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ANTHROPOLOGICAL BASIS OF SUCCESS IN SPORT

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Abstract. In order to meet the needs of the research being done on the influence that the anthropological dimensions have upon the results achieved in the sports gymnastics the fundamental research was carried out during the work on the ph. dissertation (Todorovski, 1997) entitled "The Specification Equation of Success in the Sports Gymnastics". The realization of the experimental program termed "the young hopes in gymnastics" involved the set of 71 tests in order to estimate: morphological (16), functional (5), motoric (18), cognitive (3), connate (14) and sociological domain (8) as well as 7 variables for assessment of the motion habits in the sports gymnastics (namely, only 5 variables with little girls). The sample consisted of 117 young athletes (60 boys and 57 girls) of eight years of age from 12 towns, namely, those who were participants in the competition system of the Gymnastic Association of Macedonia. It was used to determine individual (by applying the multi-variant canonical analysis - Can R %) and overall (by applying the factor analysis as a cumulative contribution (Cum %) of the extracted variant) contribution of the personality factor to success in the sports gymnastics. The above-mentioned contribution of the personality factor (DL) as an anthropological contribution represents the solution of the first unknown in the success specification equation. Thus the conditions are made to give an answer to the second part of the problem - namely, the contribution of the objective factors (0) to the success. The success in the sports gymnastics is represented as a theoretical, graphic and - for the first time - as a mathematical model. The canonical correlation analysis is applied to determine the contribution of the individually given anthropological dimensions so that it is found out that: - In the morphological domain an important influence has been spotted only among the boys, namely as one characteristic root amounting to 60% of the extracted variant (Can R%=60) at the level of significance of 95% (P=05). An important presence of 11 variables has been determined among the boys (body height, shoulder and pelvis width, circumference of upper arm and forearm, body mass and the wrinkled-skin forearm) while 6 variables have been determined among the girls (body height, arm and leg length, elbow diameter, circumference of forearm and upper arm), - Regarding functional abilities an important influence has been found out only among the girls with one characteristic root amounting to 34% of

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the extracted variant (Can R %=34) at the level of significance of 96% (P=.04). An important presence of two variables has been found out among the boys (heart beat frequency at rest and diastolic blood pressure) while three variables have been found out among the girls (heart beat frequency at rest, modified Harvard test and maximal oxygen consumption), - In the motoric domain an important influence has been found out only among the boys by one characteristic root amounting to 69% of the extracted variant (Can R%=69) at the level of significance of 100% (P=.00). What has been found out is the presence of 13 variables among the boys (coordination, segmentary speed, mobility of shoulders, hips and backbone, explosive strength of legs, running speed, strength of press of the left and the right hand, static stomach strength, repetitive strength of the legs and the stomach) as well as of 5 variables among the girls (coordination, agility, backbone's mobility, static strength of the arms and repetitive strength of the legs), - In the cognitive domain, an important influence has been found out only among the girls with one characteristic root amounting to 45% of the extracted variant (Can r%=45) at the level of significance of 100% (P=.00). An important presence is confirmed by all the three variables among the boys and girls (perceptive and symbolic reasoning and spatialization), - In the domain of connate dimensions an important influence has been found out only among the boys with one characteristic root amounting to 61% of the extracted variant (Can R%=61) at the level of significance of 99% (P=.01). An important presence has been found out of 6 variables among the boys (bravery, tension, affectomy, ego strength, carelessness and super ego) and of 5 variables among the girls (affectomy, bravery, tension, domination and radicalism-conservatism), and, - In the domain of the sociological personality dimensions no significant correlation has been found out either among the boys or girls. An important contribution has been given by 2 variables among the boys (father's activity in sports organizations and monthly wages) and by 4 variables among the girls (father's participation in sports organizations, mother's engagement in sports organizations, monthly wages, characteristics of the place that the mother comes from). By applying these results and especially those of the factor analysis (their cumulative contribution) in the success specification equation in the sports gymnastics the following indicators have been obtained: - Among the boys the contribution of the personality dimensions (DL) has been found out amounting to 43,34%, while of the objective factors (O) it amounts to 56,66%, and, - Among the girls the contribution of the personality dimensions (DL) has been found out amounting to 45,65%, while of the objective factors (O) it amounts to 54,35%. It can easily be seen that the percentage in defining success of the young athletes in both cases amounts to slightly more than 50% on the part of the objective factors. This further means that the success factors that are termed here as the objective factors must be worked upon more seriously; they refer to the conditions of work and competition, professional staff, material basis, referee staff, etc. By improving, that is, by bringing the above mentioned conditions to the highest possible level, it is possible to program with certainty the contribution of the personality dimensions to success in the sports gymnastics.

