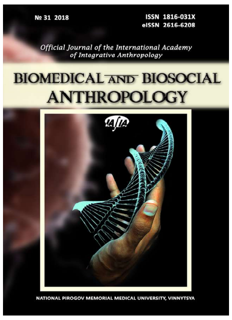
DOI: 10.31393/bba31-2018-07 Biomedical and Biosocial Anthropology, №31, Pages 53-58

ISSN 1861-031X eISSN 2616-6208

BIOMEDICAL AND BIOSOCIAL ANTHROPOLOGY

Official Journal of the International Academy of Integrative Anthropology

journal homepage: http://bba-journal.com



Regression models of sonographic parameters of the kidneys in practically healthy women of the ectomorphic somatotype depending on the peculiarities of body size

Ustymenko O. S.

Bogomolets National Medical University, Kyiv, Ukraine

ARTICLE INFO

Received: 12 March, 2018

Accepted: 25 April, 2018

UDC: 616-073.4-8:616.61:616-055.1:616-055.2

CORRESPONDING AUTHOR

e-mail: lena_ustimenko@rambler.ru

Ustymenko O. S.

The study of the constitutional features of organs in the healthy population makes it possible to find out the peculiarities of changes in their sizes in different pathologies. The purpose of the work is to construct and analyze the regression models of individual sonographic sizes of the kidneys in practically healthy women of the ectomorphic somatotype, depending on the features of anthropo-somatotypological parameters of the body. From the database of research center of the National Pirogov Memorial Medical University, Vinnytsya (within the framework of the agreement on scientific cooperation) were taken the primary sonographic parameters (length, width, front and rear size, area of the longitudinal and cross section of the kidneys and their sinuses, as well as the volume of the right and left kidneys) and anthropometric indices (according to V. V. Bunak in the modification of P. P. Shaparenko) of practically healthy women-ectomorphs of the first mature age, who in the third generation live in the Podillia region of Ukraine. Regression models of individual sonographic sizes of the kidneys, depending on the features of anthropo-somatotypological parameters of the body, are constructed using the license package "Statistica 6.1". In practically healthy women of the ectomorphic somatotype all 16 possible reliable regression models of sonographic parameters of the right and left kidneys, based on the anthropometric and somatotypological parameters with determination coefficient R^2 from 0.607 to 0.973, were constructed. Constructed regression models of sonographic parameters of both kidneys in practically healthy women of the ectomorphic somatotype most often include body diameters (24.2% of the total number of indicators included in the models), circumferential body sizes (20.9%), cephalometric indices (19.8 %) and the thickness of skin and fat folds (14.3%). The regression models of sonographic parameters of the right kidney in women of the ectomorphic somatotype most often include diameters and circumferential body sizes (by 27.3% of the total number of indicators included to the models of right kidney) and cephalometric indices (18.2%). The regression models of the sonographic parameters of the left kidney in women of the ectomorphic somatotype most often include body diameters and cephalometric indices (by 21.3% of the total number of indices included to the models of the left kidney) and the circumferential body size and thickness of skin and fat folds (by 14.9%).

Keywords: *regression analysis, sonographic parameters of the kidneys, anthropometry, practically healthy women, ectomorphic somatotype.*

Introduction

Kidneys perform a number of homeostatic functions, and the presentation of them only as an organ of urination does not reflect the true significance of them. The functions of the kidneys include their participation in regulation: the volume of blood and other liquids of the internal environment; the constancy of osmotic blood pressure, the ionic composition of the internal environment fluids and the ionic balance of the organism; acid-base equilibrium; excretion of end products of nitrogen, carbohydrate metabolism and foreign substances; blood pressure; blood clotting; stimulation of erythropoiesis; the secretion of enzymes and biologically active substances, the exchange of proteins, lipids and carbohydrates [15, 29].

Given its multifunctionality, this organ is an indicator of a large number of pathological conditions. Differential diagnosis of an increase or decrease of the organ include both nephrological and non-nephrological diseases [7, 22, 30].

Introduction to the clinical practice of sonography provides additional opportunities for timely detection of diseases of the body and the resolution of questions of surgical tactics [13]. Some pathological conditions run for a long time without clinical symptoms, and therefore it is especially important to have additional markers of health impairment. To identify changes in kidney size, it is important to determine the normative parameters of the size of the organ, which reflects their functional state [16, 22].

