MORPHOLOGICAL OPTIMISATION, OVERLAP ZONES AND SECULAR TREND IN SELECTION PRESSURES

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Summary
The concept of morphological optimization tends to give a answers to the questions on what makes the elite sportsmen successful. This is the reason that all those who professionally perform selection in sport must know in detail conceptual and methodological problems associated with defining morphological taxons. For selective procedures, the zone from the population which encompasses selective quantitative procedure is called the "Zone of catchments area" for that sporting group and differs from sport to sport. Setting in correlation two distributions it is possible calculate overlap surface of both. These zones are named overlap zones. Intersection of those two curves is defined by iterative procedure. For purposes of this article, it was body height analyzed as anthropometrical variable which subsumes all measures of longitudinal dimensionality of the skeleton. Knowing the coefficients for years (% increase of final height) using the fore-mentioned formula it is possible to perform primary selection with minimized error. Based on testing of psychomotor abilities, which are dominated by the genetic code, later, a secondary selection can be performed.

Key words: *morphology, optimisation, overlap zones, trends, waterpolo*

Conceptual and methodological problems
(in definition of morphological taxons)

The idea of morphological taxon is derived from an old idea of somatisch or constitutional type. The conception of somathotype is possible operated in a few different but also similar ways. Operationalisation of this idea is based on the fact that the relations of the different marks (signs) ar not equal in the different segments of human population. From this fact it is possible to identify morphological systems defined by different, and as a rule, with opposite intensity in the development certain groups of morphological characteristics, mainly those which defined general and specific skeleton development, quantity and the distribution of underskin fat tissue and quantity of active muscular mass. Because of the fact that the pregnant morphological forms we perceive more intensively that the forms which are expected and are therefore slightly different, the observation which shows (indicates) a large number of these forms is taken as a base for construction of several tipological theories (one of these, and to date, an actual theory was suggested by Kretchmer, 1921. (as per Lozovina, 1983). The second conception was suggested by Jardine & Gibson, 1971 (as per Lozovina, 1983). Operationalisation of this conception is based on the reckoning that the space bounded by the measures of the morphological characteristics can be divided on a final and relative small number of subspaces, defined by the zones of great density and relatively small volume, concentrated around such number of centroids on how much subspace is defined. It is reckoned that the zones defined with great density of points are separated with zones of low or null density. This recognition are equivalent to recognition based on the fact that the human population is possible over the morphological characteristics is divided on the relatively small number of distinct subpopulations. The centroids of these subpopulations in this conception are used as representatives of morphological types or morphological taxons. The third conception is related with reckoning that genetical factors somewhat have influence on the quantitative and qualitative different development of morphological characteristics and thus this fact defines constitutional types (Sheldon´s theory, 1939, 1954., as per Lozovina, 1983).All of taxonomical theories based on the reckoning an existence of distinct types are opponent to fact that in some way defined human population the system of morphological or at least anthropometrycal characteristics are multivariante normal distributed. Thus all anthropometrical dimensions are normal distributed or at least in a way which allowed their treatment as normal or quasinormal distributed variables.

The multidimensional hyperelipsoid defined by anthropometric measures in some population or somewhat representative sample from this population, it is not possible to divide on the smaller number of equally dimensioned hyperelipsoids which are enough distanced. The distinct taxons are not merely a form to define the general idea of taxons. The vectors of entities are possible to project on an arbitrary number of orthogonal or differently set vectors. It is possible to choose the kinds of vectors where extreme position on any end of any vector is related with projections near the center of any other chosen vectors. This conception is nominated as the "pollar taxon" theory and it is formulated in the works of Catell, 1966. (as per Lozovina, 1983)

The methodological problems
(related with definition of polar taxons)

These problems can be divided in several basic samples. The primary in relation with the types of data over which the taxonomical procedures are performed. The polar taxons can be defined over three types of data:

