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Anthropic topology: an affordable approach in the study of human somatic homomorphism

Topologia antropică: o posibilă abordare în studiul homomorfismului somatic uman

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Abstract

Anthropometry is an important area of biological or physical anthropology. It is represented by data sampling techniques on the human body, quantified by instrumental measuring which can be global or segmental, quantitative and qualitative. These measurements are followed by elements of calculation, comparison and interpretation of the relationship between the investigated dimensions, related to a whole series of referential specific indicators, mostly standardized.

The anthropometric assessment provides objective data by direct measurements of body dimensions. It can highlight certain features and completes some aspects observed by somatoscopic examination.

Regarding anthropometry, we propose an approach from a dual perspective, namely quantitative or observational anthropometry (with effective tool measurements, without a comparative analysis of the recorded data) and qualitative or analytical anthropometry (resulting from the analysis of relationships created between different data recorded in relation to body segments or between them and the entire body, all in relation to various anthropometric indices).

This study fits into the second category, qualitative analytical anthropometry, its purpose being the extension of interpretations through an interdisciplinary approach (biometry, biophysics, biomechanics and mathematics). From the mathematical study field, we have found that the topology domain can constitute and generate new references and new perspectives in the investigation of anthropic somatometry. It is part of a larger work which addresses in one of the chapters the issues of anthropic topology in the study of human body morpho-structurality.

Keywords: topological space, constitutional homotype, commutative corporal group, anthropic operand, kinematic binomial.

Rezumat

Antropometria este un domeniu important al antropologiei biologice sau fizice. Ea este reprezentată de ansamblul de tehnici de prelevare de date despre corpul uman, cuantificate prin măsurare instrumentală, care pot fi globale sau segmentare, cantitative şi calitative. Aceste măsurători sunt urmate de elemente de calcul, comparare şi interpretare a raporturilor dintre dimensiunile investigate, relativizate la o serie întreagă de indici specifici de referinţă, în marea lor majoritate, standardizaţi.

Evaluarea antropometrică furnizează date obiective, prin măsurarea directă a unor dimensiuni corporale. Ea poate să pună în evidenţă anumite caracteristici şi vine să completeze unele aspecte observate prin somatoscopie.

În ceea ce priveşte antropometria, propunem abordarea dintr-o dublă perspectivă, şi anume: antropometria cantitativă sau constatativă (realizată prin măsurare instrumentală efectivă, fără o analiză comparativă a datelor înregistrate) şi antropometria calitativă sau analitică (rezultată din analiza raporturilor create între diferitele date înregistrate, în relaţie cu segmentele corporale sau între acestea şi corp, raportate la diverşi indici antropometrici recunoscuţi).

Studiul de faţă se încadrează în cea de-a doua categorie, antropometria calitativă analitică, având ca scop extinderea interpretărilor printr-o abordare interdisciplinară (biometrie, biofizică, biomecanică şi matematica). Din câmpul de studiu al matematicii, am constatat că domeniul topologiei poate constitui şi genera noi referinţe, noi perspective în investigarea metriei antropice. El face parte dintr-o lucrare personală mai amplă, care abordează într-unul dintre capitole problematica topologiei antropice în studiul morfo-structuralităţii corpului uman.

Cuvinte cheie: spaţiu topologic, homeotip constituţional, grup comutativ corporal, operand antropic, binom kinematic.

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Introduction

The study of human corporality constantly offers new approach possibilities, given its morphological and structural complexity, and particularly, the functional diversity of its biomechanical dynamics, locomotor and non-locomotor, from a double perspective: global (general motricity) and segmental (fine motricity).

One of the segmental corporal dimensions - length -, forms via the joints different degrees of leverage that generate resistant and active forces, inversely proportional to the lengths of the arms adjacent to a joint (relative to the axis of rotation). Depending on these relations, active forces can amplify or decrease the level of motor actions. Other dimensional elements influence the resulting vectors (Gagea, 2002). Vector magnitude induces, in addition to actual force intensity, the direction and sense of action, segment perimeters and diameters, as well as dynamic characteristics: inertia forces (D'Alembert, 2006; Wilde, 2014), execution speed, acceleration, etc.