Even in healthy people, the size of the kidneys shows great variation. Variant anatomy of the kidneys is quite variable, depending on the constitutional type, age and sex [1, 20, 23]. Meanwhile, dimensional standards can only be used for a limited period of time (reviewed every 10 years) and specific to different ethnic groups [21].

The study of the constitutional features of an organ allows us to find out the regularities of the course of its changes and to develop diagnostic algorithms for timely detection of the limits of anatomical variability. This contributes to the individualization of the norm, the improvement of methods for early diagnosis and the development of new methods of surgical correction of congenital malformations and treatment of kidney cancer pathology [6, 11, 14].

Until now, formulas and regression equations designed to predict kidney size were convenient for use but did not reflect the anthropometric features of the subject or only one to two body sizes [24, 25, 26]. In general, the authors proposed to evaluate the linear and volumetric sizes of the kidneys only depending on height, weight and area of the body surface. This complicated the diagnostic process and led to the emergence of false medical conclusions [19].

In the literature available to us, data on the analysis of connections of kidney size and somatometric parameters with the subsequent construction of regression models in healthy subjects of various somatotypes was practically not detected [2, 8, 9, 10]. And this happens despite the fact that mathematical modeling is easy to use and accessible for use in outpatient and inpatient settings with a contingent of a certain age and constitution [5, 12].

Therefore, it was quite logically necessary to use an informative, widely available and accurate method of mathematical assessment of the correspondence of the size of the kidney norm or deviation from it by constructing a regression equation that considers the correlation of the parameters of the body with the complex of anthropo-somatometric indices in healthy individuals of a certain constitutional type.

The purpose of the work is to construct and analyze the regression models of individual sonographic sizes of the kidneys in practically healthy women of the ectomorphic somatotype, depending on the features of anthropo-somatotypological parameters of the body.

Materials and methods

Within the framework of the agreement on scientific cooperation from the database of the research center of the National Pirogov Memorial Medical University, Vinnytsya were taken the primary sonographic parameters and anthropometric indices of 121 practically healthy women of the first mature age (from 21 to 35 years old), who in the third generation live in the Podillia region of Ukraine.

The sonographic study of the kidneys (determination of length, width, anterior-posterior size, area of the longitudinal and transverse sections of the kidneys and their sinuses, as well as the volume of the right and left kidneys [18]) was performed using the ultrasound diagnostic system "CAPASEE" SSA-220A (Toshiba, Japan) with 3.75 MHz Convex Sensor and Voluson 730 Pro Ultrasound Diagnostic System (Austria), 4-10 MHz Convex Sensor.

An anthropometric survey was conducted for all women by V. V. Bunak in the modification of P. P. Shaparenko [27]. The evaluation of the somatotype was carried out according to the mathematical scheme of J. Carter and B. Heath [3]. Determination of fat, bone and muscle mass components of the body was calculated using the formulas of J. Matiegka [17]. In addition, the muscle component of the body mass was calculated using the formulas of the American Institute of Nutrition [28].

For the construction of regression models of individual sonographic sizes of the kidneys, depending on the peculiarities of anthropo-somatotypological parameters of the body, the licensed package "Statistica 6.1" was used. In the direct stepwise regression analysis, we determined the following conditions: the final version of the model should have a determination coefficient (R^2) of not less than 0.50, the value of the F-criterion is not less than 2.5, and the number of free members included in the model must be minimal.

Results

In the practically healthy urban women of the ectomorphic somatotype (n = 18), the following reliable models of sonographic parameters of the kidneys were constructed, depending on the characteristics of anthropo-somatotypological indicators:

RE_R_DL (the length of the right kidney in the longitudinal section) = 70.25 + 3.797 x $OBPL_1$ + 3.538 x OM - 2.539 x OBT + 1.498 x GBD + 3.860 x OBSH - 3.401 x B_DL_GL (R^2=0.871; $F_{(6.11)}$=12.34; p<0.001; St. Error of estimate=3.681),

where (here and hereinafter), R^2 - coefficient of determination; $F_{(!.!!)}$=!!.!! - critical (!,!!) and got (!!,!!) value of Fisher's criterion; St. Error of estimate - standard error of the standardized regression coefficient; $OBPL_1$ - girth of the shoulder in a tense state (cm); OM - bone component of body weight by Matiegka (kg); OBT - waist circumference (cm); GBD - thickness of skin and fat folds (TSFF) on the thigh (mm); OBSH - neck circumference (cm); B_DL_GL - greatest length of the head (cm);

