

Instructions for the Use of the Computer Program to Obtain the Diagnosis of Bone Age (by Hand and Tarsus) and Prediction of Adult Size of Spanish Child

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ABSTRACT

In this article, the authors detail the necessary instructions to proceed correctly to interpret the computer program to calculate the bone age and prognosis of adult size of the child under study. This program is free download from the website of the Illustrious College of Medical of Zaragoza (Spain) <https://www.comz.org/maduracion-osea>

Once downloaded on the computer, the practical doctor: radiologist, pediatrician, endocrine or researcher, from the hospital intranet, he will be able to perform the appropriate radiological measures of left hand and Tarsus, as detailed in the attached schemes and figures. When introducing them to the program's computer window, together with the size of the child and parents, the diagnosis of the child's bone age and the prognosis of their adult size can be obtained. Thus, it will be possible to know if the bone age is normal, advanced or delayed, and can be required in these cases to expand the study by other procedures as analytics.

The database of children who have served to prepare this program has been obtained from the Spanish Longitudinal Series of the Andrea Prader Center.

Keywords: Computer program; bone age; radiography measurement; hospital intranet.

1. INTRODUCTION

Since December 11, 2015, from the website (www.comz.org/maduracion-osea) of the Illustrious College of Physicians of Zaragoza (Spain) here is the possibility of free discharge of the computer program for the calculation of bone age (hand and tarsus regions) and prediction of adult size of a child under study, installing in the computer the file: "Winrar Zip installer (.zip): Ebrí SetUp IV17.06.22"

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This will allow, once discharged and installed on the user's computer, the program is used from the intranet of the health work network, to calculate the bone age and the prediction of the height of the adults of the child under study. In this article we detail the rules of use of the software itself, such as digital radiography measurement standards in intranet, radiological schemes, and updated bibliography in this regard.

The attached diagrams illustrate how to perform the measurements of the bones, and the computer window gives us the diagnosis of the bone age and prognosis of size, once the measurements in the program have been introduced.

It is advisable to work from Intranet, where it is possible to use the digital measurement tool of the bone bones and radiological metacarpals, from the hospital archive, to study children's series. The program is downloaded from the web cited to the doctor's computer, and following the rules of interpretation that we explain in the discussion section, once the bone measurements and data of the child and parents are introduced, it can be obtained fast and automatically the child's age and his prognosis of adult stature.

We hope that this service offered to interested doctors, mainly pediatricians, endocrinologists and radiologists, will be useful in their daily practice.

From this Spanish study, we estimate that the predictions will be more precise for Spanish and Hispanic children, but it can also be used in Anglo -Saxon children. The minimum time required to learn the technique will be widely rewarded by the most precise results. We believe that the method can also be used for biomedical research.

In the attached bibliography [1-15] our collaboration is reflected for many years in the study of these biological parameters of great importance such as bone age and the size of the child, as well as the importance of these parameters for research and making doctoral thesis [9].

2. DISCUSSION AND CONCLUSION

2.1 User Manual for Ivos-Ebrí Program

Through the Ebrí methodical applied to the indexes: IC (carpal), IMF (metacarpophalangeal and ICMF (carpal-metacarpophalangeal) and after introducing in the General Program for children from 0.5 to 20 years, the data of the child and the measurements of the maximum diameters of the carpal and metacarpophalangeal ossification nuclei studied, the predictive diagnoses, both of bone age and prediction of adult height, can be obtained automatically and directly. Likewise, once the installer downloaded and executed, the user will have a specific program for children from 0 to 4 years old, for the purpose of a more accurate calculation for these short ages of bone age (not for prediction of adult

height). And another program, for the region of Tarsus, for children 0 to 4 years, in order to calculate the bone age in this region, which serves as a support to further specify the ossification (it does not serve to predict adult height). The user will have to download and install on the computer, the file WinRAR ZIP (.zip): Ebri SetUp iv17.06.22 attached, which carries the program: "Ebri-Hand and foot". When executing the file, the program will be installed in the computer, being searched in "All the programs". (To do this, go to the Windows icon located in the upper left corner of the computer, and click on it. When doing so, the user will see "All programs", and clicking on it, will open, letting the program "Ebri Hand and Foot." Clicking on it again, will open up and let you see different options: 1) Uninstall the program; 2) First aid (brief information on the program); 3) Program Ebri Hand 4 years; 4) Ebri Hand Program (General Series of 0.5 to 20 years); 5) Program Ebri Foot 4 years.

