

Overview of Several Morphofunctional Index Values Used in the Study of the Female Pelvis

Konstantin Anatolyevich Bugaevsky*

The Petro Mohyla Black Sea State University, Mykolaiv, Ukraine

***Corresponding Author:** Konstantin Anatolyevich Bugaevsky, The Petro Mohyla Black Sea State University, Nikolaev, Ukraine.

Received: August 09, 2021; **Published:** September 28, 2021

Abstract

The article provides an overview of the available scientific and methodological domestic literature data from studies of scientist's anatomists and morphologists concerning the individual characteristics of some morphological and functional index values that are used in the study of the pelvic bone in men and women at different age periods.

Keywords: *Female and Male Bone Pelvis; External Dimensions of the Bone Pelvis; Anthropometric Measurements; Morphofunctional Index Values; Research*

Abbreviations

UPOW: Upper Pelvic Opening Width; GWP: Greatest Width of the Pelvis; DBIS: Distance Between Ischial Spines; UAPW: Upper Anterior Pelvic Width; SDSPF: Sagittal Diameter of the Superior Pelvic Foramen (Conjugata Anatómica); MSDSPF: Mean Sagittal Diameter of the Superior Pelvic Foramen (Conjúgata Vera); SW: Symphysis Height; ST: Symphysis Thickness; ISDSPF: Inferior Sagittal Diameter of the Superior Pelvic Foramen (Conjúgata Diagonalis); SDLPF: Sagittal Diameter of the Lower Pelvic Foramen (Distantia Symphysosacralis); SH: Sacral Height; PRI: Pelvic Ring Index; PH-WI: Pelvis Height-Width Index; TLISP: Transverse Longitudinal Index of the Small Pelvis; PBI: Pelvic Bone Index; IRWP: Index of the Relative Width of the Pelvis; PWI: Pelvic Width Index; PI: Pelvis Index; SPI: Shoulder-Pelvic Index; SDI: Sexual Dimorphism Index; PLI: Pelvic Latitude Index; SSBI: Sex Steroid Balance Index ($\Sigma T/R$); VI: Virilization Index; IR A/T: Index Ratio A/T; PUPO: Pointer of the Upper Pelvic Opening; IHWP: Index of height-width of the Pelvis; LIP: Latitudinal Index of the Pelvis; PDI: Pelvic Dilatation Index; APA: The Angle of the Pubic Arch; SI: Solovyov's Index; BI: Brimindex; RPWI: Relative Pelvic Width Index; ALA: The Angle of the Pubic Arch

Introduction

In the modern world community, in the population of people, both men and women, on different continents, under the influence of a combination of numerous external and internal factors, specific morphofunctional changes occur in the process of evolution [1]. This, first of all, concerns the weight and length of the body of men and women, anthropometric indicators of the girdle of the upper and lower extremities, and their components, their length and coverage [2-5]. Certain, various anatomical and morphofunctional changes are also undergone by the human pelvis, primarily the female pelvis, as an important component of the female reproductive system. In parallel, in the body of people, especially in women, adaptive changes in the endocrine and reproductive systems are actively occurring, with the formation of numerous variants of violations of their ovarian-menstrual cycle, with the formation of new, transitional and pathological sexual somatotypes, both somatic and psychological level, transgender phenomena are formed [6-10].

First of all, this applies to adolescents and young people, representatives of the male and female biological sexes, especially those who are actively involved in various sports. Climatic zones, changes and environmental pollution, dietary habits, intensely physical and psycho-emotional stress, the dominance of chemical products and drugs - this is not a complete list of factors influencing the formation of a new person, "adapted" to the realities of a new life in this world XXI century [11-14]. The peculiarities of the development of weight-for-height ratios and the proportionality of the development of the body, including the pelvis, must be taken into account by pediatricians for the timely detection of violations of the processes of puberty [15]. The study of the ongoing anatomical and morphofunctional problems in men and women of biomedical changes is a very relevant and demanded direction in today's medicine, anatomy, physiology, anthropology and, in a number of related, biomedical sciences. At the same time, I would like to note that among medical scientists (anatomists, obstetricians-gynecologists), in articles and everyday practice, when determining the names of the external and internal dimensions of the bone pelvis, the use of Latin scientific terminology dominates, and among sports morphologists, for example, these names are used extremely rarely, mainly Latin terms, are replaced by "diameter", "size", "distance", which sometimes introduces misunderstanding or not quite adequate interpretation between specialists with basic medical and biological education and training [16-18]. Often, medical researchers, in their articles, for example - d. spinarum, d. cristarum, d. trochanterica, c. vera and others, they have to duplicate the medical terms they understand to those that are common among researchers, without medical education, conceptual terms, for example, as "biacromial size (diameter)", or "shoulder width", "inter-crestal size (diameter)", "Intertrochanteric size", "width of the pelvis", "diameter of the pelvis", etc.