Based on these reference data, importance should be given to the somatometric study of the human body, to the morphostructural and functional aspects of the locomotion system, with a dual connotation: static and dynamic.

By approaching this investigation from a topological perspective - taken from mathematics, we want to highlight and, finally, by extending some contextual studies, to optimize the rank of factor influence of interconnections linked to anthropometric data regarding the efficiency of simple or complex motor actions (kinematic chains), specific to sports high performance in different sports branches and disciplines. All this could generate a new field of study, proposed by us: anthropokinetics.

Background

Topology (from the Greek words τόπος, "place" and λόγος, "study") is the study of mathematical shapes and topological spaces. It is an "area of mathematics in relation to spatial properties that are maintained in continuous deformations, including stretching and bending, excluding tearing or sticking" (2).

The term was introduced by Johann Benedict Listing (3) in the 19th Century. By the mid-20th century, *topology* became an important branch of mathematics. Extending the approach, *general topology* (4) establishes the fundamental aspects of *topology* and investigates the properties of topological spaces.

By extrapolating specific *topological* concepts from mathematics (Clementini et al., 1994), e.g. the *topological point-set* (Egenhofer & Franzosa, 1991), to the field of *anthropometric measurement references*, the human body can be interpreted as a *topological system* (A/N), presenting a series of anthropometric benchmarks that do not change position or location in the context of normal individual morphological transformations, such as those occurring in the ontological growth and physical development of an individual. These reference points can be defined as *homotopic points* (Fomenko et al., 1986), which are found on the body in the same place for all human individuals (Figs. 1 and 2).

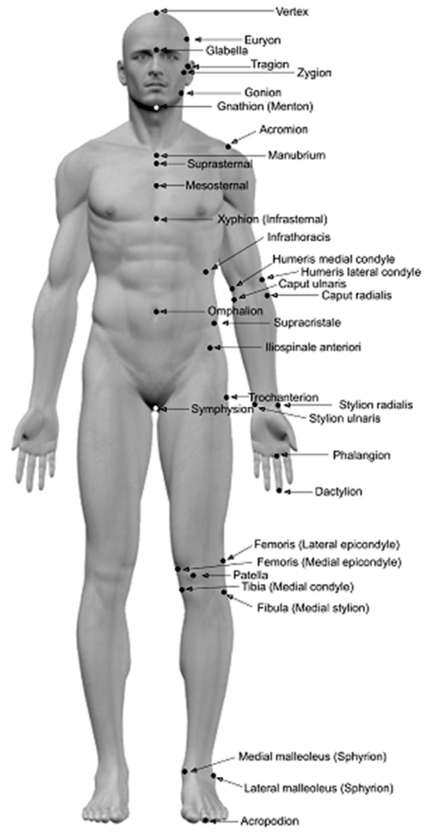

Fig. 1 – Homotopic corporal landmarks or anthropometric set-points – frontal view (Neagu, 2014).

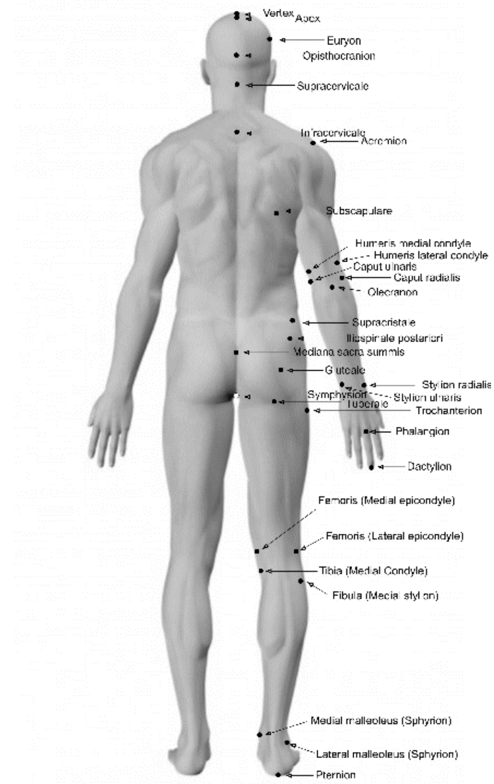

Fig. 2 – Homotopic corporal landmarks or anthropometric set-points – dorsal view (Neagu, 2014).