By clicking on any of these programs, a column is opened, where the user can enter the data: measurements of the bones (in mm, those of the hand and in cm of the feet), data of the child as sex and dates of birth and RX, size of him and his parents in cm. Once entered, "Vale" is clicked and the enclosed white space will be filled with the child's ossifying diagnosis and his prediction of adult height. Clicking on the column in "User Manual" opens an information window about the most detailed features of the program itself.

During the installation of the WinRAR ZIP File (.zip) the question will arise if the user wants to install a program icon on the desktop. If so desired, a torch-shaped icon of the 3 programs will be installed, and clicking on each one of them will appear the data entry column, and the user can act directly on this icon.

The data specified in the open column will be filled out by the user, such as the child's initials, gender: Male (H) or Female (M), the measurements of the bones in their maximum distances

(See schemes), child size and parents in centimeters, date of birth of the child and the x-ray(day and month to two digits, year in four digits). The x-ray of the hand from which the measurements are taken has to be left-hand and dorsopalmar projection, including the distal ends of cubit and radius. From a lateral x-ray of the foot and in a dorsoplantar projection, as described in the radiological charts, measurements of the tarsus (right foot) are obtained. In this way and after being entered the data of the child are validated by clicking on: "Okay!"

Thus, the following programs automatically give us the three ossific indexes of the hand: (A program calculates bone ages from 0.5 years to 20 years, and another from 0 to 4 years). Another program is for the Tarsal Index, for the calculation of the bone age from this region (children from 0 to 4 years). In all of them, osseous ages quantified by each index, and so- called IVOS (ossific indexes) that allow the reading of bone age directly, will be shown in the form of full normal, advanced or "normal" or significant delay, being recommended then

a study or follow-up of the child. The program of 0.5 to 20 years of age allows us to obtain Adult Height Predictions (PTA) through the three indices described, and in two ways: with and without the paternal mean size. The programs for children from 0 to 4 years, only allow the calculation of the Bone Age.

If you enter the data, whether the size or measurements of the bones, the program does not support them, information appears that details the causes for not accepting the data: Usually in the sizes is usually an inadequate measure, and in the nuclei some false measures by excess. Whole numbers followed by decimals, either because of mistakes in the size of the child or in the size of the bone, must be separated from the decimal by a period (.) not by a comma (,) since it is not recognized as a numerical value. If you enter several decimals, the program rounds them.

Obviously, for a correct PTA, the size of the child we introduce into the program must be obtained at a date as close as possible to the date of the hand radiograph. The size of the study child we introduce is assimilated by the program, which refers the data to the prediction equations belonging to each group of the children's base in Aragon.

The software, is well adjusted to the PTA, in a period of validity from the three years and half to 17 and a half. At bone ages outside these limits, the program does not gives estimates of PTA, although if bone age.

Obtaining PTA could also be obtained manually with a calculator from the age of four, through the prediction equations of a variable (indices), two variables (indices and size of the child) and three variables (indices, child, and paternal mean size; Equations published in the accompanying bibliographical citations. The program, of course, simplifies and automates manual calculation. The measurements obtained from the maximum diameters of the carpal bones, metacarpals and phalanges studied, as well as the radial and cubital distal epiphyses are made in millimeters and their tenths. Measurements of tarsal bones are done in cm. All the measurements have been obtained with a calimeter, nonius or a king's foot, observing the indications of measurement of these bones, as can be observed in the radiological schemes published in the attached bibliography.

As today, physical X-ray is not usually available, the measurements of the bones have to be made with a digital measuring tool, available in the X-ray viewer of intranet.

