WHAT KIND OF APPROACH TO SOMATOTYPE DETERMINING IN KINESIOLOGY?

Mislav Lozovina¹, Vinko Lozovina¹ and Dobromir Bonacin²

¹ Faculty of maritime studies, University of Split, Croatia
² Faculty of Education, University of Travnik, Bosnia & Herzegovina

Abstract

The aim of this paper was to determine actual systematic position for human morphological definitions. It is well known that such a job is very serious and even more complex. So, first of all we have to rearrange basics, include all possible significant ideas and try to reach frontiers in this complicated area. We are in that work app. 30 years, and still are looking for new universal concept. We hope this article will help others to establish strong and sustainable concept, a theory for better praxis and transformation processes.

Key words: morphological characteristics, somatotype, kinesiology, conceptual approach

Introduction

In kinesiology are particularly significant problems relating to the relationship between morphological and psychomotor characteristics because it is the foundation on which rests the practical application of kineziological knowledge in the areas of education, recreation, physical training, and agonistics. In each kinesiology activities in terms of the work involved all psychomotor performance in various mutual ratios are responsible for the implementation of energetic components (ultimately measured with mixture of anaerobic-aerobic capacity) and information components (efficiency techniques tactics and strategy) in a given activity.

In relation to the IT component, and for the efficient performance of all the techniques that are operational tactics and strategies in a sport, coordination is ultimately responsible for the proper and orderly execution of the required movement structures. There are no movement structures, even if it consisted of a single movement, which is not influenced by a complex mechanism for the regulation of complex motion. These mechanisms are described in Hošek (1972), Kurelić et al. (1975), Viskić-Stalec (1974) and Hošek-Momirović (1976) and define them as: a mechanism for regulating the movement or in the narrow sense of a mechanism for structuring movements. For complex integrative and coordinating function responsible array of devices are located cortically and sub-cortically in the CNS, which allow effective psycho-motor response to a specific stimulus or in accordance with ones intention. Coordinating function of the CNS and the visual decoding, analysis and transformation of information in an optimal kinetic structure will become less effective if there are disturbances caused by inappropriate structure of effectors system.

If the ability to zone CNS (as by Bernstein, Anokhin and Čhaizde) be defined as external and internal control circuit optimally developed disturbances caused by inappropriate characteristics effectors system, it is possible to incorporate such information element in the system for analysis and transformation which will certainly produce the most efficient kinetic output. However, the complex structure of effectors system in different kinetic situations will produce so many different noises that it is virtually impossible to identify all information at the same time and in a very short time to integrate the appropriate kinetic programs. In doing so, the biggest obstacle produces exactly morphology effector system that is in its functional definition directly subordinate to biomechanical principles, which provide a maximum of precisely aligned with the morphological structure of the body. As the biomechanical principles by definition and in all cases constant, are the most efficient implementation of the kinetic program it is always directly caused by the efficiency and flexibility of control devices and their ability to identify and absorb the information emitted by the morphology effectors system as the data that needs to be integrated into the final output program.

Complete neutralization of noise produced by the morphological structure is not possible while the kinetic programs, which can not always be in absolute agreement with the movement patterns which is influenced by the morphological structure of the body, need to be the closest to appropriate biomechanical solutions. Coordination in the literature is defined as the ability to effectively solve complex psychomotor problems and so has the meaning defined as motor intelligence (Fleishman, 1946). Similarly, in terms of intensive interactive relationship between cognitive and motor skills, coordination, interprets and describes Mejovšek (1976).

If this is true, it is possible to assume that people with near equal intellectual abilities may differ in structure and level of coordination abilities, because as the generator of these differences appear different morphological structure of effectors system that influenced biomechanical laws and produce different kinetic effects. While the motor dimensions in a situation of one type of body structure can directly interfere with the realization of the same angular physique, in another situation, the motor dimension can be extremely favorable. Hence arises the need for defining and analysis of morphological complexes present in each sport activities especially as subsets of the population from which they are drawn and selected in the activity in which they are located.
Conceptual problems associated with the determination of morphological taxons

The concept of morphological taxons is derived from the concept of somatic or constitutional type. The concept of somatotype is to be operationalized in several different ways. The most commonly used operationalization is based on the assumption that relates different characteristics are not the same in different segments of the human population and that it is therefore possible to identify morphological structures that are defined in different rule opposite intensity development of specific groups of morphological characteristics and those related to general and specific development skeleton, the amount and distribution of body fat and the amount of active muscle mass. A 'pregnant' morphological forms are experiencing significantly more intense than poorly differentiated, which are generally closer to the expected, in the creation of the theory of observation and is taken as the basis for the construction of various constitutional and typological theories including Kretschmer (1921) a long time been used in anthropological research. Very similar concept, which can be operationalized, and much closer to the notion of type or taxons, common in biological taxonomy, is offered by Jardine and Gibson (1971). Their operationalization of the concept of morphological types was based on the assumption that the area bounded measures morphological characteristics can be divided into a relatively small number of subspace defined existence of zones of high density and relatively small-scale concentrated around such a large number of centroid how many so defined subspaces, where the zone defined by a large density points separate zones of little or no density. Such logic is equivalent to the logic that is based on morphological characteristics of human populations can be divided into a relatively small number of distinct subpopulations. Centroids of these subpopulations are treated as represents of morphological types or morphological taxons.