We can consider that this *topological corporal system* has the characteristics of another concept in *general topology*, i.e., the *topological space*, which is defined as ”a set of points, together with a set of neighborhoods for each point, which satisfy a set of axioms on the points and neighborhoods” (5). The definition of the *topological space* allows defining other concepts, such as “continuity, connectivity and convergence” (Schubert, 1968). We estimate that between anthropometric landmarks, interpreted as *homotopic points*, there may be various relations of continuity, connectivity and convergence in the context of body dynamics, locomotor or non-locomotor.

Hence, the *constitutional human homotype* (6) – CHH (A/N) results, which gives identity to the human species biotype in the animal kingdom. Thus, *the constitutional homotype* becomes an invariant category of the human species. Consequently, between two individuals of the human species there may be a *constitutional homomorphism or isomorphism* relationship (A/N) and a biunivocal correspondence between the positions of their corresponding anatomical points (A/N).

Also through extrapolation, this relationship can be transferred to the body organs and segments, which are also in an isomorphism relationship in terms of form, structure, and biochemical composition.

The *constitutional morphism* of an individual can be defined as endomorphism, representing a feature of the individual’s body, defined by itself. Thus, the anatomical points as anthropometric references constitute a space of individual body dimensions, forming a *dimensional vectorial space* (A/N), which generates a series of relationships and linear combinations (rectilinear or curvilinear) between these points (Fig. 3).

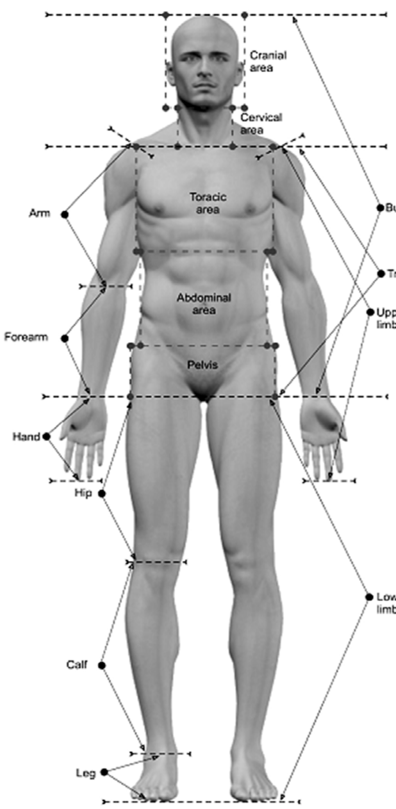

Fig. 3 – Dimensional vectorial system (Neagu, 2014).

These relations can be addressed either from a static or postural perspective, or from a dynamic perspective of the body or its segments, the body acting via locomotor or non-locomotor movements (Fig. 4).

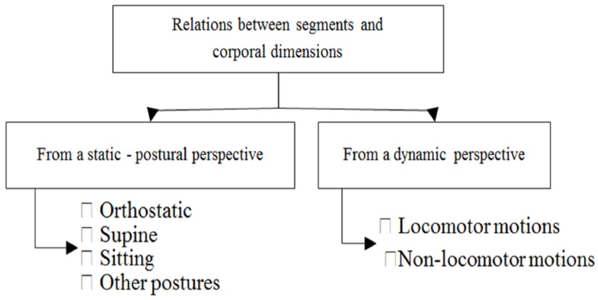

Fig. 4 – Segmental relations of the human body as a dimensional vectorial corporal system (Neagu, 2014)

From the static rectilinear relationships of anthropometric reference points, the *corporal and segmental lengths and diameters* result (Fig. 5).