2.1.1 Management of radiological measurements obtained in the intranet viewer RX. standards of measure in the bones of the hand in the viewer of X-rays after being installed in the 'Ebrí-IVOS program 'on the computer to calculate the bone age and the prediction of adult height of the child

The Installer WinRAR ZIP File (.zip): Ebri SetUp iv17.06.22, ("Ebrí Hand and Foot") will be installed on the user's computer, before the measurement of the bones of the hand. Opening this one will appear a series of icons, in the

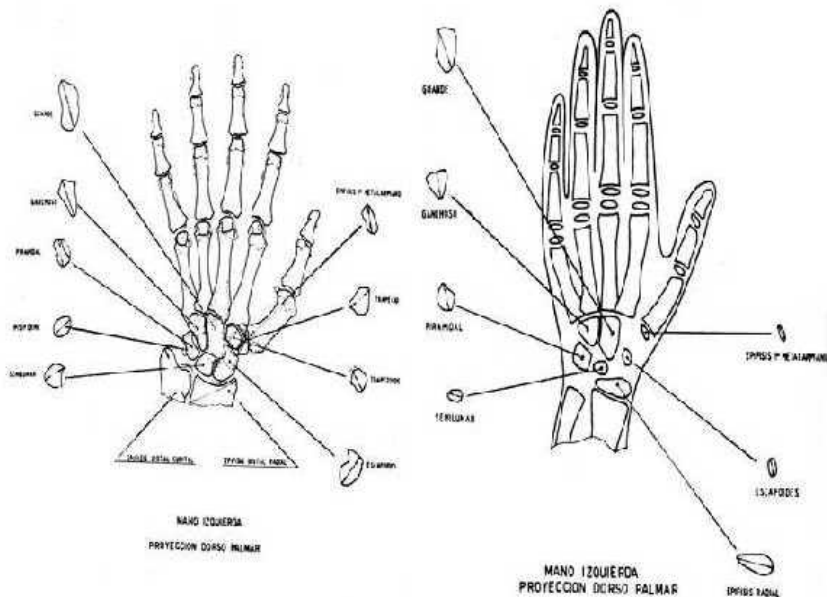
shape of a torch and it is here where we have to click on it again. Then a white space and a column with the name of the bones of the hand appear, as well as spaces to put the name of the patient, sex, date size of the child and the parents on it. It will then minimize the open image in the taskbar of the computer, while we proceed to enter the Healthcare Network Intranet.

Once in it, x-ray of patient's left hand is located to study, or lateral and dorsoplantar radiographs of the right foot to study, then opening the display where the radiographic image can be seen. Search on it: tools icon with the name of 'point to point' or 'distance' measuring instrument (terminology that varies depending on the used display). In any case, click on that instrument, so 'the mouse' is enabled to carpal bones and epiphysis nuclei that have to be measured in the hand. Thus maximum distances 'point to point' are measured to these bones and nuclei. The carried out measures will appear printed on the measured bone (See the attached diagrams that guide how to measure these maximum distances, as well as publications and the book of 'Maturing Bone' included in it). If there was an error in the measure putting 'the mouse' over the wrong measure clicking on it with the right side of 'the mouse', we can select the option of 'delete annotation'. The measures are in mm and tenths of millimeters (mm) or in centimeters (cm) in the foot. Depending on the viewer that is used for the measurement, may only allow the measurements in mm, rounding the figures without tenths. In any case and taking into account that the measurements are made about 21 bones in the hand and 9 bones in the foot, and whose result is an average, the possible errors of tenths in rounding are sometimes compensated by more and sometimes by less. It is advisable to measure a bone and then point the figure in the open column of the 'Ebrí Program' that will be minimized in the taskbar of the computer, but when you click on it (torch icon) becomes large and appears on the computer screen, then taking advantage to type the numbers obtained on the spaces prepared in it. It will proceed to continue measuring bone by bone, taking the measurements to the column. At the end of these, we fill other data such as size in cm, dates, sex, and initials of the patient.