RE_L_DL (the length of the left kidney in the longitudinal section) = 142.2 + 2.474 x GG + 6.294 x MX + 3.343 x CONJ - 2.159 x $OBPR_1$ - 1.818 x SH_N_CH - 3.799 x B_DL_GL (R^2=0.898; $F_{(6.11)}$=16.20; p<0.001; St. Error of estimate=2.683),

where (here and hereinafter), GG - TSFF on the stomach (mm); MX - mesomorphic component of the somatotype by Heath-Carter (mark); CONJ - external pelvis conjugate (cm); $OBPR_1$ - the forearm's girth in the upper third (cm); SH_N_CH - width of the lower jaw (cm);

RE_R_PO (width of the right kidney in the longitudinal section) = 28.52 - 1.079 x CRIS + 5.348 x B_SH_GL - 1.683 x OBG_2 - 0.707 x SGK + 0.361 x OBG1 (R^2=0.948; $F_{(5.12)}$=43.95; p<0.001; St. Error of estimate=1.554),

where (here and hereinafter), CRIS - intercrest distance of the pelvis (cm); B_SH_GL - maximum head width (cm); OBG_2 - the circumference of the shin in the lower third (cm); SGK - anterior-posterior chest size (cm); OBG1 - the circumference of the shin in the upper third (cm);

RE_L_PO (the width of the left kidney in the longitudinal section) = 28.36 + 1.194 x SH_N_CH + 2.682 x MX + 3.370 x EPB - 1.262 x OBG_2 + 0.995 x CONJ - 0.805 x SGK (R^2=0.933; $F_{(6.11)}$=25.45; p<0.001; St. Error of estimate=1.386),

where (here and hereinafter), EPB - width of the distal epiphysis (WDE) of thigh (cm);

RE_R_TO (anterior-posterior size of the right kidney on a cross-section) = 60.63 - 0.996 x CRIS - 1.904 x GZPL + 2.109 x PSG - 2.163 x SH_LICA + 0.404 x $OBGK_2$ - 6.278 x EPPL + 0.395 x GG (R^2=0.963; $F_{(7.10)}$=36.67; p<0.001; St. Error of estimate=1.652),

where (here and hereinafter), GZPL - TSFF on the back of the shoulder (mm); PSG - transverse mid-thorax size (cm); SH_LICA - face width (cm); $OBGK_2$ - girth of the chest on exhalation (cm); EPPL - WDE of shoulder (cm);

RE_L_TO (anterior-posterior size of the left kidney on a cross-section) = 23.85 + 2.390 x PSG + 0.822 x GBD - 1.971 x B_DL_GL + 1.083 x GPPL - 0.151 x ATV (R^2=0.914; $F_{(5.12)}$=25.43; p<0.0001; St. Error of estimate=1.451),

where (here and hereinafter), GPPL - TSFF on the front of the shoulder (mm); ATV - the height of the trochanter point (cm);

RE_R1SRE (area of the longitudinal section of the right kidney) = -29.99 + 1.939 x $OBPL_1$ + 2.142 x SH_N_CH (R^2=0.607; $F_{(2.15)}$=11.58; p<0.001; St. Error of estimate=4.975);

RE_R2SRE (square cross section of the right kidney) = 13.69 - 1.488 x GZPL + 1.067 x PSG - 0.492 x SAG_DUG + 0.823 x $OBPR_1$ - 0.493 x TROCH (R^2=0.942; $F_{(5.12)}$=39.17; p<0.001; St. Error of estimate=1.132),

where (here and hereinafter), SAG_DUG - sagittal arc of the head (cm); TROCH - intertrochanter distance of pelvis (cm);