Sheldon (1939; 1954) offered following concept of defining morphological types or taxons based on the logic that some genetic factors influence the quantity and quality differentiated development of morphological characteristics and that it is therefore acceptable to the concept of constitution and it is derived from the concept of constitutional type. Each taxonomic theory is based on the assumption of the existence of distinct types of collision (conflict) with the fact that in no matter how defined human population morphological system is or at least the anthropometric characteristics are multivariate normally distributed, and therefore all the anthropometric measures are normally distributed or distributed so as to allow to treat them as if they were normally distributed. Multidimensional hyper-ellipse that define anthropometric measures of a population or a representative sample of it, in any meaningful way is not possible to divide in the smaller number of equally dimensioned hyper-ellipse that are mutually far enough . That is why it is not possible to accept the classical notion of morphological type. Distinct taxons are not the only form that can be reduced to a general concept of taxons . Vectors of entities can be projected onto any number of vectors, orthogonal or placed in any other suitable relationship.

This means that it is possible to choose such vectors so that the extreme positions on either end of any of them associated with projections close to the common origin of all the other so selected vectors. This concept is known as the concept of polar taxons defined in the work of Cattell (1966) and is close to Sheldon’s understanding of the fundamental constitutional variables, and is acceptable for real properties anthropometric variables.

Methodological problems associated with determining the morphological taxons

Except for classic indirect taxonomic procedures, based on the functions of distance or similarity, which is the purpose of the separation of a set of entities on a number of distinct subsets, methodological problems associated with the determination of polar taxons can be divided into several groups.

Problems associated with the type of data on which to perform taxonomic operations

Polar taxons can specify operations over three types of data. The simplest way to determine the polar taxons is to act on the data obtained by measurement. The analysis can enter as raw, standardized or transformed into a suitable metric (transformation into image or Harris metrics). If the overall variance is significant for determining the morphological taxons and if expected to be measured by units which are expressed anthropometric measures important for defining taxonomic circuits and if it is expected that the anthropometric dimensions are commensurable (standardized and measurable) taxonomic data analysis procedures are best performed over the original non-standardized data. As the anthropometric variables commensurable only for some segments of morphological space, it is necessary to do some operations of commensurable standardization. Sometimes it is useful to apply anthropometric measures given to the importance of which is proportional to their variance in the common area and inversely proportional to their variance in 'unique (anti-image) space in order to avoid ' unique variance of the measures involved in the formation and morphological taxons made representative in the universe of morphological characteristics.

In the first case it is reasonable to transform data to standardized and sometimes non-standardized variables in image form, and the second is to transform anthropometric variables into Harris form which eliminates the problem of the original units. Often anthropometric variables have special significance for the determination of morphological taxons. In these cases, the variables obtained by measurement have to be transformed into a suitable system of latent anthropometric dimensions. Number of such transformation is unlimited. As a suitable system of latent dimensions of which are performed taxonomic procedures, can be used a principal components system whose number is based on estimates of their generalization, their representativeness and the actual dimensionality of latent space. These components can be derived from standardized and non-standardized measures, transformed in the image or Harris form and as such commonly can not be treated within concepts of polar taxons.
As a basis for taxonomic procedures it may be used the components transformed into a suitable orthogonal or orthogonal parsimonic system as a set of anthropometric measures in latent space. If the system is un-orthogonal, dimensions have to be executed by the subsequent orthogonalisation, usually by least-squares. Parsimonic system can be determined on the basis of any methods belonging to the generalized parsimax criterion and sufficient degree of ease when oblique transformation achieved from oblimin technique or one of two standard types of orthoblique techniques. In varimax orthogonal transformation there are the most of the group orthomax procedures. Factor values obtained by conventional factor model because of its indeterminanost are not suitable for taxonomic procedures. Details of which are performed taxonomic procedures can be used to determine the measure of similarity or distance between the entities. Taxonomic procedures can be applied over so transformed the basic data. Among the similarity measures for taxonomic purposes may be used scalar product vector of entities defined in any metrics of original variables or defined after transforming the original data into a suitable system of latent dimensions. If such similarity measures apply using scalar products of standardized entities vector (correlation coefficients between the entities) on the outcome of taxonomic procedures will affect only structural but not quantitative similarities. Determination of polar taxons based on the distance function is not normal procedure but such approaches are possible. As a measure of distance is usually taken Euclidean spaces or Mahalanobis distance between the entities, but this distance can be expressed in another $L_1$ metric. As a measure of distance can be used coefficients similarity profile, metric distance function, or any other measure suitable for this purpose (Momirović, 1972).