Once completed everything, we click on 'Ok' column of data. Then in the blank space will appear the bone age by the three methods IVO-Ebrí diagnosis and the prediction of the adult height of the child (General Series) (See the outline of a clinical case in the window of the computer where an example of a patient is detailed). Likewise, bone age can be obtained in children aged 0 to 4 years by the three IVO-Ebrí and IVO-Tarsiano methods.

2.1.2 New modifications of the ebrí computer program, for the calculation of the bone age and prediction of adult height of the child

On July 1 (2017), you can already have access to the new version of Dr.Ebrí's computer program, which appears on the banner (bone maturation) of the website (www.comz.org) of the illustrious College of Physicians of Zaragoza.



Scheme 1. Scheme of obtaining the maximum diameters of the bones of the carpus

This new program allows after having been downloaded in the user's computer, through a running installer, the possibility of having three programs for the calculation of the bone age of the children under study: a) Program for children from 0.5 to 20 years, through the left hand dorsopalmar Rx, which also allows the predictive calculation of Adult Size; B) Specific program for the calculation of the bone age of children from infants to 4 years, through left-hand Rx dorsopalmar; C) Program that allows the calculation of the age of the child through the tarsus (lateral Rx and dorsoplantar standing) from newborn to 4 years.

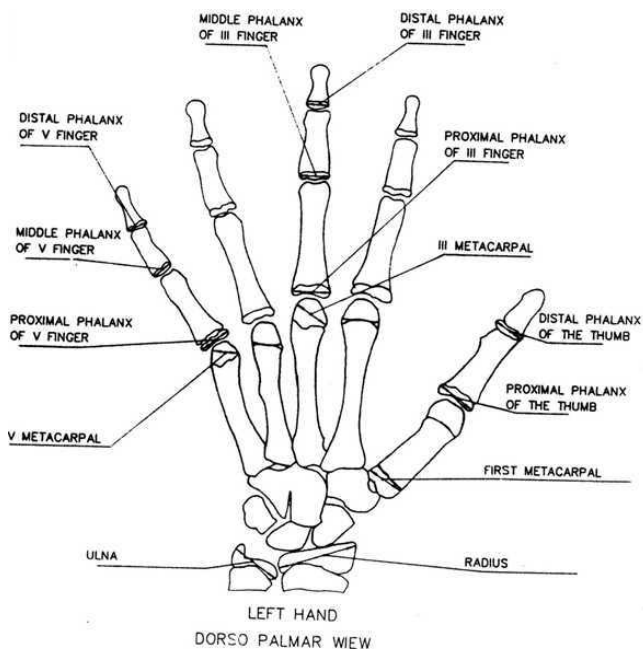
These programs, already have inserted the indications of use.

It is interesting to note that in the ossific diagnosis of the child, bone age (relative to chronological age) may be "normal, advanced or delayed" (calculated through the IVOS: IC, IMF, ICMF, IT). And if there is no significant delay or advance, (as the program does, if it occurs) it will not require further cause-finding studies, since they are within the normal distribution of the Gaussian Curve. Consequently, for example, a delayed or advanced bone age with respect to the chronological period can be given and considered as normal through the IVOS.

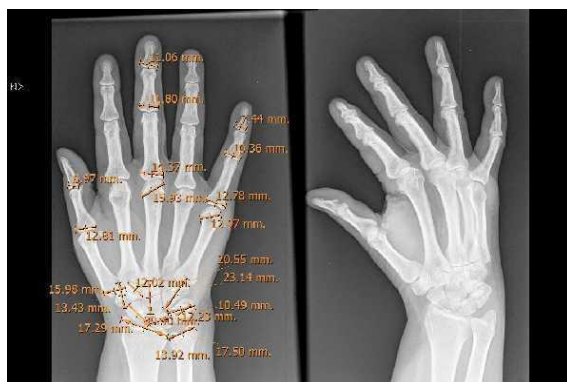
The new programs made for children up to four years fit better for these ages, since the general equations can give lower IVO values, due to the "weight" of the

older children of the "Andrea Prader" General Casuistry on the Children.