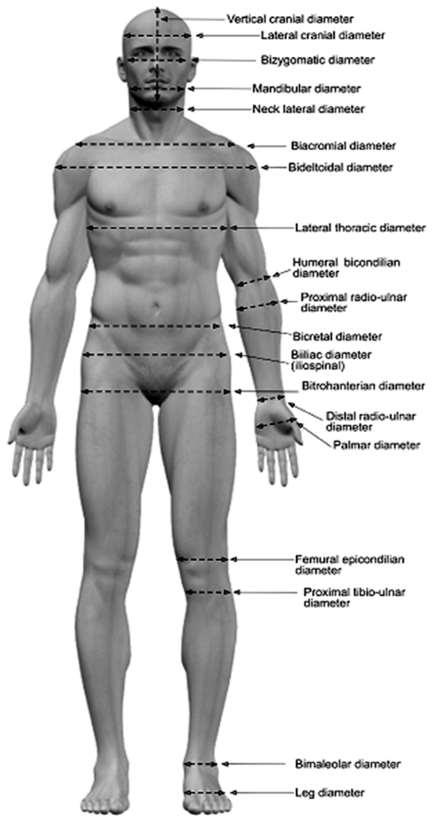

Fig. 5 – Corporal diameters (Neagu, 2014)

From the static curvilinear relationships of anthropometric reference points, the *corporal and segmental perimeters* result (Fig. 6).

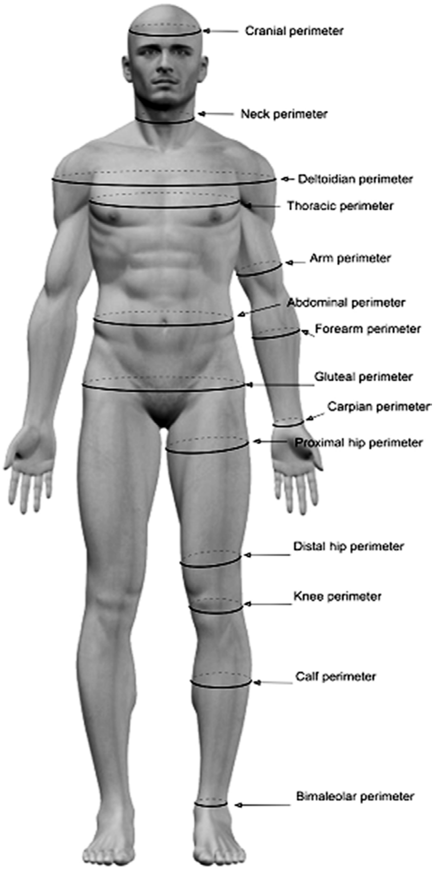

Fig. 6 – Corporal perimeters (Neagu, 2014)

From dynamic relationships, angles, levers, forces and vectors between the body and its different segments, between different body segments, and between the body and the environment result.

From an anthropometric perspective, highlighting these relationships is achieved by goniometric and dynamometric measurements (Fig. 7).

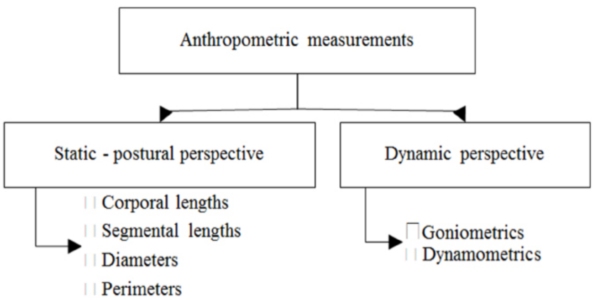

Fig. 7 – Types of anthropometric measurements from a dual perspective – static and dynamic.

Thus, the human body becomes a group of corporal segments forming a *commutative corporal group* (A/N), a term extrapolated from the concept of *abelian group* (Hazewinkel, 2001), introduced by the Norwegian mathematician Niels Henrik Abel (1).

