions and motor abilities on the results of special fitness tests in specific years of the training;
3. Definition of factors which condition the process of motor learning, i.e. technique acquisition.

1. Scope

The research embraced 87 students of sports classes specialised in handball in the Elementary School No. 91 in Kraków. Starting from the fifth form the boys were trained in handball.

The tests were made with year intervals, in the years 1988-91, at the physical education classes. At first measurements of morphologic features were made and then followed tests of motor abilities and special fitness.

To resolve the main problems posed in this paper, results of a complete research (i.e. conducted for four years) were used. That research covered 22 boys who started their education in the fifth form in 1988. In that year boys attending higher forms (6^{th}, 7^{th} and 8^{th}) were also included in the research. This pattern was repeated in the following years, in result of which a second series of tests (semilongitudinal) was obtained.

The scope of research covered what follows:

1. Morphological-structural predispositions: body height, length of the upper limb, hand span, arm circumference, body mass, fat mass, and spine flexibility (Eurofit 1991);
2. Energy-related capabilities (fitness):
   - strength capabilities: strength of hand hold, dynamic strength of abdominal muscles (Eurofit 1991),
   - speed capabilities: running speed (a 10 m run from a flying start, with 6 m runway), agility-oriented steeplechase (description – Szopa 1988), a jump-up and a long jump from a spot, as tests of the explosive power;
   - endurance capabilities: measurement of $V_{O2\ max}$ with a test by Magaria et al. (1965);
3. Coordination predispositions: spatial orientation tested with the cross-bar apparatus (of Polish construction), vision-motor coordination tested with the Piórkowski apparatus (of Polish construction), time of simple reaction to an aural stimulus (electronic gauge M-302), balance measured with the 'flamingo balance' test (Eurofit 1991), frequency of hand movements measured with the 'plate tapping' test (Eurofit 1991). Names of the capabilities were taken from the papers by the tests' authors.
4. Special fitness: measured with the Pytlik and Żarek test (1975). The test has been devised and standardised in Poland, and it covers what follows:

- ball throw to a goal after bouncing – recording the time of a slalom track run ten times, and accuracy of throws;
- medicine ball put (2 kg): with one hand, from a spot, lateral position;
- movement in defence – recording the time of a path along the goal area line run four times;
- ball rebounded against a wall – measurement of the number of rebounds of a ball thrown from a distance 5 m, within 1 minute.

In order to adjust the score of the above-mentioned test (devised for adults) to measurement of the special fitness of children aged 11-14, the expert method was applied.

A questionnaire-based study was conducted with 27 handball coaches who currently work with youth teams. The coaches were to assign to each test a percentage score reflecting to what extent a given test conveys the information about the technique level. The scoring was applied to tests in each year of training separately. Thus obtained data were used to calculate the arithmetic averages used for test calibration.

2. Methods

The statistic analysis included what follows:

1. Calculation of the elementary statistic features (x, SD, t^0 –per student);
2. Creation of the correlation matrix for all the tested parameters in order to find the strength of relations between them);
3. Reduction of the number of features covered by the research using the factor analysis. In the calculations all collected materials were used (87 observations). The materials were divided according to school teams, which included classes attended by the boys at tests. Results of the teams were used in a factor analysis, for boys from the 5^{th}, 6^{th}, 7^{th}, and 8^{th} form separately. This division caused that the group of boys from the 5^{th} form included students tested in 1988 and 1991. Number of boys in the test series was as follows: in the 5^{th} form – 69, in the 6^{th} form – 57, in the 7^{th} form – 56, and in the 8^{th} form – 54. Variables applied in the analysis were standardised as arithmetic averages and standard deviations of results of separate class teams. Applied variation of the analysis was based on the main constituents Hotteling method in the Tucker modification, appended with the Varimax rotation proposed by Kaiser (Czyż 1971), according to the program from the SSP Library. The analysis was conducted in three phases varied with the

number of analysed features (reduced in the consecutive phases). As the factor analysis is very 'sensitive' to the set of features used for calculations, a preliminary selection was made based on the basic features (not calculated).