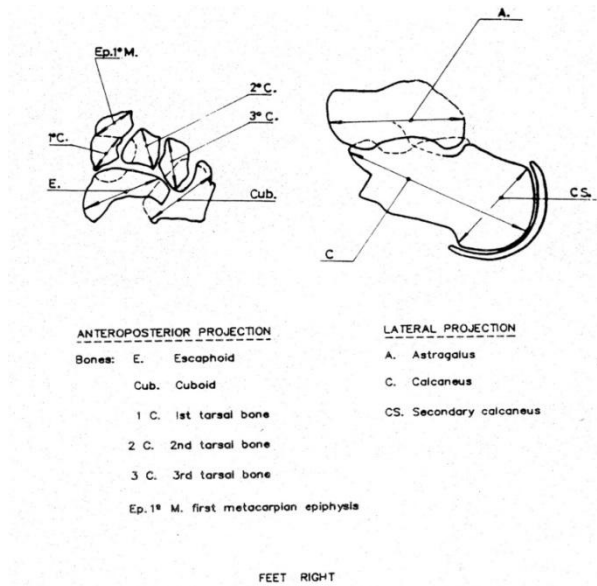
The comments of the users, can be directed to the email: b.ebri@yahoo.es
 Or go to <https://sites.google.com/site/doctorbernardoebri/test>



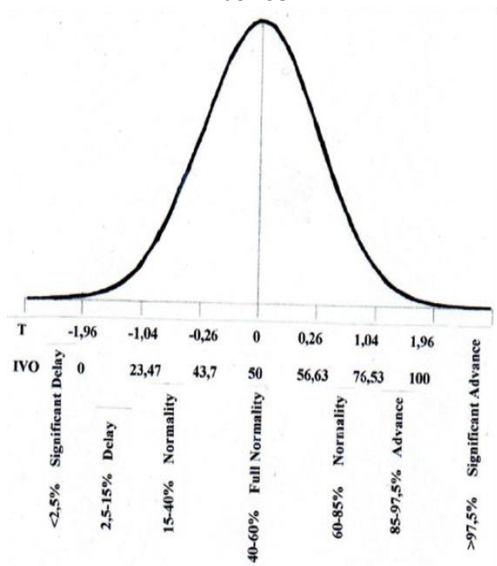
Scheme 2. Scheme of obtaining the maximum diameters of the Metacarpal and Phalanxes bones



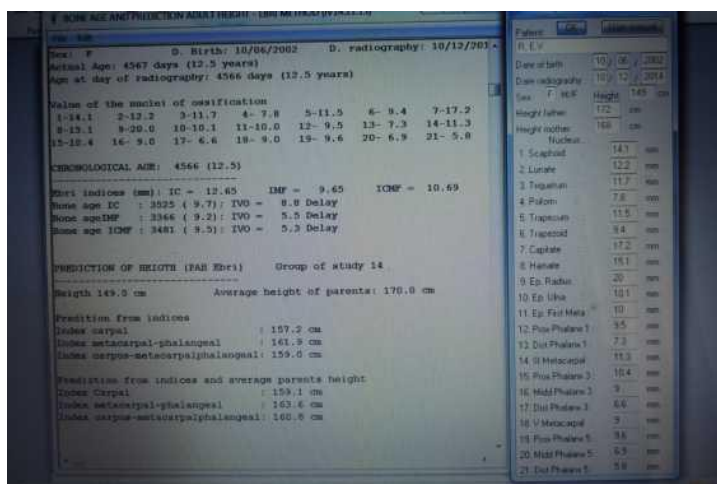
Scheme 3. Scheme of obtaining the maximum diameters of the bones of the carpus, metacarpal and phalanxes



Scheme 4. Scheme of obtaining the maximum diameters of the tarsus bones



Scheme 5. Gauss Curve to read the diagnosis of bone age through the Ivos obtained from the computer program



Scheme 6. Figure of Bone age and prognostic age of adult size of a girl under study