The human body is also in a relationship governed by *the law of internal composition* (Vialar, 2015), a concept borrowed from mathematics, algebra, in which the most important body segments involved in body statics or dynamics are segment pairs called by us *motricity binomials or kinematic binomials* (A/N), which can act in the same direction (synergistic) or in opposite directions (antagonistic).

Taking other concepts from mathematics, we can define the body segments as *anthropogenic operands* (A/N), and the generated vectors as *products* of the action/interaction of *anthropogenic operands.* The *end product* is the third element of this initially binary vector relationship (Zamansky, 1989) (Fig. 8).

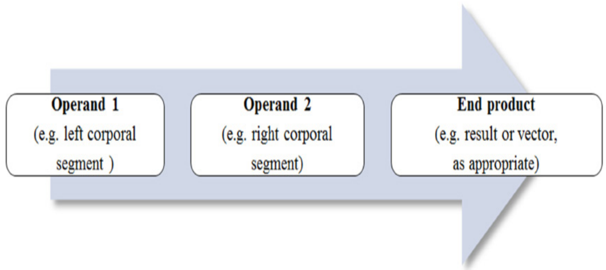

Fig. 8 – Possible components of a commutative binomial corporal group.

We are talking here about a *commutative binomial corporal group* (A/N). These issues will be the subject of an analysis in one of the future volumes of the *Human Biometry* series.

In the case of *commutative binomial corporal groups* (A/N), the number of *operands* can obviously be multiple. The end product of such a relationship will present a series of highly complex physical characteristics (Fig. 9).

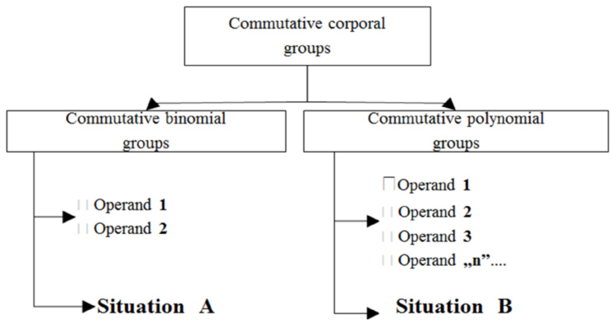

Fig. 9 – Typology of commutative corporal groups.

When the body is static – in stable or unstable equilibrium – we are talking about a *posture-balancing commutative group* (A/N), and if the body is engaged in motion (locomotion or non-locomotion), a *commutative chain* (A/N) or kinematic chain, defined as a *dynamic commutative group* (A/N) is discussed. If the body is in a stable static position, without any maintenance, control or balancing action (supine position), we define the body as a *non-commutative group* (A/N).

The segments of interest of the *commutative corporal group* can be on the same side of the body (homolateral), when the location is on the right or left side of the body, or in the upper or lower region of the body (para-regional). However, they are more frequently situated on opposite sides (heterolateral, left ↔ right), i.e., *left hemibody - right hemibody* (A/N) or *upper body – lower body* (hetero-regional). In this case we are talking about *upper parabody* or *lower parabody* (A/N) (Fig.10).

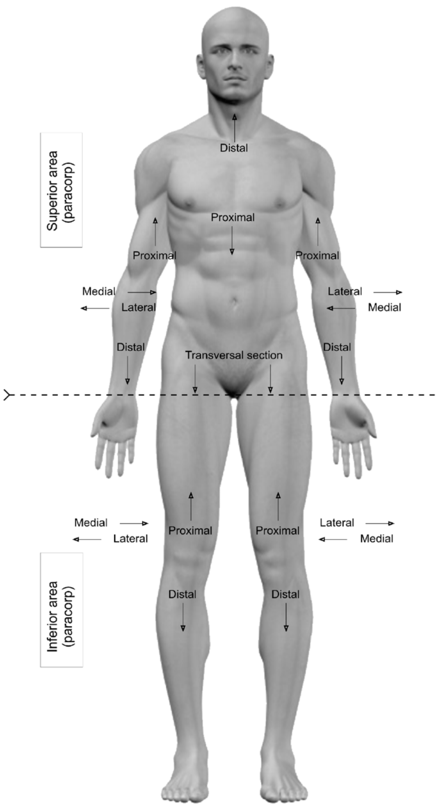

Fig. 10 – Corporal areas (Neagu, 2014).