4. Selection of factors which are most important for the high level of the special fitness, using the coefficient of correlation and multiple determination. In the regression analysis there is no explicitly specified criteria of selection of the optimal subset of variables independent of the regression model. In this research the step regression was applied i.e. before inputting an independent variable to the model the partial F was calculated for this variable, and the value of F qualified the variable to the model (Furdal 1989).

Groups of parameters selected in result of the factorial analysis were adopted as variables independent of the regression model. The analysis was made for the whole collected material and the multiple correlation was conducted using measurements obtained during four years long continuous research. It was adopted that the obtained factors would be comparable for both the groups (1^{st}: the total number of persons under research - a group of 87; 2^{nd}: a group of 22 persons under four years long cycle of survey).

Results and discussion

Due to limitation related with the edition, this paper does not include results of the linear correlation. Also, a detailed interpretation of the obtained factors was abandoned, as their selection is logical and easily justifiable.

The main goal of the factorial analysis was to reduce the number of the parameters. For qualification of a parameter for an appropriate factor, charge values equal or greater than 0.3 were taken to account. Adoption of such a low level depended on the further methodological proceedings assumed, as in mathematical calculations applied to regression analysis a whole factor was used rather than only the leading feature. Therefore it was important that for each factor as much interrelated variables were found as possible.

Table 1. Factorial structure of the tested boys' teams

Factors	Features	Factor values in separate age groups			
		11 years	12 years	13 years	14 years
1	2	3	4	5	6
I. Body size	Body height	-90	-84	not observable	not observable
	Body mass	-79	-86		
	Fat mass	-33	-		
	Arm circumference	-51	-64		
	Upper limb length	-75	-79		
	Hand span	-42	-67		
	Static strength	-60	-78		
	Agility	-58	-		
	Jump-up	-	-33		
II. Stoutness of the body	Body mass	not observable	not observable	-60	-79
	Arm circumference			-77	-88
	Fat mass			-75	-64
	Static strength			-45	-49
III. Leanness of the body - strength	Upper limb length	not observable	not observable	-65	-70
	Body height			-89	-78
	Body mass			-73	-48
	Arm circumference			-35	-
	Hand span			-52	-
	Static strength			-59	-
	Jump-up			-58	-
	Long jump from a spot			-59	-
	Agility			-	-64
IV a Stoutness of the body – explosive power (in the age of 11 and 12 years)	Jump-up	-60	-59	-44	-73
	Agility	-	-53	-73	-59
	Long jump from a spot	-62	-74	-57	-81
	Running speed	-53	-41	-70	-62
	Dynamic strength of abdominal muscles	-39	-	-	-
IV b Explosive power (in the age of 13 and 14 years)	Balance	-46	-	-33	-
	Flexibility	-	-45	-58	-54
	Fat mass	--81	--71	-	--36
	Arm circumference	--69	--58	-	-
	Body mass	--53	--39	-	-

Table 1

1	2	3	4	5	6
V a Coordination – speed (in the age of 11 and 12 years)	Tapping	-36	-71	-68	-68
	Vision – motor coordination	-74	-68	-64	-62
	Spatial orientation	-70	-62	-45	-70
	Simple reaction	-34	-32	-41	-
V b Coordination (in the age of 13 and 14 years)	Balance	-	-	-	-59
	Agility	-55	-34	-	-
	Running speed	-40	-	-	-
VI Aerobic efficiency	Pulse 2	-81	-75	-83	-89
	Pulse 1	-85	-69	-73	-81
	Agility	-	-41	-	-
	Dynamic strength of abdominal muscles	-34	-30	-	-

Table 1 presents a structure of factors observed in groups of boys. In result of analysis 8 factors were picked. Only one of them, **'aerobic efficiency'** appears in consecutive age categories. The **'coordination – speed'** factor appearing at the age of 11 and 12, is later divided into two independent factors: **'coordination'** and **'explosive power'**. In the younger age categories the tests of long jump from a spot, jump-up, running speed and agility were identifiable with some somatic characteristics within a factor called **'stoutness of the body – explosive power'**. The factor **'body size'** appears at the age of 11 and 12. In the following two years the factor is divided into two factors: **'stoutness of the body'** and **'leanness of the body – strength'**.