1. The data which can be, but not must be, standardized or transformed in any appropriate metric (for example: Harris metrics)
2. Taxonomic procedures over reckoning is that the anthropometric variables are commensurable and can possibly be performed over the original data (nonstandardized). Because of the anthropometrical measures (variables) are commensurable only for some segments of morphological space, it is necessary that all measures make commensurable with some operation for standardization. Very often the importance of anthropometrical variables is defined in the proportionality of their variability in a common space, or oppositely in proportion with their unique variance.
3. As a base for taxonomic procedure, it can be used in component which are transformed in some orthogonal or non orthogonal parsimonical system as a system of anthropometrical measures in the latent space. If the system is nonorthogonal it is appropriate to make some operations for orthogonalisation, very often under the criteria of minimal quadrants. The parsimonical system can be defined with any method which depends on general parsimax criteria, but enough in degree of simplification by skewed transformations and is derived by oblimin technique or by one of two standard types of ortoblique techniques.

The data over which taxonimical procedures are performed can be used in determining the measure of similarities or differences so that taxonomical procedures can be performed and over the transformed original data.

For this purpose, scalar products of vectors of entities defined in any metrics original variables, or transform in some suitable latent system. In those case on the results of taxonomical procedure has influence on qualitative and quantitative, by means of structural similarities or differences of entities. If the scalar product of standardised vector of entities, as a measure of similarity, is taken (for example: correlated coefficients between entities) impact on results of taxonomical procedure is given by structural but not quantitative similarity or differences. Determination of polar taxons based on function it is not usual, but is a possible procedure. Specific problem in taxonomical procedures is definition (allocation) a number of morphological taxons. The number of taxons can be predetermined, but only if regular theoretical foundation for this procedure exists. The valid theoretical conceptions which permit employment of these strategies are few. In an other case were the anthropometrical measures transformed in some metric is used as a base for taxonomical procedure, the number of taxonomical variables can be defined in accordance with criteria to assess a significance of principal components. Usually in this operation, the number of principal components with nonnegative coefficients of generalisability are the peak limit of polar taxon numbers. The number of rational polar taxons can be smaller than rational maximum, if the system of anthropometrical measures are adequately representative, it can be limited on the number which derives the variance in common, the image-space, of anthropometrical dimensions. Since the number of latent dimensions is defined by the number of significant principal components, the number of taxons defined on the base of latent anthropometrical dimensions, can be defined in a same way (equal). The problem to define a number of morphological taxons become complicated when the taxonomical procedure are based on the measures of distances. Then, with the number of taxons it is possible to define a minimal number of dimensions under which is possible to make some operation of multidimensional scaling.

Concept of morphological optimisation
The concept of morphological optimization pretends to give a answers to the questions on what makes the elite sportsmen successful. Anthropometrical measures directly defined shape, proportionality and composition of a sportsman body as well as defining the possible success in a chosen sport. By description of central and dispersive parameters of anthropometrical dimensions of sportsmen, it is possible to establish relative significance of any of those dimensions (Norton, & Olds, 1996; Lozovina, 1983, 2004.). Comparing the parameters of anthropometrical variables of elite sportsman with the same parameters of population, as well as parameters of elite sportsman mutual subpopulation,

it is possible to quantify the significance of body structure characteristics as well as functional direction of success in different sports. Comparison parameters of anthropometrical variables of elite sport subgroups with parameters of population enables successful procedures for primary selection in sport subgroups as a procedure for sport orientation, improvement and specialization. The secular trend is result-wise transfer in some anthropometrical dimension either towards zone of positive or negative results, during a ten year time span. Based on actual experimented measurements under the samples, which gave mathematical possibilities for generalisation, it is always possible to explicitly calculate a move in values. Usually the absolute move in values are expressed in coefficients. Secular trend in stature in different European countries is describe in figure 1.