Key Words: *anthropological status, anthropological dimensions, psychosomatic status, integral development, personality structure, success specification equation*

1. INTRODUCTION

The universal progress of human society is already clearly related to developments in the physical culture, and especially in its representative part - the top sport. The

application of science in this domain of human activity has resulted in progress that is primarily reflected in the abilities of human organism. Therefore, science in the domain of sports increasingly takes on the direction of an integral observation of the athlete's personality (integral development), that is, of his bio-psycho-social *integrity*.¹

Since man can be said to represent a complex organizational dynamic and integration system, a multi-disciplinary approach must be applied to studying it. Thus it can be found out that the athlete's personality, on one hand, and the possibility of controlling the training process, on the other hand, both represent a specific challenge to science in sports. The contribution to highlighting these problems that spring from complex interactive relations within the system on the whole and between the system and its parts is an indispensable requirement to be met by science. The changes within these systems take place under the influence of the genotype, on one hand, and the phenotype, on the other hand as well as of particular factors whose degree of influence cannot be determined.

The changes within man (as a system) and his personality dimensions (as subsystems) lead to interaction changes that most immediately affect an effective control of the system.

Since the determination of particular personality dimensions is an extremely complex process primarily due to their hierarchical and poly-dimensional structure it is necessary to apply intricate mathematical-statistical analyses (factor, canonical and regression multi-variant analysis) both for the sake of identifying the dimensions and of determining their structure as well as of determining their relation to the success in a particular branch of sport.

The phenomenon of success in sport is related to the contribution of the anthropological dimensions² both on the lot and separately and thus it is the focus of interest of this paper.

2. MULTIDIMENSIONAL APPROACH TO THE STUDY OF SUCCESS IN SPORT

This approach should be applied in order to avoid an unpleasant discovery that often occurs in sports practice when, after many years of mutual exhausting work of the athlete and the coach, it must be concluded that the athlete who is engaged in a particular sports activity has failed to achieve top results in the competitive sense.

This discovery and especially the way in which it is made to the athlete both represent an everlasting dilemma that has caused disputes among research scientists and experts. Namely, their opinions differ regarding the fact that the coach's decision must not be inhumane in the sense that he "rejects" less able athletes, on one hand, and the fact that such an athlete should be removed as soon as possible from an unequal struggle for the place in the team. Among other things, this dilemma can be solved by an integral approach to the problem of determining the anthropological status first and then the contribution to sports success. Therefore, an integral approach represents a necessity.

¹ Malacko, J.: *Basis of the Sports Training*, 1982

² We have chosen to term them the anthropological dimensions, though they can be termed as psychosomatic and so on.

The theory about the integral development³ originated in the works of Charles Darwin (1868); the essence of its understanding lies in the basic assumption that “man is more than the sum of his parts”. Thus, as viewed by *Hall* and *Lindsay*, “the organism behaves as an entity, not as parts of a different entity”, that is, there is “a complex correlation between psychic and physical characteristics” (*Steinhaus*, 1964).

Sheldon (1970) stated in one of his works that “there is a parallel between somatic types and personality types, that is, that there are two closely connected structures, the physical and psychic”. On the other hand, *Gratty* (1964) shows that the physical activity only partially contributes to the personality clarification.

Since the basic factors of the human capabilities (and thus, of success in sports) are part of the philogenetic legacy, it is necessary to determine the ways of their discovery. On the basis of these discoveries it is necessary to program a selection for particular sports separately for the sake of forecasting final efficiency in a particular sports activity. It is indispensable to determine their structure that represents, regarding morphological, functional, motoric, cognitive, connate and sociological personality dimensions, an anthropological contribution to success in sport.