The same problem also applies to the issue of university training of specialists in biomedical areas, the same sports morphologists, without taking into account the level of medical, special education and the level of knowledge of specific medical terminology, in contrast to Western specialists-researchers of the same areas. Personal experience in writing scientific articles and submitting them to foreign specialized publications shows that Western colleagues are familiar and widely use the clear Latin medical terminology and practically do not use the widespread medical and biological terminology that is commonly used in our country, such as "shoulder width and/or the width of the pelvis", requiring its Latin counterpart, used and understandable, the use of Latin terminology used in the English-language scientific literature. At the same time, I would like to note that our, domestic scientific research literature and the scientific volume of research, uses and actively applies in its research, a lot of new and, importantly, methods unknown to Western experts, in particular many morphological and functional index values, widely known, often and widely used by domestic scientists and researchers, morphofunctional index values.

Articles containing these data, often cause surprise and sincere admiration, among the majority of Western colleagues and researchers in similar areas of anthropology, sports morphology, several biomedical disciplines. I would like to note that the existing and widely known differences between the male and female pelvis are widely used in anthropological, morphological and forensic medical research, allowing to determine the sex, body length, and often the racial, constitutional and age affiliation of the bone remains of the pelvic bones, and many other distinctive features [19-28].

Also, I would like to draw attention to such an important fact as the understanding of the anatomical norm in relation to the size of the pelvis. E.L. Demarchuk [29], in his dissertation work, writes the following about this: "The size of the pelvis of a modern woman is smaller in comparison with the currently available (but adopted back in the 80s) standards in obstetric practice. But the dimensions we received are not signs of an anatomically narrow pelvis. Most obstetricians consider the pelvis to be narrow if all sizes or at least one of them are shortened by 2 cm or more compared to normal. The anatomical norm seems to be a constantly changing quantity, which is in unity with constantly changing environmental conditions (VV Kupriyanov, VV Kulikov, 1974) [30]. According to D.B. Bekov (1988), the anatomical norm should be understood as a genetically determined, rationally highly organized structure of the shape of the body, its organs, tissues and systems, which ensures the normal life of a person" [31]. With this variant of the norm TK Fedotov, AK Gorbacheva (2016), adaptation to the impact of climatic-geographical, medical, socio-psychological factors can be considered [32].

Purpose of the Study

In this regard, the purpose of our study is to study and analyze all possible markers for studying the changes occurring on the part of the bony pelvis in men and women, with consideration of the available options for determining the morphofunctional index values concerning their bony pelvis. This study is an overview, representing the arsenal of anatomists, anthropologists, morphologists, incl. and sports, accessible and informative methods and algorithms for determining the ongoing and already existing adaptive changes in the bone pelvis of men and women. Ordering, studying, analyzing the diversity of body sizes and proportions, in people of both biological sexes, and different age and racial groups of people, makes it possible to assess their level of physical development.

Materials and Methods

In carrying out this research work, we used methods such as: anthropometry, with the necessary anthropometric measurements, the method of indices, the method of literary-critical analysis of available scientific sources of information on the issue under study, Internet resources. We, for consideration, first of all, took such morphofunctional index values, in which, as the main component, the external (external), as well as the internal dimensions of the bone pelvis of a person, both men and women, are used.