Their movements can be associated or dissociated, simultaneous or alternative, continuous or syncopated, synchronous or asynchronous, in identical directions and different senses, in different directions and different senses, etc.

The human body, presenting segment pairs that are symmetrical in size and position, is mainly characterized as a *dual modular kinematic system* (A/N), in which its static functions - posture-balancing and dynamic functions - locomotion or non-locomotion are, in most cases, the result of the synergistic or antagonistic action of at least two participants. If the action of the two co-participating elements is agonistic/synergistic, we can talk about an *autodual kinematic system* (A/N), and when the action is antagonistic/non-synergistic-opposite, a *dual kinematic system in itself* can be discussed (A/N) (Fig. 11).

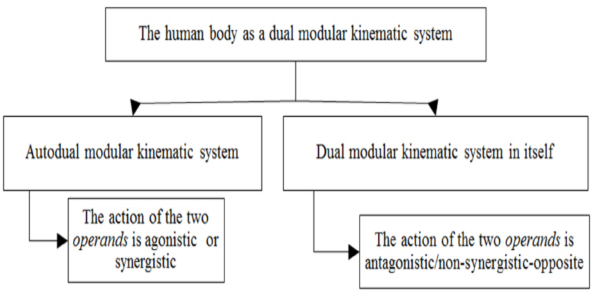

Fig. 11 – The design of dual kinematic corporal systems.

In some cases, the adjustment of the kinematic system or the posture-balancing system is the consequence of an unpaired body segment (*single operating element*), such as the head or torso. We define in this situation the human body as a *monogenic commutative group* (A/N). In other cases, adjustment is the consequence of the action of two segments - paired or not. This is the case of the *stereogenic commutative group* (A/N).

In relation to the types of movements, *the dynamic commutative group* can be a *cyclic-repetitive commutative group* (when the powertrain is composed of cyclic movements), or an *acyclic-non-repetitive commutative group* (when the powertrain is composed of acyclic movements) (Fig. 12).

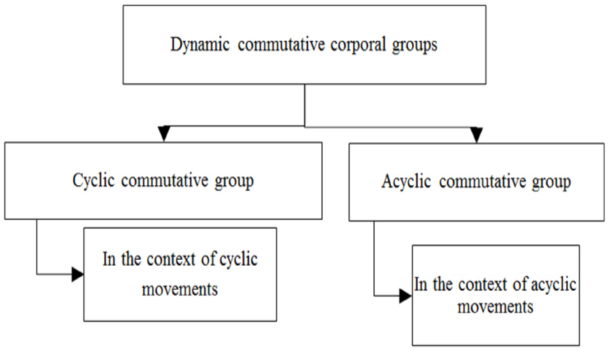

Fig. 12 – The taxonomy of commutative corporal groups depending on the typology of operand movements.

Conclusions

1. We believe that the terminological developments of the presented study, taken and adapted from mathematics, converge on the idea of an interdisciplinary approach, outlined in the introduction.
2. Given the growing demands related to achieving high performance in sports, any action that could have a favorable influence is desirable. For now, our approach was within the virtual field of concepts. We estimate, however, that an extension of the studies and applied research could lead to the generation of operational elements in sports practice.
3. An early identification of possible limiting morphostructural factors, which in turn will negatively affect other factors in achieving athletic performance, will allow streamlining the training process based on the biomechanical analysis of various motor structures specific to different sports categories and events.
4. Starting with anthropometric analysis elements, continuing with biomechanical analyses, the road to high performance will be somewhat less difficult. Anthropokinetics, proposed by us as a new approach in the study of human corporality in motion, could be one solution. We hope that our proposal will be evaluated critically and objectively.

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