The part that is related to the personality dimensions (factor DL) represents an influence that is associated with the athlete as a personality; the part that occurs outside the training process and that is related to conditions, referees, training staff, material giving, etc. is regarded as the objective factor of success (factor O). Thus it should be said at the beginning that the approach to determining an anthropological contribution to success in sport is not sufficient in itself unless the other objective factors are also taken into consideration.

It is for this reason that the assumed multi-disciplinary research is used as an example by which, through the success specification equation, it is possible to show how to solve successfully the problem of the anthropological contribution (through the athlete's personality dimensions); thus it is possible to show other objective factors that cannot be experimentally proved.

2.1. ANTHROPOLOGICAL CONTRIBUTION TO SUCCESS IN SPORT

In the research done so far in the anthropological domain for the sake of defining it through anthropological dimensions no exact data have been obtained in order to make successful generalizations of the contributions to success in sport. There are many reasons for this; several of them should be pointed to such as an inadequate sample, practical research of one or two domains, a very small number of research projects that viewed sports success, from the standpoint of functional, connate and especially sociological dimensions.

Namely, almost as a rule, all the research projects are most frequently related to anthropometry and motorics; those projects that are available to the author do not treat this problem in an integral way in any sport.

Therefore, it should be made clear that when we speak about the specification equation of success in sport we refer to a *hypothetical equation*, since, as we have already

³ Ismail, A. H., *Integral Development*, Kineziologija, Zagreb, 1976 (No. 1-2, p.7-28)

pointed out, there has been no single study that would regard this problem by applying an analysis of all the personality dimensions. The success specification equation in sports contains all the primary dimensions of the anthropological status, while the significance of its influence is determined by individual contributions of all the subdomains. The already existing partial research of the contribution of particular anthropological dimensions of success in sport has given first attempt to determine the hypothetical success equation in sports. One of these attempts has been made in sports gymnastics shown as a theoretical model (Petković, 1989); on the basis of these results a graphic model of the mentioned equation is shown (Petković, 1994). Still, since there has been no integral approach, it is not possible to give any solution of this problem through the success specification equation in the form of a mathematical model.

This problem has been especially dealt with by K. Momirović (1971), B. Gustav (1981), J. Malacko (1982), D. Petković (1994).

On the basis of the assumption that all anthropological subdomains have been explored by applying the factor analysis we can propose a model of how to use the specification equation of success in sports in order to solve the problem.

To prove this in the mathematical form assumes that the sports model (Rs) in its most simple form is represented as a function of input variables (U) and a particular system (S).⁴

$$R_s = f(U, S), \quad (1)$$

Having in view the fact that all the anthropological dimensions in general affect success in sport the formal equation can be expressed in the following form:

$$R = a_1A + a_2F + a_3K + a_4Z + a_5G + a_6C + a_7M + a_8V + a_9S + a_{10}T + a_{11}O + a_{12}E \quad (2)$$

where a_1, a_2, a_3, \dots denote the coefficients of relative contribution of each particular dimension which makes up the sum of the anthropometric factors (A), functional capabilities (F), motoric factors (K), motoric data (Z), cognitive factors (G), connate factors (C), motivation factors (M), value system (V), sociological factors (S), training factors (T), objective factors (O) and error factors (E).

In order to simplify the problem the present specification equation can be shown in a somewhat simpler form (Petković, 1994):

$$U_s = adA + adF + adM + adG + adK + adS + O + E \quad (3)$$

where success in sport (U_s) is equal to contribution of the anthropological dimensions (ad), anthropometry (A), functional capabilities (F), motoric capabilities (M), cognitive capabilities (G), connate characteristics (K) and sociological characteristics (S). All of them together make up the personality dimensions that exclusively depend upon the athlete (DL) and those that are not related to the athlete, namely, the objective factor (O) and error in measurement (E).

$$U = Y + X = DL + (O+E), \quad (3.1)$$

It can be concluded that the specification equation of success in the sports gymnastics

⁴ J. Malacko, op. cit.,

is made up of two groups of factors.⁵ If these two groups of factors are denoted as Y, that is, X, respectively, then the equation can be viewed in its original form as:

$$Us = (adA+adF+adM+adG+adK+adS) + (O+E) \quad (3.2)$$

where success (U) is equal to the sum of the personality factors (Y) and the environment factors (X). Hence this equation can be also regarded as:

By applying the multi-variant analyses (factor, canonical), the obtained number of significant factors, that is, their cumulative contribution (cum %) already assumes error in measurement as well.