The problems with number of taxons definition

Number of taxons can be fixed in advance if there is a valid theoretical basis but on the basis of information obtained by previous research which is little, it is not likely. Valid theoretical concepts which permit the implementation of this strategy has little even when taxonomic procedures applied to the data that belong only to the segment of morphological space. The problem of determining the number of polar sensitive taxons in each taxonomy is because a solution depends on the nature of data on which to perform taxonomic operations and mathematical models lay in the basis of which the taxonomic algorithmic procedures are prepared. When used as a basis for determining taxonomic operations of anthropometric measures, transformed into any metrics, number of taxonomic variables is defined according to the criteria for assessing the significance of the main components of which may be severe or less severely penalizing. Since it is not reasonable to produce more taxonomic variables than there are major components with non-negative coefficients of generalizability, the number of such components is also the upper limit of the number of polar taxons. Reasonable number of taxons may be lower if the sample is representative in anthropometric dimensions space, or sufficient because then the possible number of taxonomic variables limited to as much as is sufficient to exhaust the variance in common (image) space.

Dimensions simply exhaust real variance in joint subspace of original anthropometric dimensions and those dimensions are transformed in image form. As the number of latent dimensions determined by the number of significant principal components, the number of species on the basis of certain latent anthropometric variables can be determined in the same manner. As the eigen-values of the matrix of scalar products of entities equal eigen-values of the matrix of scalar products of the variables, the same procedure to determine the number of morphological taxons can be applied when the similarity measures base to perform taxonomic operations. The problem of determining the morphological taxons becomes more complex when the taxonomic operations conducted over the distance measures. In this case the number of species is defined as the minimum number of dimensions along which one can perform some operations of multidimensional scaling (Sziovica, Momirović, Hošek, & Gredelj, 1972).

Problems associated with the choice of an algorithm to determine the taxons

Problems of determining any and any type of taxons are generally not realized at the level of the algorithm at all, for the simple reason that the algorithm is contained already prepared a logical concept that is implemented in the chosen method of determining types regardless of mathematical procedures, or a mathematical procedure is already integrated into the logic of polar taxons. However, although at first glance the foregoing logic polar taxons is viable, it also holds the germ of inconsistencies, because the assumption of real existence of ellipsoid or hyper-ellipsoid data, already in the beginning it is clear that the ellipsoid is "stretched" by the prolonged axis, which means that it is "stretched" the whole set of any kind of data collected, and then it does not mean anything other than polarization, or in terms that we are interested in - precisely distinct taxonomization, regardless of whether or not a full set is - hyper-normally distributed. On the other hand, the polarization in the set of normally distributed data (a latent dimensions such still are) very seriously brings us into question any consideration of possible distinct position taxons, and thus of course, to the question of their existence at all. Having said this it is clear that the problems of universal taxonomy are not resolved, and that such problems do not belong to informatics area et al.

The results of some recent studies of morphological types (historical overview)