Each factor was constituted by several different parameters. The values of the parameters were standardised to averages and standard deviations of result for each age category. Values calculated in this way were multiplied by the factor charge values. Sum of the values was treated as 'the power' of a given factor typical for a specific person.

Multiple correlation referred to results of continuous research (four years long) of 22 boys. The correlation was aimed at finding the complexes of factors that conditioned the level and effectiveness of mastering of the special fitness in specific age categories of 11 – 14 years. The significance of the problem may be recognised by studying the target champion models in the discussed sport discipline (Żarek 1983, Czerwiński 1990). It is apparent that effectiveness of special fitness mastering in young handball players depends on many various factors, including somatic, coordination-related and energetic ones. As you

know the factors not always act separately. Usually they interweave with one another and appear in complexes (Żak and Sakowicz 1995) – also various interactions occur between them.

Table 2. Coefficients of correlation and multiple determination between the level of technique of tested boys and the factors obtained in the factor analysis

Score	Age	Variable introduced to the model	R	R^2	$R^2_{pop.}$	F
Elementary	11 years	Factor 3: coordination - speed	0.41	0.17	0.13	4.11*
	12 years	Factor 4: coordination - speed	0.60	0.36	0.33	11.48**
	13 years	Factor 2: explosive power	0.57	0.32	0.29	
		Factor 4: coordination - speed	0.65	0.42	0.36	
		Factor 3: stoutness	0.74	0.55	0.47	7.31**
	14 years	Factor 2: explosive power	0.58	0.34	0.31	10.41**
Modified	11 years	Factor 3: coordination - speed	0.61	0.37	0.34	11.64**
	12 years	Factor 4: coordination - speed	0.74	0.55	0.53	24.28***
	13 years	Factor 2: explosive power	0.52	0.27	0.23	
		Factor 4: coordination - speed	0.62	0.38	0.31	5.80**
	14 years	Factor 2: explosive power	0.57	0.32	0.28	
		Factor 4: coordination - speed	0.66	0.44	0.40	9.29**

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

Table 3. Coefficients of correlation and multiple determination between the level of technique of tested boys (in the age of 14 years) and the factors obtained in the factor analysis (in the age of 11 years)

Score	Variable introduced to the model	R	R^2	$R^2_{pop.}$	F
Elementary	Factor 3: coordination - speed	0.48	0.23	0.19	5.92*
Modified	Factor 3: coordination - speed	0.57	0.33	0.30	9.82**

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

The analysis of multiple correlation delivered a clearer view on the investigated relations at introducing the results of the special fitness tests to the modified model of result regression (dependent variable). Evaluation of the tests by means of the experts' method allowed for ordering the tasks included therein and for giving the top rank to the elements more useful in the play, i.e. the more complex ones. It appears that only results of that test are worth attention in terms of their relation with the parameters taken as independent variables. To make any comparisons in tables 2 and 3 values of determination coefficients and of multiple correlation were juxtaposed. The values were obtained through introduction of results of the special fitness test, in the elementary and modified version, to the regression model.

Variability of the results of the special fitness test in the first two years of training (age 11 and 12 years) can be explained by the **'coordination and speed'** factor (fig. 1). In the age category of 11 years the factor explains 34% of the collective variation, and in the age category of 12 years - 53%. At this age coordination-related predispositions determining the vision-motion coordination and spatial orientation have the biggest influence on the level of the special fitness mastered by the boys. This phenomenon is easily understood, as the measurements are correlated (Szopa et al. 1985), and in statistic analyses they are often grouped within one factor (Szopa 1988, Szopa and Wątroba 1992). Therefore it seems that they measure similar functions of the nerve system at the various levels of sensomotor coordination (Mleczko 1991). It should be stressed that the rate of their increase, especially at the school age, has great dynamics, and a relative stabilisation occurs at the age 14 – 15 years. Also, it should be noted that the rate of results' increase is higher then this of somatic features (Mleczko 1991, Żak 1991). Taking to account considerable linear correlations between the discussed components of motor coordination and the movement technique, the problem in question seems obvious and does not require further explanations. However, high charges of the factor related to the agility test are surprising.