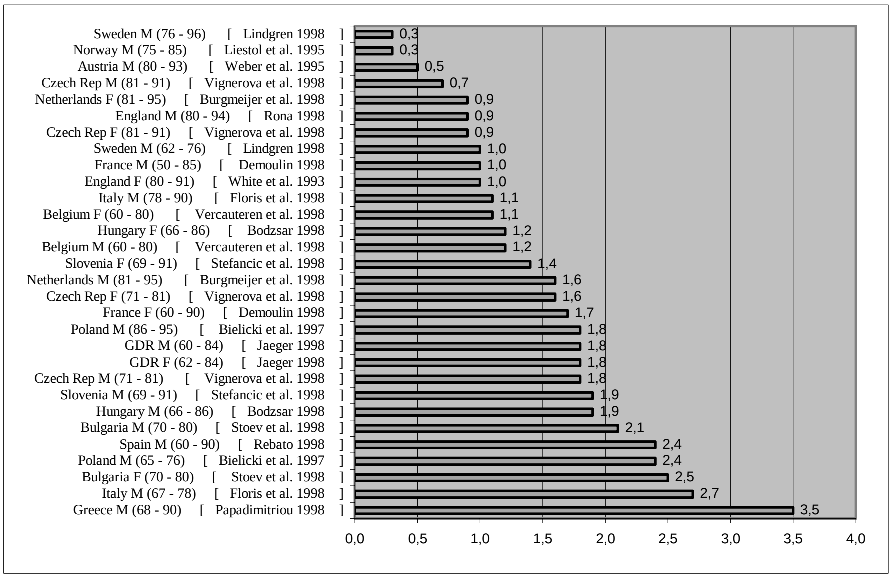


Figure 1. Secular trend (increment) in stature by adult (cm/decade) in different countries in Europe (source: 1-12, 16-25 as per Huspie-Verkautern 1998)

A group of sportsmen is drawn from a wider population as a "catchment area" for that sporting group. This wider population is termed "potential population for specific sporting groups". The potential population zone is specific and different from sport to sport and depend from parameters like a age, social-economical factors, etno-geographical factors and other factors. In potential populations the anthropometrical variables are normal or approximately normal distributed. Exceptional cases make some measures expected for detection of underskin fat tissue. Basic characteristics of anthropometrical variables of potential population and sports subgroups are represented by means and standard deviations. (μpop , δpop., μsport , δsport). All measures of longitudinal dimensionality of the skeleton is subtotaled in the anthropometrical variable HEIGHT. Since the skeletal system is dominantly under the genetic code, there is a small possibility to have an influence on it (it can be influenced by physical activites, proper nutrition, vitamin traffic, etc.) and during a specific period of growth but not after completed growth and development (21 to 23 years – women/men). "Canon" (the rule of proportional structure of the human body) biomechanics defines proportionality of longitudinal and transversal components of the skeletal system. Measuring the height as a longitudinal dimensionality of the skeleton, we have sensed about the transversal dimensionality of the skeleton, except when morphological aberration occurs. The body mass of sportsmen, which is mostly composed of soft tissue (muscle mass, underskin fat tissue and free fat cells), is of significant for sports results, and can be changed with training in the desired direction. After growth and development of the skeletal system ends, a regime of training can directly determine functionality, which under biomechanical laws is defined. Possible optimal biomechanical outputs are conditions for sports specialization and through it maximal achievements. All stated above is for reason why in sport primary selection is used based on prognosis of final height (after end of growth and development). It is important to know the model characteristics of sportsmen for which they are selected (height), which is the average height in the chosen sport in the year when selection is performed. With the known coefficients for years (average percent of final height, dr. Radovan Medved 1980. as per Lozovina, 1983), and a simple formula with direct measures in the selective period (7-9 years) can predict the final height after the end of growth and development with an error of 0,01.