According to the authors (Albonico, 1970; Lozovina, 1983 ), the first attempts to classify people into constitutional types dating back to the distant past. So Hypocrate (460-390 BC) hypothesized the existence of four structural elements in the structure of the body of a man whose qualitative variations in people differ from one another. Galen, developing Hypocrates hypothesis based on the domination of one of the existing elements, forms a theory that there are four temperaments (sanguine, choleric, phlegmatic and melancholic). Halle and Rostan (1826) on the basis of its own anthropological study hypothesized the existence of constitutional types, which are called: vascular, muscular and nervous. From these early beginnings to the present in the literature can be found numerous and very different
types in the same anthropological space, depending on the criteria on which they are based. So there are many social, phyletological, psychological, morphological and within the latter sports and psychomotor. In his work "Mensch-Münschen typen" Albonico (1970) provides a vertical view the most significant effort to determine the morphological types from the beginning until today. Here we should mention just a few of these studies have historical significance, and which provided the largest contribution to the scientific study of these problems. Research of Siguada (1908) and his followers Chaillon and Mc Aulifa, whose common view that the only external environment main generator forming the constitution and not hereditarily, as claimed by most other authors, has resulted in work in which the authors distinguish four basic types of relative to the dominant muscular, respiratory, gastrointestinal and cerebral systems by defining them as: 1) tipus muscularis - developed limbs, a large mass of skeletal muscles, triangular face with a vertical as well as the long side, the approximate equality between the upper (cerebral) medium (respiratory) and lower (digestive) fuselage, 2) Tipus respiratorius - diamond look middle part of the face, long and wide nose, protruding eyeballs, trapezoidal shape of the hull (with a base turned above), wide and broad chest with sharp epigastria angle, poorly pronounced belly, 3) Tipus digestivus - prominent belly, short and wide chest with a blunt epigastria angle, conspicuously developed lower segment faces; 4) Tipus cerebralis - whole body gives the impression of slimness, developed forehead, triangular face (with the base facing up) It is difficult to discern why these authors attribute their constitutional types of exogenous origin when the basis of their analysis is skeletal construct, which is not and can not deny hereditarily. The next author who deserves to be ranked with history important persons is Kretschmer (1921) who classified its types, at reasonable, easily and what is most important, by measurable criteria. He distinguished three basic types, 1) Ektomorph type characterized by a strong skeleton, long and slender neck, narrow chest, long limbs with a thin muscular - developed limbs, a large mass of muscularis - developed, 2) Mesomorph type characterized by a strong skeleton, developed and strong muscles, a well-developed and strong limbs, broad thorax and relatively narrow pelvis. Picnic type is defined with pathological personality traits, it talks about dysplastic type. It is obvious that he is an author who takes into account both the skeletal, muscular and adipose components, and for this reason it have today many respects. As defined by the pure types, Kretschmer connects them with some psychological dimensions. Connecting them with pathological personality traits, he talks about schizoids at leptosomes, and cyclothymics in picnic types. With regard to mental illness suggests a greater likelihood of schizophrenia in leptosome types, genuine epilepsy in athletics and maniacal - depressive states in picnic types (Lozovina, 1983). Leptosome type is characterized by considerable longitude body, long limbs, a narrow chest, and a long and thin muscles. Athletic is defined by a strong skeleton, developed and strong muscles, a well-developed and strong limbs, broad thorax and relatively narrow pelvis. Picnic type is defined with poorly developed structure, weak to moderately strong muscles, a relatively wide pelvis, a considerable body weight, thick neck, short, wide and thick trunk with a pronounced belly and short and thick limbs. Athletic is characterized with trapezoidal shape of the hull, broad shoulders and a relatively narrow pelvis, extremities that are appropriate with large hands and feet and a powerful muscle relief of entire body. The author, whose work is also very important is Conrad (1941), who attempted to establish the principle factor that underlies the formation of constitutional types. Starting from the premise that there are certain, probably genetic, the criteria for the formation of different constitution, the author has created three theories in which there are possible standards of growth and development of the body, or primary, secondary and tertiary options for forming types: 1) The theory of the primary variant unites two different growth trends: a) conservative tendencies of growth relates to the types in which the growth and development resulted in a relatively small proportional shifts during development, when in adulthood retained body proportions from early childhood (infantile form). The same trend is evident in both psychological maturity of this type whose character set defined primeval innocence, simplicity, immediacy and sociability, and b) The progressive tendency of growth is defined types whose development is accompanied by a relatively large proportional shifts with finite strong deviation in the form of the body from the physical form of a child. Character structure of this type is marked as shisotic and means guys who are focused on the analysis itself. Conservative trend growth with morphological point of view the author identifies with pico-morph guy, a progressive tendency to increase with leptomorph type; 2) The theory of secondary variants unites the two tendencies of growth that occur independently of the primary variants and are defined as: a) type with hypoplastic tendency of growth corresponding asthenic type of which is characterized by a short beard, pulled inward, poorly expressed the frontal lobe, narrow shoulders, bent back, poorly formed end parts of the limbs and a relatively low height. With this type it is possible to perceive the presence of the conservative tendencies of growth, b) type with hyperplastic tendency of growth suits Kretschmer's athletic type. With this type we can notice very prominent frontal lobe, a strong shoulder girdle, chest with sharply pronounced epigastria angle, a relative lower height. With this type it is possible to perceive the presence of the progressive tendencies of growth, c) type with hyperplastic tendency of growth suits Kretschmer's athletic type. With this type we can notice very prominent frontal lobe, in contrast to its rear, broad shoulders and a relatively lower height. Such a structure, according to the authors, based on increased impetus to growth, that type occurs after puberty in those areas at that time and still allow for the possibility of growth. It refers to the skeletal and muscular system; 3) The theory of tertiary variant refers to pathological changes that accompany the growth and development of the body and result in dysplastic and dismorphic type (Lozovina, 1983). Entirely new principle in the study of constitutional types introduced Sheldon (1939), started from the hypothesis that certain organ systems, as well as branches of three developmental sheets (endoderm, ectoderm and mesoderm) show different trends of growth and development. According to the dominance of one of the three components, it is possible to distinguish three types: 1) Endomorph type characterized by the curvature of the contours of the body, a considerable body weight, short and thick neck, broad torso, expressed fat especially in the belly, short and thick limbs, 2) Mesomorphic type characterized by a strong skeleton, developed and powerful muscles, long and muscular neck, wide and protruding chest, narrow waist, strong extremities and well developed, 3) Ektomorph type characterized by high growth, slim physique, broad forehead on a small face, pointy nose, long and slender neck, narrow chest, long limbs with a thin and graceful musculature. 107
Since most people represent a combinations of endomorph, mesomorph and ektomorph type, Sheldon has developed a labeling system of mixed types with three numbers that vary 1-7, the size of which speaks of the presence of each of the three basic characteristics of the type. Number 1 indicates the absence of the appropriate characteristics of type traits. Numbers 2-7 are saying about the appropriate level of quality. Markers like ‘7 -1- 1’ indicates a person of pure endomorphic type, ‘1-7-1’ pure mesomorph type, and label ‘4 -4-4’ person pure mixed type. Aware of the high interconnectedness of morphological characteristics, which on the basis of the embryonic origin of the projects a three-dimensional coordinate system, Sheldon becomes the initiator of a new approach to typology. His hypothesis is that virtually no real clean guys who would by definition exclude the presence of other types of structural elements of the beginning of the idea of continuous multimodal distribution structure morphological dimension. Based on the theory of the existence of Sheldon endomorph, mesomorph and ektomorph type Brozek (1950) has been thoroughly elaborated labeling Sheldonovitl types and set out the criteria for morphological structure of individual parts to the labeling system that could even declare endomorph, mesomorph or ektomorph. The whole body is examined by the author in five regions: a) head and neck, b) thoracic part of the trunk, c) arms shoulders and hands, d) abdominal part of the hull , and e) legs and feet. For each of these regions the author stated detailed characteristics (Lozovina, 1983). Somatotyping techniques are used to assess body shape and composition. Somatotype is defined by quantifying shapes and composites of the human body and it is expressed with three figures represent endomorph, mesomorph and ektomorph component, always in the same order and it evaluates each component. Ratings 3-5 are moderate and considered to be low, 5 ½ to 7 are high and 7 ½ and over are very high (Carter & Heath, 1990). The rating is based on phenotypic characteristics and the concept of the geometric proportion of the human body, and the technique is applicable to both genders from children to adulthood. Heat- Carter somatotyping is today the most widely used method. There are three ways to determine the somatotype: 1) Anthropometric method, in which anthropometry is used to evaluate the criteria somatotype, 2) Photoscopic method, in which the marks are made on the basis of standardized photographs, and 3) Anthropometric plus Photoscopic (combined) method, which combines anthropometry and ratings of photographs.