RE_L1SRE (area of the longitudinal section of the left kidney) = -64.04 + 7.872 x B_SH_GL - 3.364 x OBG_2 + 1.880 x CONJ + 1.424 x GZPL - 0.714 x GB + 0.997 x OBS (R^2=0.952; $F_{(6.11)}$=36.48; p<0.001; St. Error of estimate=1.627),

where (here and hereinafter), GB - TSFF on the side (mm); OBS - foot girth (cm);

RE_L2SRE (cross-sectional area of the left kidney) = -1.124 + 8.661 x EPG - 0.294 x CRIS - 0.444 x ATP + 1.326 x MX - 5.792 x EPPR + 0.591 x ACR + 0.665 x GGR (R^2=0.945; $F_{(7.10)}$=24.55; p<0.001; St. Error of estimate=1.003),

where (here and hereinafter), EPG - WDE of shin (cm); ATP - height of the finger point (cm); EPPR - WDE of forearm (cm); ACR - shoulder width (cm); GGR - TSFF on the chest (mm);

RE_R1SSI (area of the longitudinal section of the sinus of the right kidney) = 43.54 + 0.749 x OBG_1 - 1.187 x ATPL + 2.650 x EPB + 0.784 x ATV + 1.004 x CONJ - 1.085 x OB_GL (R^2=0.904; $F_{(6.11)}$=17.25; p<0.001; St. Error of estimate=1.248),

where (here and hereinafter), ATPL - height of shoulder point (cm); OB_GL - girth of the head (cm);

RE_R2SSI (square cross section of the sinus of the right kidney) = -388.0 - 48.08 x GZPL + 27.24 x PSG + 23.02 x SH_N_CH + 30.88 x $OBPL_2$ - 26.61 x $OBPR_2$ + 24.43 x SPIN - 19.93 x TROCH (R^2=0.965; $F_{(7.10)}$=39.81; p<0.001; St. Error of estimate=37.03),

where (here and hereinafter), $OBPL_2$ - shoulder girdle in a non-stressed state (cm); $OBPR_2$ - girth of the forearm in the lower third (cm); SPIN - interspine distance of pelvis (cm);

RE_L1SSI (sectional area of the longitudinal sinus of left kidney) = -33.70 + 2.262 x B_SH_GL - 1.078 x B_DL_GL + 0.381 x SAG_DUG + 0.811 x OBSH - 0.270 x GB (R^2=0.939; $F_{(5.12)}$=36.95; p<0.001; St. Error of estimate=0.720);

RE_L2SSI (square cross section of the sinus of the left kidney) = 2292 + 37.30 x TROCH - 43.57 x ATND + 242.1 x OM - 361.7 x EPPR + 19.00 x OBBB + 32.45 x ACR (R^2=0.930; $F_{(6.11)}$=24.50; p<0.001; St. Error of estimate=44.09),

where (here and hereinafter), ATND - height of suprasternum point (cm); OBBB - hips circumference (cm);

RE_R_VRE (volume of the right kidney) = -154.1 - 7.926 x CRIS + 32.06 x B_SH_GL - 9.552 x OBG_2 + 2.456 x ATP - 3.130 x GL + 3.586 x PNG (R^2=0.973; $F_{(6.11)}$=65.94; p<0.001; St. Error of estimate=6.740),

where (here and hereinafter), GL - TSFF under the shoulder blade (mm); PNG - transverse lower-thoracic size (cm);

RE_L_VRE (volume of the left kidney) = -264.7 + 5.600 x PSG + 10.67 x MX + 21.26 x EPB + 4.418 x SAG_DUG - 11.47 x B_DL_GL + 4.656 x OBSH (R^2=0.945; $F_{(6.11)}$=31.22; p<0.001; St. Error of estimate=6.235).

Discussion

Thus, in practically healthy women of the ectomorphic somatotype all 16 possible reliable regression models of sonographic parameters of the right and left kidneys were constructed depending on the anthropometric and somatotypological parameters with the determination coefficient R^2 from 0.607 to 0.973 (for the right kidney R^2 from 0.607 to 0.973; for the left kidney R^2 from 0.898 to 0.952).