PERCENT OF FINAL HEIGHT

Years of age	Boys	Girls
Newborn	28,6	30,9
1	42,2	44,7
2	49,5	52,8
3	53,8	57,0
4	58,0	61,8
5	61,8	66,2
6	65,2	70,3
7	69,0	74,0
8	72,0	77,5
9	75,0	80,7
10	78,0	84,4
11	81,1	88,4
12	84,2	92,9
13	87,3	96,5
14	91,5	98,3
15	96,1	99,1
16	98,3	99,6
17	99,3	100,0
18	99,8	100,0

Current measured height / coefficient for years x 100 = Predicted height (0,01)

In secondary selection, at the end of the cadet stage, we made a very simple and effective testing of speed and explosive strength. Both have a very high hereditary coefficient. We are developing other psychomotoric abilities which are noted during training, therefore, we do not test them. Low values in speed and explosive strength are impossible to correct with training and will not achieve maximum results.

The Overlap zones (OZ)

Quantification of indexes as a level of differences in the distributions of the anthropometrical variables between potential population and sport subgroups enables:

understanding the relative significance of different anthropometrical indicators, especially for formulating the hypotheses for biomechanics and psyhomotorical rationalisations

- considering for criteria creation for talent identification
- facts about the evolution of anthropometrical dimensions during the time as a indicator of a changes in potential population
- partial contribution in a changes conditioned by rule-changes and by nature of different sports
- comparative access and difference setup in populations subgroup (male-female, sport categories with different achievement)
- early and timely selection, sports orientation, improvement and specialization.

Two distributions are mutually different insofar as their means are mutually secluded and in case when the standard deviation (variability) of one is significantly different from the other. Setting in correlation two distributions it is possible calculate overlap surface of two distributions.

These zones are named overlap zones. In the research of Reilly, 1990; Withers, Craig, Bourdon & Norton, 1987; Foley, Bird & White 1989; Tittel & Wutscherk, 1992.; Withers, Craig et al., 1987; and Stepnicka, 1986 (as per Norton & Olds, 1996), are placed in a relative height of the potential population and sporting population (soccer, pursuit cycling, AFL players and discus throwers). They found various distribution of sport groups with various intersections of curves of the general population and various overlap zones as shown in Figure 2.

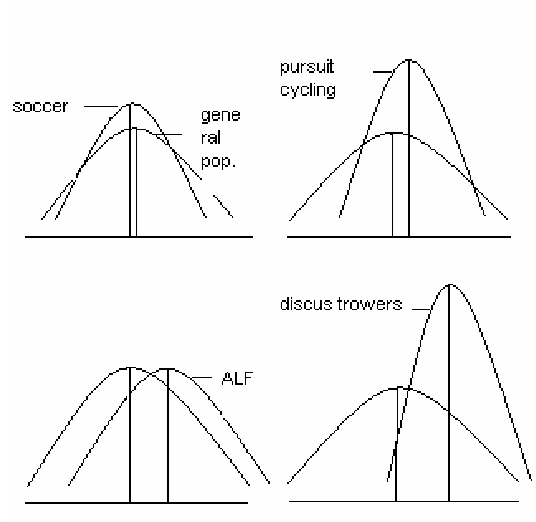


Figure 2. Various distribution of sport groups with various intersections.

The equation of normal distribution describe probable distribution somewhat anthropometric variable A for somewhat sports subgroup with mean μsport and standard deviation δsport:

$$p_{sport}(A=X) = \frac{1}{(2\pi\delta_{sport})^{1/2}} \exp \frac{\left[-\frac{X-\mu_{sport}}{}\right]^2}{2}$$

Analogously, equation with normal distribution describe the distribution of variable A in potential population with mean μpop and standard deviation δpop.

$$p_{pop}(A=X) = \frac{1}{(2\pi\delta_{pop})^{1/2}} \exp \frac{\left[-\frac{X-\mu_{sport}}{\delta_{pop}}\right]^2}{2}$$

Intersection of those two curves is define by iterative procedure based on the exact measured values of the variables A, psport and ppop. Calculated intersection points is possible to convert in z-scores (z=(X – μ)/ δ). Determination of the area under the curves can be calculated with the use of computer programs or using a standard statistical table.