Measurement techniques
Ten anthropometric variables are needed to calculate the anthropometric somatotype: height, body weight, four skin folds (triceps, subscapular, supraspinale, medial calf), two of the bones (humerus and femur bicipicondylar) and two on the scope of the extremities (arm flexion and relaxed recumbent). Detailed descriptions are given by Carter and Heath (1990). Further adjustments and improvements are given in Ross and Jones (1991), Carter (1996), Carr and Carter (1999), Duquet and Carter (2001) and Isak Manual (2001).

Reliability of measurements
The advantages of anthropometry are lost unless the measurements are accurate and reliable (i.e. precise). It is essential to learn precise measurement techniques and accurate calculations. Although at first sight anthropometry appears easy to the beginning investigator, obtaining a high level of skill and reliability requires training under a criterion anthropometrist and considerable practice. Although calculation of the Heath Carter is an objective procedure, the validity of the rating depends on the reliability of the measurements used. Investigators should report test-retest reliability of the measurements. In comparisons of distributions of two independent measures on the same subjects, that means should not differ significantly, and the Pearson product moment (r) should be above 0.90. Specifically, height and weight should have test retest values of r = 0.98. Girths and diameters should have r’s between 0.92 and 0.98. For skinfolds r’s between 0.90 and 0.98 are reasonable. Currently, many anthropometrists use the technical error of measurement (TEM) for evaluating the consistency, or precision, of the means on a given variable. The TEM is the square root of the sum of the differences between those measures and two squared, divided by twice the number of subjects (Cameron, 1984; Norton and Olds , 1996). The TEM provides an estimate of the measurement error that is in the units of measurement of the variable. This value Indicates that two thirds of the time a measurement should come within + / of the TEM. The TEM can be converted to a percentage of the mean of the total number of measures (grand mean). This allows comparisons among these measures or for groups of variables. Generally, the TEM for skinfolds should be about 5% , and that for breadths and girths 1% , and for height about 0.5% The equations are as follows: TEM = ( Σd2 / 2n ) 0.5 , and % TEM = 100 (TEM / grand mean) Calculating the memory somatotype There are two ways to calculate the memory somatotype: a) Enter the data onto a somatotype rating form b) Enter the data into equations derived from the rating form. The Heath Carter Somatotyping Rating Conducted 16 steps in calculating the order Mesormorphysch, Ectormorphysch and Ectormorphysch components. The second method of obtaining the memory somatotype is by means of equations into which the data are entered. Endomorphy = -0.7182 + 0.1451 (X) -0.00068 (X ²) + 0.0000014 ( 3 X ) where X = (sum of triceps, subscapular skinfolds and supraspinale) multiplied by (170.18/height in cm). This is called height -corrected endomorphy and is the preferred method for calculating endomorphy. The equation to calculate mesormorphy is: Mesormophy = 0.658 x humerus breadth + 0601 x femur breadth + 0.188 x corrected arm girth + 0.161 x corrected calf girth - height 0131 + 4.5. Three different equations are used to calculate ectormorphy according to the height - weight ratio: 1) If HWR is greater than or equal to 40.75 then: Ectormophy = 0.732 HWR - 28.58; 2) If HWR is less than 40.75 but greater than 38.25 then ectormophy = 0.463 HWR - 17.63; and 3) If HWR is equal to or less than 38.25 then ectormophy = 0.1. The preceding equations, derived from data used by Heath and Carter (1967), use metric units. The equation for endomorphy is a third degree polynomial. The equations for mesomorphy and ectormorphy are linear (when the HWR is below 40.75 a different equation is used for ectormophy). If the calculation equation for any component is zero or negative, a value of 0.1 is assigned.
That as the component rating, because by definition ratings can not be zero or negative. Because the somatotype is a three - number expression, meaningful analyzes can be conducted only with special techniques. Somatotype data can be analyzed by both traditional and non-traditional descriptive and comparative statistical methods. Although descriptive statistics are used for each of the components, comparative statistics should be made in the first instance using the whole (or global) somatotype rating. This, is followed by analysis of separate components. Here are some definitions: somatopoint (S) = A point in three - dimensional space determined from the somatotype which is represented by a triad of x, y and z coordinates for the three components. The scales on the coordinate axes are component units with the hypothetical somatotype 0-0-0 at the origin of the three axes. Somatotype attitudinal distance (SAD) = The distance in three dimensions between any two somatopoints, calculated in component units. Somatotype attitudinal mean (SAM) = The average of the SADS of each somatopoint from the mean somatopoint (S) of a sample. The U.S. Represents the "true" distance between two somatopoints (A and B). The U.S. is calculated as follows: U.S. A, B = \sqrt{((endomorphy A-endomorphy B) \times 2 + (mesomorphy A - mesomorphy B) \times 2 + (ectomorphy A - ectomorphy B) \times 2)}\] Where A and B are two individuals, two different times for one individual, or two means. The SAM is calculated by dividing the sum of the SADS from their mean somatopoint by the number of subjects. These equations are used in the calculation and analysis of somatotype data. Items 1 and 2 are for calculating and plotting the somatotype. Items 3 - 6 are for analysis of the whole somatotype. Item 7 suggests methods for comparisons