Constructed regression models of sonographic parameters of both kidneys in practically healthy women of the ectomorphic somatotype most often include body diameters (24.2% of the total number of indicators included in the models), circumferential body sizes (20.9%), cephalometric indices (19.8%) and the thickness of skin and fat folds (14.3%). Among the individual anthropo-somatotypological parameters of the body models most often include the largest head length and transverse mid-thoracic size (up to 5 models), the largest head width, the width of the lower jaw, the outer pelvis conjugate, the pelvic intercrest distance, shin girth in the lower third, the thickness of the skin-fat fold on the back of the shoulder and the mesomorphic component of the somatotype of the Heath-Carter (up to 4 models).

The regression models of sonographic parameters of the right kidney in women of the ectomorphic somatotype most often include diameters and circumferential body sizes (by 27.3% of the total number of indicators included to the models of right kidney) and cephalometric indices (18.2%). Among the individual anthropo-somatotypological parameters of the body to the models of the right kidney most often include the transverse mid-thoracic size, the intercrest distance of the pelvis and the thickness of the skin-fat fold on the back of the shoulder (up to 3 models).

The regression models of the sonographic parameters of the left kidney in women of the ectomorphic somatotype most often include body diameters and cephalometric indices (by 21.3% of the total number of indices included in the models of the left kidney) and the circumferential body size and thickness of skin and fat folds (by 14.9%). Among the individual anthropo-somatotypological parameters of the body models of the left kidney most often include the greatest length of the head and the mesomorphic component of the somatotype (up to 4 models) and the outer conjugate of the pelvis (up to 3 models).

In previous studies [4, 31], we found that in practically healthy women of mesomorphic somatotypes of 16 possible sonographic parameters of the right and left kidneys, based on anthropometric and somatotypological indicators, were constructed 7 reliable models with a determination coefficient from 0.607 to 0.641, and for women endo-mesomorphic somatotype - 14 valid models with a determination coefficient from 0.672 to 0.912. In women of mesomorphic somatotype constructed models most often include the circumferential dimensions of the body (29.8%) and cephalometric indices (19.1%). In women of the endo-mesomorphic somatotype constructed models of the right kidney most often include cephalometric indices, body diameters, and circumferential body sizes (by 24.2%), and models of the left kidneys - circumferential body dimensions (22.2%), body diameters, and TSFF (17.8%) and cephalometric indices (15.6%).

Thus, as a result of the use of regression analysis, it is possible for each researched to calculate the size of the kidneys according to the equations specific to the Podillia region of Ukraine, and, if necessary, to compare them with the corresponding nomograms for the assessment of the state of the organ. It expands the boundaries of the diagnosis of the physiological state of persons of the first mature age and promotes the identification of the risk group of contingent, prone to kidney disease, at an early or preclinical stage.

Conclusions

1. In practically healthy women of ectomorphic somatotype of 16 possible sonographic parameters of the right and left kidneys, based on the anthropo-somatotypological indicators, all 16 valid models with a determination coefficient, respectively, from 0.607 to 0.973 and from 0.898 to 0.952 were constructed.

2. Models constructed for women of ectomorphic somatotype most often includes: for the right kidney - the diameters and the circumferential dimensions of the body (by 27.3%) and cephalometric indices (18.2%); for the left kidney - body diameters and cephalometric indices (by 21.3%) and the circumferential dimensions of the body and the thickness of skin and fat folds (by 14.9%).

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РЕГРЕСІЙНІ МОДЕЛІ СОНОГРАФІЧНИХ ПАРАМЕТРІВ НИРОК У ПРАКТИЧНО ЗДОРОВИХ ЖІНОК ЕКТОМОРФНОГО СОМАТОТИПУ В ЗАЛЕЖНОСТІ ВІД ОСОБЛИВОСТЕЙ РОЗМІРІВ ТІЛА

Устименко О. С.