Results and Discussion

Proceeding to a detailed examination of the available morphofunctional index values associated with the size of the bone pelvis, I would like to start with the values of the relative pelvic width index (RPWI). The study of this morphofunctional index value, both in men and women, has been actively studied in different years by such authors as BA. Nikityuk, FI Kozlov, 1990 [33]; Kovtyuk NI, 2003 [34], VV Abramov, II Shevchenko., *et al.* 2007 [2], SN Derevtsova, 2010 [11], OV Kalmin, TN Galkina, AV Galkin, 2013 [12], NG Nichiporuk, 2019 [35], Bugaevsky KA, 2014-2021. Speaking about the coverage in the domestic scientific research literature of recent years, on the issues studied and presented in this article, I would like to note some scientific studies by domestic authors. So, in his dissertation work, for the degree of candidate of medical sciences "Typological and individual features of the structure of the bone pelvis in adult women in the norm with prolapse of the pelvic organs", 14.03.01 - human anatomy and 14.01.02 - obstetrics and gynecology; St. Petersburg, 2019 [35], NG Nichiporuk, quite fully, in detail and clearly, presented the morphofunctional index values most often used in medical practice, describing in detail their definition. According to her research, "In 1885, W. Turner proposed "brimindex" (BI) or "pelvic index", which is the percentage of the direct size of the entrance to the small pelvis to the transverse one (Bernard R., 1951-1952). According to this parameter, the following forms of the pelvis were later identified: dolichopelic, mesopelic and platypelic (Bernard R., 1951, 1952; Shvetsov EV, 1997) [36]. In literary sources, this index is also referred to as the index of the pelvic ring (PRI) (Martin R., 1928) [37]. The next parameter studied was the ring index (RI) - (Sozon-Yaroshevich AYu, 1926) or the indicator of the upper pelvic opening (PUPO) (Garmus AK, 1990). This parameter reflects the ratio of the true conjugate to the transverse size of the entrance to the small pelvis (Manuilov K.A. (1947)). According to this index, the author described the following forms of the pelvis: squeezed from the sides and squeezed from front to back. Topinard P. (1885) and Martin R. (1928) described the index of height - width of the pelvis (IHWP). IHWP is the percentage of pelvic height (distance from the ischial tuberosity to the highest point of the iliac crest) to distantia intercrossalis.

According to this index, low, medium and high forms of the pelvis were distinguished (Vinogradov SV, 2006). The latitudinal pelvic index (LIP) was proposed by VV Moskalenko. and Rakhman IM in 1928-1929. It is equal to the percentage of external conjugate (c. externa) and distantia interspinosa. According to the authors, this parameter most fully characterizes the longitudinal-latitudinal indicators of the pelvis. According to this index, the following were identified: wide, harmonious and narrow forms of the pelvis (Vinogradov SV, 2006) [38]. In his works VV Bunak (1937; 1941) [39], studied the pelvic dilatation index (PDI), which is the percentage of distantia intercrossalis to the transverse size of the pelvic inlet.

At the same time, this parameter differs somewhat in men and women and can characterize a narrowed, uniform, or expanded pelvis. The authors point out that for a comprehensive assessment of the structure of the pelvis, it is necessary to use several indices, since, in this

case, the analysis of the shape of the pelvis based on the index parameters is optimal (Akinshchikova G.I., 1977; Vinogradov S.V., 2006) [35,40,41]. In his dissertation work, for the degree of candidate of medical sciences, 03/14/01 - human anatomy - "Regularities of the variability of the physical status and size of the pelvis of women, taking into account the time vector", Krasnoyarsk, 2012, NN Strelkovich, notes the importance of the relationship between the parameters of the bony pelvis of women and their constitutional features, and also highlights the importance of studying the variability and dynamics of the formation of the inert pelvis in ontogenesis, in age and in time (overtime periods - the present time, past decades, centuries). The author notes the presence of the existing variability in the parameters of the structure and shape of the bone pelvis (in particular, female), in different historical time periods of the life and activity of people. According to the author's research, "using the equation of regression analysis: $SDLPF$ (sagittal diameter of the lower pelvic foramen) = $73.48 + 11.68 \times UPOWO - 0.43 \times UPOW^2 + 0.25 \times GWP$, according to anthropometric parameters (width of the upper pelvic opening and the largest width of the pelvis), it is possible to calculate the sagittal diameter of the lower pelvic foramen" [42]. The author, in her studies, used 66 indicators, of which 36 in determining the parameters of the pelvis as a whole, and 30 indicators for the sacral and coccygeal bones. So, the author, in particular, used the following values: "The main osteometric parameters of the pelvic bones, measured on female skeletons: A) top view: UPOWO, the width of the upper pelvic opening; DBIS, the distance between ischial spines; UAPW, upper anterior pelvic width; B) sagittal view: SDSPE, a sagittal diameter of the superior pelvic foramen (conjugata anatómica); MSDSPF, mean sagittal diameter of the superior pelvic foramen (conjúgata vera); SW, symphysis height; ST, symphysis thickness; ISDSPF, the inferior sagittal diameter of the superior pelvic foramen (conjúgata diagonalis); SDLPF, sagittal diameter of the lower pelvic foramen (distantia symphy-sosacralis); SH - sacral height (the height of the sacrum)" [26].