by components. To identify the contributions of the three - somatotype components to possible differences between samples, we can use standard MANOVA designs or Discriminant Analysis. For quantitative evaluation of the longitudinal changes in somatotype components use MANOVA techniques with and within - subject design. To assess the relationship over time for a component use interage and within - subject design. To assess the relationship over time for a component use interaction partial correlations for one component while holding the other two constant. Somatotype - Calculation and Analysis V 1 1. Monte Goulding, Sweat Technologies, Mitchell Park, South Australia. It is a new comprehensive user - friendly PDF platform program designed to calculate individual and group somatotypes, somatotype data import from, and export to other files. Reports show statistics, somatoplots, categories and comparisons of individuals and / or groups. HC - StypeCalculation - 03.xls is a simple program for calculating the Heath - Carter somatotype from anthropometry, useful for individual or group data. No plotting or analysis. LifeSize. V1.0 for Windows (or Mac), (1999), by Olds & Norton is a memory profiling and analysis program. It is a tool which assists in the collection and analysis, has a database containing norms for somatotype, body fat and skinfolds for the general population and specific sporting groups. B.O.R.I.S. (2002) - Alexander is a CD-Rom software program in Spanish for memory evaluation, including somatotype. Although this approach to determining somatotype is modern and more objective of all previous typology, it is questionable why the authors specify for exactly this methodology because this way of calculating the morphological characteristics allow the occurrence of errors and a significant loss of information. It is undisputed that the latent space much better define a number of originally measured anthropometric variables, such as index values themselves have a greater loss of important information in defining latent morphological dimension and it could declare a huge lack of Heat - Carter methods for determining somatotype. An objective approach based on experimental data and of factor - analytic methods in the study of morphological dimension was introduced by Spearman (1927). The results concluded that there exist "type-factors" that can be understood in terms of taxonomic and appear alongside mandatory isolated general anthropometric factors. Similar results find Raes & Eyseek (1945), as well as representatives of the British school, using orthogonal factor procedures. Their U.S. counterparts Thurstone (1946), Howells (1951) and Heath (1952) have come up with very similar results using the factor solutions (Lozovina, 1983; 1986; Lozovina et al., 2004; 2008; Lozovina, 2012). Authors Eyseek & Rees (1945) argue that the human body can be seen as a rectangle, and it can be defined by latitude and longitude. To estimate the length there are taken measures of arm and leg length and height, while for estimating the width, the width of the chest, circumference of chest and pelvic width. Multiplying the length and width overtaking the overall size of the body, dividing the length of the width given to the relationship that was the shape of the body, i.e. talked about whether the body is relatively short or long. On the basis of such analysis the authors performed two indices of physical material on which was represented by the size and shape of body composition. Antropometrics often compare the dimensions of the two parts of the body or body size are compared with some general measures that describe it or place body size in relation to other functions such as the psychomotorics, energy outputs, technical and tactical performance, and sports competition and more. Such comparative studies are called Allometric. In biology allometrics refers to changes in the relative size of body parts and correlated with changes in overall size (Julian Huxley and Georges Teissier, 1936 by Norton & Olds, 1996). If there exists the independent variable x, which is in relation to body size or body shape (X = body weight or height) and is put in relation with the dependent variable y (Y = skin folds, basal metabolic rate or locomotion ) and determine any relationship between these variables, did we step towards a theoretical model where on our theoretical knowledge and choice of appropriate statistical and mathematical procedures depends how well the variable x predict variable y? The model does not decide mechanically but chooses the one that best fits the concept of the research and the logic of nature phenomena we study. N the anthropometric surveys, there are three models commonly in use: 1) Ratio model expressed by the equation: y = kx , where k is a constant. For example, the length of the limbs are considered constant fraction of body height within ethnic subpopulations, and once the bone growth has to stop; 2) Regression model, expressed by the equation Y = a + bx , where a and b are constants. For example, the relation between stroke volume and body mass, Tanner (1949) determined by the equation : MV = 0.32 * Mass + 79.5; and
3) Power model or general allometric equation as refer by Huxley (1932) and Teissier (1931) which suggests that the proportional relations can best describe the general function expressed by the equation $Y = Bx^a$, or by logarithm of both sides $\ln y = \ln a + b \ln x$, where $x$ is the size of a part of body size or general measures of body size (height and weight), and $y$ is the size another part of the body or a body function. When $a = 0$, $y$ is equal to $b$, which is the case when the dimensionality of one part of the body is dependent on the total dimensionality. Example the size of red blood cells in mammals is equal regardless of the size of the mammal. So mouse and horse red blood cells have a similar size.