Вивчення конституціональних особливостей органів у здорового населення дозволяє з'ясувати особливості змін їх розмірів при різних патологіях. Мета роботи - побудувати та провести аналіз регресійних моделей індивідуальних сонографічних *розмірів нирок у практично здорових жінок ектоморфного соматотипу в залежності від особливостей антропо-соматотипологічних параметрів тіла. Із бази даних науково-дослідного центру Вінницького національного медичного університету ім. М. І. Пирогова (у рамках договору про наукове співробітництво) взяті первинні сонографічні параметри (довжина, ширина, передньо-задній розмір, площа поздовжнього та поперечного перерізу нирок та їх синусів, а також об'єм правої і лівої нирок) і антропометричні показники (за В. В. Бунаком у модифікації П. П. Шапаренка) практично здорових жінок-ектоморфів першого зрілого віку, які у третьому поколінні проживають на території Подільського регіону України. Регресійні моделі індивідуальних сонографічних розмірів нирок в залежності від особливостей антропо-соматотипологічних параметрів тіла побудовані за допомогою ліцензійного пакету "Statistica 6.1". У практично здорових жінок ектоморфного соматотипу побудовані усі 16 можливих достовірних регресійних моделей сонографічних параметрів правої та лівої нирок в залежності від антропометричних і соматотипологічних показників із коефіцієнтом детермінації R^2 від 0,607 до 0,973. До побудованих регресійних моделей сонографічних параметрів обох нирок у практично здорових жінок ектоморфного соматотипу найчастіше входять діаметри тіла (24,2% від загальної кількості показників, що входять до моделей), обхватні розміри тіла (20,9%), кефалометричні показники (19,8%) і товщина шкірно-жирових складок (14,3%). До регресійних моделей сонографічних параметрів правої нирки у жінок ектоморфного соматотипа найчастіше входять діаметри й обхватні розміри тіла (по 27,3% від загальної кількості показників, що входять до моделей правої нирки) та кефалометричні показники (18,2%). До регресійних моделей сонографічних параметрів лівої нирки у жінок ектоморфного соматотипа найчастіше входять діаметри тіла і кефалометричні показники (по 21,3% від загальної кількості показників, що входять до моделей лівої нирки) та обхватні розміри тіла і товщина шкірно-жирових складок (по 14,9%).*

Ключові слова: *регресійний аналіз, сонографічні параметри нирок, антропометрія, практично здорові жінки, ектоморфний соматотип.*

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Устименко Е. С.

Изучение конституциональных особенностей органов у здорового населения позволяет выяснить особенности изменений их размеров при различных патологиях. Цель работы - построить и провести анализ регрессионных моделей индивидуальных сонографических размеров почек у практически здоровых женщин эктоморфного соматотипа в зависимости от особенностей антропо-соматотипологических параметров тела. Из базы данных научно-исследовательского центра Винницкого национального медицинского университета им. Н. И. Пирогова (в рамках договора о научном сотрудничестве) взяты первичные сонографические параметры (длина, ширина, передне-задний размер, площадь продольного и поперечного сечения почек и их синусов, а также объем правой и левой почек) и антропометрические показатели (по В. В. Бунаку в модификации П. П. Шапаренко) практически здоровых женщин-эктоморфов первого зрелого возраста, в третьем поколении проживающих на территории Подольского региона Украины. Регрессионные модели индивидуальных сонографических размеров почек в зависимости от особенностей антропо-соматотипологических параметров тела построены с помощью лицензионного пакета "Statistica 6.1". У практически здоровых женщин эктоморфного соматотипа построены все 16 возможных достоверных регрессионных моделей сонографических параметров правой и левой почек в зависимости от антропометрических и соматотипологических показателей с коэффициентом детерминации R^2 от 0,607 до 0,973. К построенным регрессионным моделям сонографических параметров обеих почек у практически здоровых женщин эктоморфного соматотипа чаще всего входят диаметры тела (24,2% от общего количества показателей, которые входят в модели), обхватные размеры тела (20,9%), кефалометрические показатели (19,8%) и толщина кожно-жировых складок (14,3%). К регрессионным моделям сонографических параметров правой почки у женщин эктоморфного соматотипа чаще всего входят диаметры и обхватные размеры тела (по 27,3% от общего количества показателей, входящих в модели правой почки) и кефалометрические показатели (18,2%). К регрессионным моделям сонографических параметров левой почки у женщин эктоморфного соматотипа чаще всего входят диаметры тела и кефалометрические показатели (по 21,3% от общего количества показателей, входящих в модели левой почки) и обхватные размеры тела, а также толщина кожно-жировых складок (по 14,9%).

Ключевые слова: *регрессионный анализ, сонографические параметры почек, антропометрия, практически здоровые женщины, эктоморфный соматотип.*