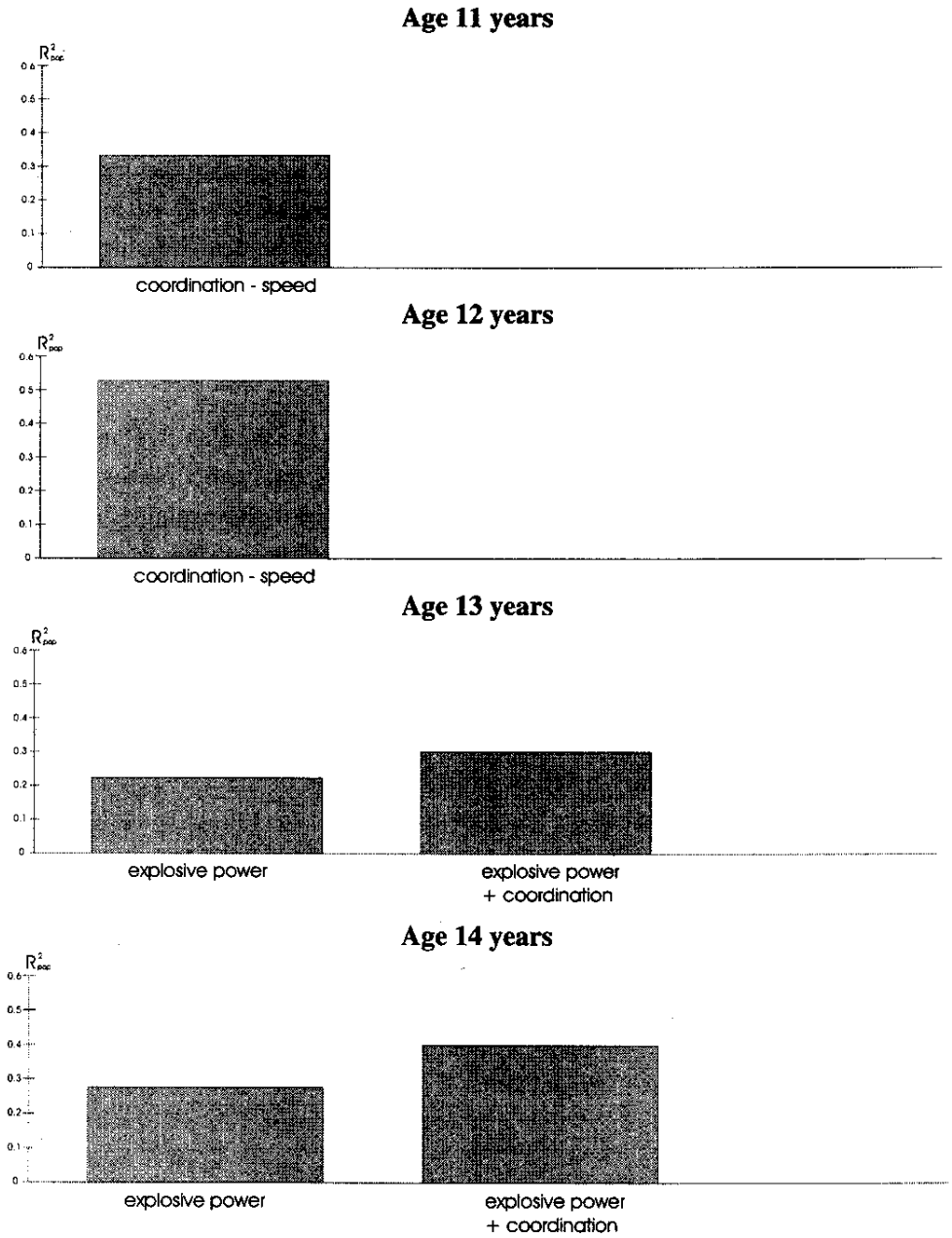

Figure 1. Coefficients of multiple determination between the level of the special fitness of tested boys and factors obtained in the factor analysis.

The high factor charges of the agility test are surprising, however this refers to many factors. This phenomenon indicates the hybrid character of the test, and therefore its low usefulness for diagnostic purposes, especially for the coordination-related sphere of the motor features. This results, obviously, from the construction of the test (considerable variability of motions). This is confirmed by the results of survey conducted by Szopa (1988), Raczek and Mynarski (1992) and by many other authors.