Thus the given equation can be transformed into the form that assumes that. $Y=DL$ which also includes error (E) as well as the objective factors $X=O$ including error in measurement (E).

It follows from this that success in sport is equal to:

$$Us=(adAe+adFe+adMe+adGe+adKe+adSe) + (Oe) \quad (3.3)$$

$$Y=DL= (adAe+adFe+adMe+adGe+adKe+adSe) \quad (3.4)$$

where

$$O=Oe= (OAe+OFe+OMe+OGe+OKe+OSe) \quad (3.5)$$

applied in the equation can be represented as:

$$Us= (Ae+Fe+Me+Ge+Ke+Se) + (OAe+OFe+OMe+OGe+OKe+OSe) \quad (3.6)$$

$$Us = (Ae+OAe)+(Fe+OFe)+(Me+OMe)+(Ge+OGe)+ \\ +(Ke+OKe)+(Se+OSe) \quad (3.7)$$

that is,

The individual contribution of each dimension tends, in its final form, to its maximal participation. If each contribution is then represented as an index 100, it follows that it is:

$$\begin{aligned} Ae+OAe &= 100 \\ Fe+OFe &= 100 \\ Me+OMe &= 100 \\ Ge+OGe &= 100 \\ Ke+OKe &= 100 \\ Se+OSe &= 100 \end{aligned} \quad (3.7.1)$$

It can be assumed from this that success in sport is equal to the sum of maximal individual contribution of the anthropological dimensions.

$$Us=100+100+100+100+100+100 = 600 \quad (3.8)$$

Thus we have obtained our answer to specification equation of success regarding the contribution of the personality dimensions and the objective factors of success in sport by making the left and the right sides equal ($600=600$).

⁵ As stated by Željaskov, C., 1978, these two groups are genotype (as inheritance factors) and phenotype (as habits of skill, empirically gained characteristics)

2.1.1. MATHEMATICAL MODEL OF THE SUCCESS SPECIFICATION EQUATION

Let's take an example of the contribution of particular personality dimensions to success in some sport - namely, sports gymnastics - obtained by the factor analysis giving the cumulative sum (CUM%): for anthropometry 65%, for functional capabilities 42%, for motoric capabilities 70%, for cognitive capabilities 42%, for connate capabilities 59% and sociological capabilities 51%; the contribution of the objective factors of each dimension can be calculated, namely:

$$U_s = (65 + O_{Ae}) + (42 + O_{Fe}) + (70 + O_{Me}) + (42 + O_{Ge}) + (59 + O_{Ke}) + (51 + O_{Se}) \quad (4)$$

If the assumed contribution in the equation is replaced by index values, then it is

$$\begin{aligned} O_{Ae} &= 100 - 65 = 35; & (4.1) \\ O_{Fe} &= 100 - 42 = 58 \\ O_{Me} &= 100 - 70 = 30 \\ O_{Ge} &= 100 - 42 = 38 \\ O_{Ke} &= 100 - 59 = 41 \\ O_{Se} &= 100 - 51 = 49 \\ U_s &= DL + O_e, \end{aligned}$$

then the personality dimensions can be represented as:

$$DL = 65 + 42 + 70 + 42 + 59 + 51 = 349 \quad (4.1.1)$$

which explains the first group of factors related to the contribution of an athlete; it represents the *anthropological contribution to success*. The other group of factors which is independent of athletes, namely, the one termed the objective factors, is represented as:

$$O_e = 35 + 58 + 30 + 38 + 41 + 49 = 251 \quad (4.1.2)$$

Success in sports gymnastics represents the sum of the two already mentioned groups of factors: $DL + (O+E)$ that in our case assumes the value $DL=349$ and the value $O=251$.

$$U_s = 349 + 251 = 600 \quad (5)$$

$$600 = 349 + 251 = 600 \quad (5.1)$$

Since it is necessary to plan each success in sports as the maximal one, that is, the one with 100%, it is assumed that:

$$U_s = 600 = 100\% \quad (6)$$

The need to express the result by means of percentage is based on the requirement that in this form it can be accepted by those for whom it has been prepared in the first place, namely, by athletes and coaches.