In his research, NN Strelkovich, practically applied the calculation of the following pelviometric index values of the bone pelvis: the index of the pelvic ring (PRI), the index of the height-width of the pelvis (PH-WI) and the transverse-longitudinal index of the small pelvis (TLISP) according to IV Gaivoronsky, SV Vinogradov (2006) [21,26].

EL Demarchuk, in her dissertation for the degree of candidate of medical sciences "Anatomical and anthropological features of the body and the size of the pelvis of women at the youthful stage of ontogenesis", code 14.01.02 - obstetrics and gynecology, Novosibirsk, 2004, revealed the relationship of the sexual somatotype of women, with their constitutional features, including prolongation of the formation of the morphological and functional state of the body of women after 17-20 years, including the size of the pelvis. Also, the author, for the first time calculated the coefficients of the ratio of the sizes of the pelvis and the circumference of the wrist: To the inter-crestal diameter = 1.83; K intertrochanteric diameter = 2.03; K external conjugates = 1.26, which are practically the same for all somatotypes of women and therefore can be considered as constants [23].

NI Kovtyuk, in the materials of his dissertation, for the degree of candidate of medical sciences "Comprehensive assessment of the development of school-age girls", code 14.01.10 - pediatrics, Lviv, 2003, assessed the degree of development and/or existing deviations in the development of the pelvic bone of girls, depending on age, stages of sexual development. The pelvic bone index (PBI) proposed by the author is calculated by multiplying the transverse size of the pelvis (distantia trochanterica), in cm, by the values of the external conjugate, in cm, and dividing by the value of the Soloviev index (in cm). The indicator ranges from 10.0 to 60.0 cm. Average PBI values are in the range of 30.0 - 40.0 cm. Girls with PBI indices less than 30.0 cm can be attributed to the risk group for the successful development of bone maturity, as one of the components of the reproductive system [6,19,20,34].

The size of the pelvis correlates with the weight and length of the body, the girth of the pelvis, as well as with the body mass index, which was proved in the study by Tian OV., *et al.* (2012) [43].

Also, in addition to the already indicated morphological and functional index values, other indexes are also actively used. These are index values such as:

1. Index of relative pelvic width (IRPW), or morphine index for women [19]. According to the results obtained, when determining this morphofunctional index value, there are distinguished: dolichomorphs, brachimorphs and mesomorphs [20].

This morphofunctional index was proposed for practical use by the famous Soviet scientist, anatomist and surgeon VN Shevkunenko in 1935 [21]. This index is a percentage of the ratio of the pelvic width (d. cristarum value, to the length of the lower limb) of the patient under study, and the pelvic width index (PWI) is the percentage of distantia interspinosa, to the length of the human body [26,35]. E.N. Khrisanfova and I.V. Carriers, 1991, also offer IRPW, with the calculation of the index of the relative width of the pelvis (IRWP) according to the formula: % ratio of the width of the pelvis index (PI) - d. cristarum, cm divided by body length, cm of this morphofunctional index value: stenopyelia (narrow pelvis) - indicators less than 15.9; metropielia (normal-average indicators of the size of the pelvis) - indicators from 16.0 to 17.9; euripielia (wide pelvis) - indicators from 18.0 and above [19-21,26,35,44].