At the age group of 13 and 14 years the test results are increasingly influenced by two factors, namely **'explosive power'** and **'coordination'** (fig. 1). The factors explain, respectively, 31% and 40% of variability of results of the special fitness trials. All relations discussed above are important in statistical terms.

Studying the inner structure of the factors that played an important role in shaping the special fitness test the two typical phenomena cannot be overlooked:

1. The coordination-speed factor at the older age (13 and 14 years) was divided into two separate factors named 'coordination' and 'explosive power';
2. With time 'agility' was ousted from the second factor.

'Agility' was replaced with trials that are most representative for this factor (Szopa 1988), namely jump-up and long jump from a spot (factor charges exceeding values 0.7 and 0.8). It should not be surprising, as all exercises made by boys are always typified by great dynamics. Moreover, one should remember about significant relations of the parameters with the results of the special fitness test (linear correlations). However, the change of the 'agility' test from the 'correlation – speed' factor to the 'explosive power' factor. This confirms domination of the energetic components in the trial.

The two factors described above which were integrated in the joint **coordination – speed'** factor at the age of 11 years, had an apparent influence on effectiveness of mastering of the special fitness (measurement taken at the age of 14 years) explaining 30% of variability of test results (fig. 2). It appears apparent that the most important predispositions for the special fitness of motion and its mastering are various components of motor coordination with the special role of vision-motion coordination and spatial orientation. Also, parameters defining the frequency of movements appear important. These observations are similar to those made by other authors (Szczepanik and Szopa 1993). For the results of so-called special fitness the energetic factor based on

components of explosive power – MMA – is also significant. One can assume that this is the main predisposition to allow a player to attain the full effectiveness of motional abilities (playing techniques), especially in the situation of the spots fight.

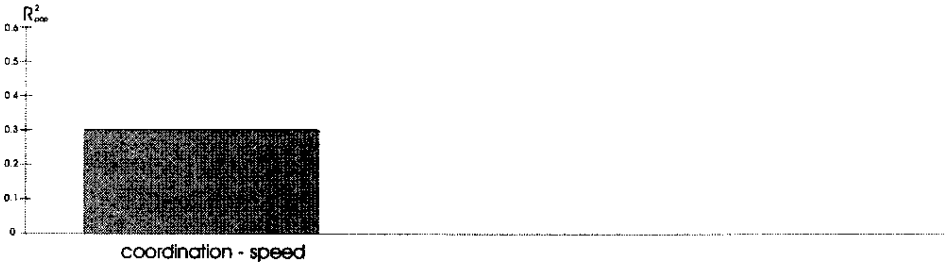

Figure 2. Coefficients of multiple determination between the level of the special fitness of tested boys (in the age 14 years) and factors obtained in the factor analysis (in the age 11 years).

Conclusions

Based on the data presented in the section *Results and discussion* the following conclusions can be formulated:

1. Effectiveness of mastering of the special fitness in handball depends, to large extent, on the level and development of motor coordination, and especially those element that are related with the higher level of the sensomotor coordination. The analysed abilities should be included in all recruitment sets, as they are hardly trainable after adolescence.
2. The level of the special fitness in the boys under survey is conditioned, to a large extent, apart from motor coordination, with development of explosive power. Therefore it may be assumed that the basic technique predisposition at the initial phase of training of handball players is motional coordination, and effectiveness of technique application in the situation of a sports fight depends on the level of explosive power – MMA – of a player.
3. High level of somatic features development does not condition high level of the playing technique (at the age of 11 – 14 years). However it is the basic feature of the 'adult champion model' finding the determinants of the 'champion model' at the initial training is aimless.
4. Accurate special fitness tests should be searched for.

REFERENCES

Czerwiński J. 1990. *Characteristics of handball.* Scient. Edit. Ac. Phys. Educ., Gdańsk. (In Polish)

Czyż T. 1971. *Zastosowanie metod analizy czynnikowej do badanej struktury ekonomicznej regionalnej Polski.* Prace Geograficzne, PAN, Wrocław, no. 92. (In Polish)

Eurofit. 1988. *European Test of Phisical Fitness.* Conncil of Europe, Brussels.