Since the anthropological contribution to success in sport (factor DL), on one hand, and the contribution of the objective factors (O), on the other hand, are, in our case, $U_s = DL + O$, it follows that

$$DL = 349: 600 \times 100 = 58,16\% \quad (6.1)$$

$$O_e = 251: 600 \times 100 = 41,84\% \quad (6.2)$$

We have obtained *maximal success in sport* which is equal to the sum of the contribution giving the personality dimensions and the objective factors.

$$100\% = 58,16\% + 41,84\% = 100\% \quad (7)$$

$$U_{sg}\% = 58,16\% + 41,84\% \quad (7.1)$$

Therefore, the results in the sports gymnastics in the given case can be explained by the contribution depending on the athlete which makes it the anthropological basis of success with 58,16%, while the rest of the contribution that does not depend on the athlete is regarded as the objective factor with 41,84%.

3. AS A CONCLUSION

Using the assumed contribution for each of the six anthropological dimensions we have obtained a mathematical form of the success specification equation which goes on being a hypothetical structure mainly because of the assumed results. Two global conclusions, however, can be drawn from this, namely:

(1) By applying the factor analysis on the determined cumulative contribution (Cum%) of the significantly extracted factors for each individual dimensions we have had an opportunity to explain, by means of the sum of individual contributions through the success specification equation, the role of the personality dimensions as an anthropological contribution to success, on one hand, and the role of the objective factors, on the other hand. (), and,

(2) Though aware of the fact that an integral approach to this problem is a very complex process, it should be expected that this type of research should be soon realized for a particular branch of sports. Only then will we be in the position to substitute the results in the above-mentioned way in the success specification equation in sport. This the above given hypothetical equation in its mathematical form will be completely meaningful and important. The hypothesis will thus become the reality.

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ANTROPOLOŠKE OSNOVE USPEHA U SPORTU

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Tokom izrade doktorske disertacije pod nazivom "Jednačina specifikacije uspeha u sportskoj gimnastici" (Todorovski, 1997) obavljeno je fundamentalno istraživanje sa ciljem ispitivanja uticaja antropoloških dimenzija na rezultate u sportu. Realizacija eksperimentalnog programa pod nazivom "mlade nade u gimnastici" bazirana je na bateriji od ukupno 71 testa za procenu: morfološkog (16), funkcionalnog (5), motoričkog (18), kognitivnog (3) konativnog (14) i