Evaluate overlap zones (OZ) can have theoretical rank 0 (when overlap does not exist) to 100 (when totally overlaped). The values of OZ are specific for anthropometrical variables and brings in relation the sports subpopulation with potential population. The parameters of sport subpopulation must be calculated over the experimental measured variables on the representative sample. The primary selective procedure can be execute if the parameters of anthropometrical dimensions of population as well as parameters of sport subgroups are known. To regret, the data for anthropometrical dimensions of Croatian population does not exist (at least not in recent investigations), and a similar situation is with the sport subpopulation. Height as a anthropometrical variable (measure) represented longitudinal dimensionality of a skeletal system and it is extremely important in sport and is presented as fundamental information for primary selection. In the case that we know central and diverse parameters of this anthropometric variable (height) of a sport subgroup (for example water polo players) as well as parameters of population, it is possible to calculate an area in the population from which is possible make a selection. The parameters of a population in which have not determined exact measurements is possible to reconstruct on the basis of older data with given limits. Considering in relation of distribution of height of the potential population and sports subgroups (water polo), the intersection of the two curves can define the overlap zone and the exact percent from the population that can be primarily selected in water polo. The first problem we encounter is that the same persons fit the criteria to be selected into other sports (handball, volleyball, rugby, rowing, etc.) which significantly narrows and directly limits the selective base. The second problem is that the selection is made from the area of children between the ages of 9 to 11 years old. It is necessary to recognize the curves of development for this age group because in the opposite case, the prognosis of the final height after growth and development has finished, is prone to large errors. Other various limits exist in the potential population which include geographical, socio-economical, lifestyles, nutritional, sanitary situation, and social stratification. Known and calculated increased coefficient on the anthropometric variable HEIGHT for the world's population

K=1,22/10g., K =0,61/5g., K=0,122/1g

Population of SFRJ (Kurelić et al, 1975.) μpop = 172,1 δpop = 6.5

< 172,1 – 2 . 6,5 ; 172,1 + 2 . 6,5 > = < 159,1 ; 185,1> sig 0,05 <172,1 – 3 . 6,5 ; 172,1 + 3 . 6,5 > = < 152,6 ; 191,6 > sig 0,001

Reconstruction of standard deviations: if for the Croatian population as a part of ex-SFRJ population is of value: pά { 172,1 < X < 172,71 }

if an increase for a 5 year period is 0,61, then 172,1 + 0,61 = 172,71

p = (0,094) = 0,03586 or 3,586% which defines significance on the level 0,96414 or 0,001

A water polo players δ (standard deviation) in 15 years has decreased for 0,1 (from 5,4 on 5,3 measured and calculated) 5,4 . X = 5,3, = 0,98145 or 0,1962962% for 1 year

0,1 / 15 = 0,0066 (for 1 year)

1 year = 0,0066, 5 years = 0,0333 ≈ 0,983, 10 years = 0,066 ≈ 0,966.

The same conditions are valid for a population whose constituent are water polo players. Reconstruction and calculation of Croatian population based on data from 1975 and Australian population based on data from 1992.

	CROATIA (pop) μ	δ	AUSTRALIA(pop) μ	δ
1975	172,10	6,50	------------	
1980	172,71	6,50 * 0,983 = 6,34	176,53	7,14
1985	173,32	6,34 * 0,983 = 6,28	177,14	7,12
1990	173,93	6,28 * 0,983 = 6,18	177,75	7,10
1995	174,54	6,08	178,36	6,97
2000	175,15	5,98	178,97	6,85
2005	175,76	5,88	179,58	6,73

WATER POLO PLAYERS

	M	δ
1980	185,70	5,40
1985	186,93	5,37
1990	188,16	5,34
1995	189,40	5,30
2000	190.60	5,27
2005	191,87	5.24

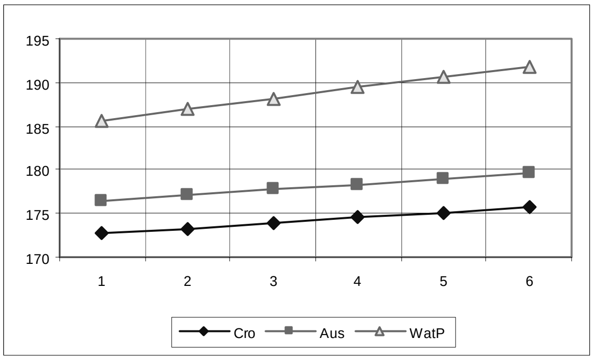
In the period of 15 years, water polo players height, on the average, increased 3,7 centimeters, or 0,246 centimeter per year.