Furdal P. 1989. *Modelowanie statystyczne w badaniach empirycznych.* Prace i Materiały, Instytut Sportu, Warszawa, T. XXX. (In Polish)

Kuźniecow W., Nowikow A. 1976. *System szkolenia w okresie doskonalenia wyższego mistrzostwa sportowego.* Sport Wyczynowy, no. 2, p. 17-26. (In Polish)

Margaria R., Aghemo P., Povelli E. 1965. *Indirect determination of maximal O_2 consumption in man.* J.Applied Physiology, 20 (5), p. 1070.

Mleczko E. 1991. *Przebieg i uwarunkowania rozwoju funkcjonalnego dzieci krakowskich między 7 a 14 rokiem życia.* Wydawnictwo Monograficzne, AWF, Kraków, no. 44. (In Polish)

Naglak Z. 1994. *Zespołowa gra sportowa - studium.* Studia i Monografie, AWF, Wrocław, 45. (In Polish)

Pytlik J., Żarek J. 1975. *Test sprawności specjalnej /technicznej/ w piłce ręcznej.* Wydawnictwo Skryptowe AWF, Kraków, no. 26, p. 5-22. (In Polish)

Raczek J. 1991. *Podstawy szkolenia sportowego dzieci i młodzieży.* Resortowe Centrum Metodyczno-Szkoleniowe KFiS, Warszawa, p. 9-12. (In Polish)

Raczek J., Mynarski W. 1992. *Koordynacyjne zdolności motoryczne dzieci i młodzieży - struktura wewnętrzna i zmienność osobnicza.* AWF, Katowice, p. 44. (In Polish, Engl. Summ.)

Szczepanik M., Szopa J. 1993. *Wpływ ukierunkowanego treningu na rozwój predyspozycji koordynacyjnych oraz szybkość uczenia się techniki ruchu u młodych siatkarzy.* Wydawnictwo Monograficzne, AWF, Kraków, no. 54. (In Polish, Engl. Summ.)

Szopa J. 1988. *W poszukiwaniu struktury motoryczności: Analiza czynnikowa cech somatycznych funkcjonalnych i prób sprawności fizycznej u chłopców i dziewcząt w wieku 8-19 lat.* Wydawnictwo Monograficzne, AWF, Kraków, no. 35. (In Polish, Engl. Summ.)

Szopa J., Mleczko E., Cempla J. 1985. *Zmienność oraz genetyczne i środowiskowe uwarunkowania podstawowych cech psychomotorycznych i fizjologicznych w populacji wielkomiejskiej w przedziale wieku 7 - 62 lata.* Wydawnictwo Monograficzne, AWF, Kraków, no. 25. (In Polish, Engl. Summ.)

Szopa J., Wątroba J. 1992. *Dalsze badania nad strukturą motoryczności ze szczególnym uwzględnieniem uzdolnień ruchowych.* Antropomotoryka, no. 8, p.32. (In Polish, Engl. Summ.)

Szopa J., Mleczko E., Żak P. 1996. *Podstawy antropomotoryki.* Wydawnictwo Naukowe PWN, Warszawa - Kraków, p. 33-34. (In Polish)

Ważny Z. 1981. *Współczesne systemy szkolenia w sporcie wyczynowym.* Sport i Turystyka, Warszawa, p. 73. (In Polish)

Żak P. 1991. *Zdolności kondycyjne i koordynacyjne dzieci i młodzieży z populacji wielkomiejskiej na tle wybranych uwarunkowań somatycznych i aktywności ruchowej.* Wydawnictwo Monograficzne, AWF, Kraków, no. 43. (In Polish)

Żak P., Sakowicz B. 1995. *Rozwojowe i koordynacyjne uwarunkowania doskonalenia sprawności specjalnej dzieci uprawiających piłkę ręczną.* Antropomotoryka, no. 12-13, p. 25. (In Polish, Engl. Summ.)

Żarek J. 1983. *Wybrane zagadnienia modelowe w sporcie wyczynowym na przykładzie zawodników piłki ręcznej.* Wydawnictwo Monograficzne, AWF, Kraków, no. 18. (In Polish, Engl. Summ.)