sociološkog domena (8), kao i 7 varijabli za procenu navika u kretanju u sportskoj gimnastici (samo 5 varijabli kod grupe koje su činile male devojčice). Uzorak je činilo 117 mladih sportista - učesnika takmičarskog sistema Makedonskog gimnastičarskog udruženja - (60 dečaka i 57 devojčica) starosti 8 godina iz 12 različitih gradova. Na ovom uzorku utvrđivani su individualni i opšti doprinosi faktora ličnosti na uspeh u sportskoj gimnastici (individualni primenom multivarijantne kanoničke analize - Can R% i opšti primenom faktorske analize kao kumulativnog doprinosa (Cum %) izdvojene varijable). Gore pomenuti doprinos faktora ličnosti (DL), kao jedan od antropoloških doprinosa, predstavlja rešenje prve nepoznate u jednačini specifikacije uspeha. Tako su stvoreni uslovi da se da odgovor na drugi deo problema - doprinos objektivnih faktora (O) na uspeh. Uspeh u sportskoj gimnastici je predstavljen u formi teoretskog, grafičkog i - po prvi put - matematičkog modela. Za utvrđivanje doprinosa pojedinačnih antropoloških dimenzija korišćena je kanonička korelaciona analiza na osnovu koje se došlo do sledećih zaključaka: - Važan uticaj u morfološkom domenu utvrđen je samo kod dečaka (Can R%=60) na nivou signifikantnosti od 95% (P=.05). Kod dečaka je utvrđeno značajno prisustvo 11 varijabli (visina tela, širina ramena i karlice, obim nadlaktice i podlaktice), dok je kod devojčica utvrđeno 6 varijabli (visina tela, dužina ruku i nogu, dijametar lakti, obim podlaktice i nadlaktice), - U pogledu funkcionalnih sposobnosti utvrđen je značajan uticaj samo kod devojčica (Can R%=34) na nivou signifikantnosti od 96% (P=.04). Kod dečaka je utvrđeno značajno prisustvo dve varijable (frekvencija srčanog rada u mirovanju i dijasoltni krvni pritisak), dok su kod devojčica utvrđene tri varijable (frekvencija srčanog rada u mirovanju, modifikovani Harvardov test i maksimalni utrošak kiseonika), - U motoričkom domenu utvrđen je značajan uticaj samo kod dečaka (Can R%=69) na nivou signifikantnosti od 100% (P=.00). Utvrđeno je prisustvo 13 varijabli kod dečaka (koordinacija, segmentarna brzina, pokretljivost ramena, kukova i kičme, eksplozivna snaga nogu, brzina trčanja, snaga stiska leve i desne ruke, statička snaga trbuha, repetitivna snaga nogu i trbuha), kao i 5 varijabli kod devojčica (koordinacija, okretnost, pokretljivost kičmenog stuba, statička snaga ruku i repetitivna snaga nogu), - U kognitivnom domenu, značajan uticaj je utvrđen samo kod devojčica (Can R%=45) na nivou signifikantnosti od 100% (P=.00) I kod dečaka i kod devojčica potvrđeno je značajno prisustvo sve tri varijable (perceptivno i simboličko rasuđivanje i snalaženje u prostoru), - U domenu konativnih dimenzija utvrđen je značajan uticaj samo kod dečaka (Can R%=61) na nivou signifikantnosti od 99% (P=.01). Kod dečaka je utvrđeno značajno prisustvo 6 varijabli (hrabrost, napetost, osećajnost, snaga ega, neopreznost i super ego), kao i 5 varijabli kod devojčica (osećajnost, hrabrost, napetost, dominacija i radikalizam-konzervativizam), i - U domenu socioloških dimenzija ličnosti ni kod dečaka, ni kod devojčica nisu utvrđene signifikantne korelacije. Utvrđen je značajan doprinos dve varijable kod dečaka (aktivnost oca u sportskim organizacijama i mesečna plata) i četiri varijable kod devojčica (očeva učešće u sportskim organizacijama, sportska aktivnost majke, mesečna plata, karakteristike mesta iz koga potiče majka). Primenom ovih rezultata, a naročito rezultata faktorske analize (njihov kumulativni doprinos) na jednačinu specifikacije uspeha u sportskoj gimnastici dobijeni su sledeći pokazatelji: - Utvrđeno je da doprinos dimenzija ličnosti (DL) kod dečaka iznosi 43,34%, dok, kada su u pitanju objektivni faktori (O), taj postotak iznosi 56,66%, i - Kod devojčica doprinos dimenzija ličnosti (DL) iznosi 45,65%, a doprinos objektivnih faktora (O) 54,35%. Lako se uočava da je postotak koji utiče na uspeh mladih sportista u oba slučaja nešto malo iznad 50% kada se radi o objektivnim faktorima. To dalje znači da se na faktorima uspeha koji su ovde nazvani objektivnim faktorima mora raditi ozbiljnije; to se odnosi na uslove rada i takmičenja, stručni tim, materijalnu osnovu, sudije, itd. Poboľšanjem, odnosno podizanjem gore navedenih uslova na najviši mogući nivo, otvara se mogućnost za uspešno programiranje doprinosa dimenzija ličnosti na uspeh u sportskoj gimnastici.

Ključne reči: antropološki status, antropološke dimenzije, psihosomatski status, integralni razvoj, struktura ličnosti, jednačina specifikacije uspeha.