When $a = 1$ size of the two parts of the body (or the size of the body and the whole body) is in a linear relation, for example length legs still growing just as the growth and overall height. When $a = 2$ body part size increases with the square of body size. The cross-sectional area of muscle and body surface area are examples of body characteristics which increase approximately with the square of height. When $a = 3$, the body characteristics increases with the cube of body size. Volume would be expected to increase with approximately cube of height. When $a = -1$, $y$ decreases as $x$ increases inversely. The mean height of sprinters increases as the sprint distance increases from 50 to 400 m. Over longer distances, acceleration is much less important than in short sprints (Norton & Olds, 1996). What is obvious is that the people have basically the same shape. Similarity of comparative anthropometry makes it possible and easier. Certainly there are exceptions to this rule, and then we talk about morphological aberrations incurred for any reason, but always remains the possibility of comparing two individuals of different shapes and forms. A large number of differently dimensioned body characteristics can be presented as different sized cubes. If the leg length ($L$) doubles size will quadruple ($L^2$) and the volume will grow eight times ($L^3$). Similarly, human breadths generally increases linearly with height, surface areas increase with the square of height, and masses and volumes increase with the cube of height.

This process can not run indefinitely. From a technical point of view, machines, including biological, such as animals or human-machines if are becoming bigger must be functionally adapted. Already Galileo reasoned that if the length of the muscle and bone grows quadratic and cubic volume, the critical point will be reached when the bones and muscles are no longer able to support the weight of the body. In addition bone mass grows at a relatively greater rate than body mass. This represents a structural response to functional demands which "breaks the allometric rule". There are interesting parallels between allometric relation to animals and correspondent allometric changes in objects made by hand of man. Mc Mahon (1983) by Norton & Olds (1996) proposed a system of elastic similarity with logic that the size and shape of the animal forces have undergone some important criteria, of which are inertia and gravity force most responsible. Geometric system and similarity together, is applicable in the real human anthropometry on a wide number of variables that describe the body size but do not always provide the expected results, which in turn opens up the possibilities of new research of which is maybe most interesting research result by Muftić (1992; 1996). On the ex-Yugoslav population, most important anthropological research was performed by Škerlj. In the area of physical education a number of papers refers to the study of anthropometric parameters of students in a relatively lesser athletes specialties. Research of manifest and latent morphological and anthropometric dimensions and factor analysis began in 1960 as research in the area of reliability and validity of measurement instruments. Momirović et al. (1960) analyzes that interdependence measure of body fat, and tues study determined the general factor of subcutaneous fat.