2. The pelvic index (PI) is the sum of all 4 external dimensions of the pelvis, in cm: d. spinarum + d. cristarum + d. trochanterica + c. vera. PI scores less than 100 indicate the presence of a narrow pelvis; from 100 to 107 - for the normal size of the pelvis; more than 107 - for a wide pelvis. This morphofunctional index value, in clinical practice, is used for the anatomical and morphological characteristics of the structure and structure of the pelvis [3,45,46].
3. Index of bones pelvic (PBI), according to the method of IN Kovtyuk, 2002. According to the author's formula, the value of ICT is determined as the sum obtained by multiplying the value of d. trochanterica (intertrochanteric size), by the coniugata externa (external conjugate), and divided by the Solovyov index (SI), or coverage of the lower part of the forearm, in cm, the norms of which differ in men and women. The author points to the normative indicators of PBI, with a range of values from 10 to 60 [6,19,20,34].
4. Shoulder-pelvic index (Brachio-pelvic index) (SPI), calculated according to the methodology proposed by E.N. Khrisanfova, 2002. This indicator is defined as the mathematical percentage obtained as a result of dist. cristarum (Width pelvis), on the indicator of the width of the shoulders, in cm. This makes it possible to judge the shape of the body of the investigated person. The parameters of the obtained index values are as follows: values, up to 69.9 units, indicate a trapezoidal shape of the body, from 70.0 to 74.9 units, about an average shape of the body, values, from 75.0 units. and more, about the rectangular shape of the body [19,21].
5. Sexual dimorphism index (SDI), according to the method of J. Tanner and W. Marshall, incl. and modified by NM Sharaikina, 2005. This index, quite reliably, allows you to determine the ratio of body proportions to the sex of the person under study. Its value is calculated according to the following formula proposed by these scientists: three times the indicator of the biacromial diameter (BD), minus the value of d. cristarum multiplied by 100 (%). For women, the following sizes are accepted, in conventional units: values less than 73.1 - gynecomorphic sexual somatotype; from 73.1 to 82.1 - transitional mesomorphic sexual somatotype (sex dysplasia); indicators from 82.1 and above - pathological, inverse, andromorphic sexual somatotype. For men, the SDI values are as follows: an indicator of less than 83.7 - phenomena of gynecomorphy, from 83.7 to 93.1 - manifestations of mesomorphism, more than 93.1 - phenomena of andromorphy [11,20,45,47].
6. Andromorphy index (AI), is defined as the difference between three times the width of the shoulders, and twice the value of d. trochanterica (intertrochanteric size). Values less than 67.5 are hyperginoid; from 67.5 to 73.5 - orthoginoid type; more than 73.5 - android type [6,35].
7. Pelvic latitude index (PLI), according to V. Moskalenko and IM Rahman (1926-1929) is the percentage of coniugata externa (external conjugate), and d. spinarum. This index characterizes the longitudinal-latitude indicators of the pelvis, with the allocation, according to the authors' classification, of a wide, harmonious and narrow forms of the pelvis [19,21,35].
8. Sex steroid balance index (SSBI) $\Sigma T/R$ is an indicator of the ratio of the sum of the four external dimensions of the pelvis, in cm to body length, in cm ($\Sigma T/R$), in cm, which is used in clinical practice to characterize androgenic effects in the female

organism, incl. the pre-diagnosis of delayed development of the bone pelvis (VK Likhachev, 2007) [48], with standard indicators of 60.4 - 62.8 (VV Abramov and al., 2005; IM Shevchenko, 2006). Its standard indicators are before the onset of a woman's menarche (Me) - 55.3-60.3; after the onset of menarche - from 60.4 to 62.8 [2,49].

9. The index of masculinization /virilization (IM/VI), one of the main markers occurring in the body of a woman, incl. and an athlete, adaptive somatic changes, is calculated as the derivative of dividing the indicator of biacromial size (shoulder width), in cm, by the value of d. trochanterica (intertrochanteric size), in cm [6,45,50].
10. Index ratio A/T - (IR A/T) - biacromial diameter (shoulder width), to d. trochanterica (intertrochanteric/intertrochanteric distance/size). This index was proposed by Professor VV Abramov et al., Dnepropetrovsk Medical Academy, Ukraine), and involves assessing the severity of puberty and the degree of development of the bone pelvis. According to the authors, the A/T values at the age of 10 - 11 years can be in the range of 1.5 - 1.53. In athletes 12-14 years old, the same indicator indicates a delay in sexual development (DSD) and a lag in the development of the bone pelvis. The A/T values in athletes aged 15 - 19 years, within 1.35 - 1.44, allows us to assert, according to the authors, about primary estrogen deficiency and is a consequence of excessively intense physical activity [2,20,49,51].
11. The angle of the pubic arch (ALA) is a parameter with which it is possible to determine the shape of the exit and the size of the pelvis, based on which it is possible to predict, among other things, unfavorable intranatal outcomes associated with anatomical narrowing of the pelvis. Mudrov VA., *et al.* (2018) developed a method for mathematical calculation of the pubic arch angle when comparing ultrasound and X-ray pelvimetry [52,53].

Conclusion

The above overview information regarding the use of a sufficiently large number of morphofunctional index values, using the values of the width of the shoulders or the size of the bone pelvis, suggests that morphological sciences do not stand still, and offers for practical application a large set of available and reliable methods for determining the dynamics of formation and the development of the body of men and women, in their ontogenesis, taking into account their individual differences.

The article fully describes in detail a number of most persistent in the post-Soviet space, in scientific and practical activities, morphofunctional index values associated with the size of the female bone pelvis.

The presented morphofunctional index values are useful for active use in anatomy, morphology, obstetrics, anthropology, sports medicine and forensic examination.

Conflict of Interest

The author notes the complete absence of any conflicts of interest.

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Volume 12 Issue 10 October 2021

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