1 year ------ 0,246 centimeters
5 years ------ 1,233 centimeters
10 years ------- 2,46 centimeters
15 years ------ 3,7 centimeters

Height, Cro, Aus, and Wat

year	Cro	Aus	WatP
1. - 1980	172,71	176,53	185,70
2. - 1985	173,32	177,14	186,93
3. - 1990	173,93	177,75	188,16
4. - 1995	174,54	178,36	189,40
5. - 2000	175,15	178,97	190,60
6. - 2005	175,76	179,58	191,87

Figure 2. Trends



Based on the experimental base of water polo subpopulation, in a period of 10 years, the increased coefficient of height was 2,4 centimeters. At the same time, the potential population increased coefficient of height was 1,22 centimeters. Is the absolute 2,4 centimeters of water polo players in relation with absolute 1,22 centimeters by the potential population different or relatively same? Graphic illustrations of curves show absolute differences but relative similarities in secular trends of population and subpopulation of water polo players.

The base for determination of somatotype is given by orderly performed anthropometrical measurements. Large number of anthropometrical measures, measured on the representative sample, will depict a hyperelypsoid with so much dimensions as how much anthropometrical measures are measured. This procedure can be execute on the population as well as on the sport subpopulation. Analogously calculating the overlap zones for single anthropometrical variables, the same procedure is possible to apply in the hyperspace of anthropometrical variables.

Logically procedures, which gave direct usefulness, are determination of relative importance every of anthropometrical dimensions (exactly measured) in any sports activity. Regressive analysis is the best for resolving these requests. Determination and explanation of significance any of (single) anthropometrical variables are very important and gave most subtle solutions since those which are given over structures. It is necessary to measure anthropometrical dimensions as recommended by IBP, and using more variables if possible which gives possibility to use every method to define the somatotype. Definition of somatotype is always a second plan operation.

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MORFOLOŠKA OPTIMIZACIJA, ZONE PREPOKRIVANJA I SEKULARNI TREND POD PRITISKOM SELEKCIJE

Sažetak
Koncept morfološke optimalizacije trebao bi dati odgovore na pitanje što sportaše čini uspješnima. To je razlogom da svi oni koji se profesionalno bave selekcijom u sportu moraju detaljno poznavati konceptualne probleme povezane s određivanjem morfoloških taksona, kao i metodološke probleme povezane s istima. Kod selekcijskih postupaka, zona iz populacije koju obuhvaća selektivni kvantifikacijski postupak naziva se "zonom potencijalne populacije" i različita je od sporta do sporta. Stavljajući u odnos dvije distribucije dobivene kod dva uzorka, moguće je obračunati površine prepokrivanja obiju. Ove zone nazivamo zonama prepokrivanja. Intersekcija dviju krivulja određuje se iterativnim postupkom. U primjeru je analizirana visina tijela kao antropometrijska mjera u kojoj su subsumirane sve mjere longitudinalne dimenzionalnosti skeleta. Poznajući koeficijente za godine (% prirasta od konačne visine) upotrebom navedenog modela moguće je izvršiti primarnu selekciju s minimiziranom greškom. Na osnovi testiranja psihomotoričkih osobina, koje su dominantno pod genetskim kodom, naknadno, izvrši se sekundarna selekcija.

Ključne riječi: *morfologija, optimizacija, zone prepokrivanja, trendovi, vaterpolo*

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