Viskić (1963) according to Lozovina (1983) analyzed the factor structure of body weight. There are three factors, and defines them as dimensionality of the skeleton, the volume of muscle and subcutaneous adipose tissue. Momirović et al. (1966) studied the effect of latent anthropometric variables on the orientation and selection of top athletes. This analysis identified four latent anthropometric factors which the authors named as: longitudinal dimension of the skeleton, transversal dimensionality of the skeleton, volume and subcutaneous adipose tissue. The assumption is based on morphological characteristics of human populations that can be divided into relatively small and limited number of strictly distinct subpopulations, found no justification even when, for the purpose of identifying these subpopulations, were used a very fair anthropometric, mathematical and statistical procedures. For these reasons, it has recently rejected the criterion of strictly distinct groups, and in today's research is based on the hypothesis that each participant takes a relatively stable position in each of several multivariate continuous distributed taxonomic variables. Such studies are based on taxonomic and component models. These procedures belong to the family of data processing TÂXOBŁ algorithms, and some of them have been applied in studies by "Zagreb school." So Hošek, Medved, Stojanović and Momirović (1997) in Morphotax modification of Taxobl procedures analyzed extraction and try to identify the optimal number of taxonomic variables (polar taxons) using a space of 23 manifest anthropometric variables. They found five taxon variables and identified five morphological mechanisms within which the authors identified as types M, K, D, R and E. Polar variables marked with an M - morphological structure defined by body volume which is based on mesomorph structure. Variable marked with K - morphological structure also defined by volume, but basically that is the general adiposity. With D it is marked morphological structure defined distinct skeletonomphy. With R it is defined structure in whose base lies adiposity, while the structure of the E -type is defined by a specific set of morphological characteristics obtained after extraction of the previous four taxon variables.
Why model of “Zagreb school” and not Heat-Carter somatotyping model?

Although the Heat-Carter somatotyping model for a number of years in use worldwide, authors of this paper believe that the model of the “Zagreb School” with 24 anthropometric measures that are designed to detect latent dimensions (longitudinal dimensionality of the skeleton, transversal dimensionality of the skeleton, circular dimensions and subcutaneous adipose tissue) far more efficiently and better provides usable data for further analysis.

And for the reason that in apparent area operates with originally measured variables, not the index value as it is the case in determining somatotype in Heat-Carter method. Furthermore, the latent space is very well covered by the original anthropometric variables with high coefficients of participation, virtually in all previous studies. Respecting the fact that they are mostly all anthropometric measures normally or approximately normally distributed (except make some measures of subcutaneous adipose tissue) in the analysis of latent space we can use taxonomic analysis algorithms that are not based on an analysis of the differences and similarities that certainly gives more options in defining and clarifying polar taxonomic variables as is the case when you use Morphotax model taxonomic analysis, although Uditax procedure is very interesting (Bonacin, 2008). Therefore, the authors recommend just such an approach in the study of the anthropometric and morphological characteristics of the athletes, and of course a production of some new research techniques and scientifically approved algorithms.

References


Muftić, O. (1992). Harmonical Method of Man’s Figure Drawing, XI International Anthropological Conference / Zagreb.

Muftić, O. (1994). Method of Man’s Figure Drawing, Coll. Antropol. 18(Supl.1), 27-32.


KAKO PRISTUPITI ODREĐIVANJU SOMATOTIPOVA U KINEZIOLOGIJI?

Sažetak

Cilj ovog rada bio je utvrditi aktualno sustavno stajalište za definiciju morfoloških dimenzija čovjeka. Poznato je da je takav posao vrlo ozbiljna, pa čak i jako složena zadaća. Dakle, prije svega moramo preuređiti osnove, uključiti sve moguće značajnije ideje i pokušati prijeći granice u ovom kompliciranom području. Mi smo u tom “poslu” oko 30 godina, i još uvijek u potrazi za novim univerzalnim konceptom. Nadamo se da će ovaj članak pomoći drugima uspostaviti jak i održiv koncept, teoriju za praksu boljih transformacijskih procesa.

Ključne riječi: morfološke karakteristike, somatotip, kineziologija, konceptualni pristup

Received: August 10, 2012
Accepted: June 10, 2013
Correspondence to:
Prof. Vinko Lozovina, PhD
University in Split
Faculty of maritime Studies
21000 Split, Domovinskog rata 8, Croatia
Phone: +385 (0)21 393 500
E-mail: lozovina@pfst.hr