3. SYNOPSIS AND PROLOGUE

After a comprehensive bibliographic review of Skeletal Maturity and Growth in its physiological and pathological aspects, the main existing methods of bone age calculation and size prediction are described. In this sense, we provide in this thesis a new numerical method for bone age calculation based on the carpal (IC), meta-carpal-phalangeal index (IMF), and carpal-meta-carpal-phalangeal (ICMF) indexes, as well as on the Ossified Value Index IVO (Indice de Valoración Osificativo) of the three above mentioned indexes, which simplifies the diagnosis of the child's bone age through a computing program using the radiological measurements of the ossification cores. The casuistry length of our study covers 160 children from Aragon, 73 male and 87 female, from the child longitudinal study developed at the CAP (Centro Andrea Prader), who are divided by genre and age from their birth until the age of 21, excluded. The radiological study was carried out at Miguel Servet Children's Hospital in Zaragoza, calling every child annually on his birthday. The "Statistix" statistical package has been used for the statistical work, and the Excel program for the elaboration of the tables and the Graphics study that we present. Numerical tables and descriptive graphics of mean values, standard deviations, percentiles (from 3 to 97) of all the parameters studied, including the bone ages obtained by our indexes and the Greulich- Pyle and TW2 bone ages, children's sizes, and the carpal and meta-carpal-phalanges core diameters, are presented in this thesis for practical use. Moreover, non-descriptive statistical results such as correlation coefficients, multi-regression equations of adult size prediction, are presented in tables and graphics. We have compared the results of our series with others like the Spanish transversal series and the longitudinal series of the Swiss child, as well as the original CAP series. We have also carried out a study of the chronology of appearance of ossification

cores and the finding of accessory bones of the hand, contrasting them with the ones found by other authors. We have ascertained that our indexes are closely co-related with the chronological age, with a statistical significance $p < 0.001$, being the bone ages IC, IMF, ICMF statistically different from the bone ages GP and TW2 ($p < 0.001$). Therefore, the average differences between the EO (bone age) and the EO (chronological age) that we have found must be corrected between them when want to pass from our ages to those of GP or TW2, or vice versa, that is, when we want to transform one group of ages to others. However, it is not recommended to do so if they are referred to the Spanish child calculated with using our bone age methods. This methodology allows the adaptation to different populations, creating bone age standards of different racial groups. This is one of the most remarkable aspects of this contribution, as it does not require extrapolations of foreign methods in native populations, avoiding subsequent corrections of the bone age, as racial and social-cultural characteristics of the studied populations are respected. The average PTA for the different bone ages have not statistically differed from the adult size reached. To this current revision of our method, it has been incorporated into the general computer program (children up to the age of 20 years), which allows the calculation of the bone size and prediction of the child's adult height, another computer program, with equations that allow the calculation of Bone age children through the hand, up to four years. Likewise, another computer program has been incorporated, with equations that allow the calculation of Bone age in Tarsus, of children up to four years, from the Casuistry of Doctoral Thesis of the author (1977). The software can be downloaded directly from the address indicated in the book

4. PROLOGUE

The gigantic work of Dr. Bernardo Ebrí on bone maturation is reflected in this book.

That such a simple measurement with a vernier of greater diameter than carpal-metacarpal bones and phalanges much information on bone maturation method, can be attributed to the method but not its author. Dr. Ebrí constancy over decades, its rigor, not only longitudinal but also transversal studies only deserve their applause filled with admiration.

Those who have devoted much of our activity to the study and monitoring of child growth and development into adulthood, we know the importance of properly assessing possible as we call bone age. Being as old bone is a tool in the diagnosis and follow various situations affecting the child, we cannot ignore that and unexpected biological evolution itself can change dramatically in a short period of time, 1-2-3 years, thus modifying the initial predictions of adult height, based on bone age should always be made and communicated to parents with great prudence and clarifying that it is a forecast. It is therefore important repeated, particularly around the onset of puberty, control bone age that you can change sharply, to normalize or otherwise mature slowly or do it fast. Studies by Dr. Ebrí especially longitudinal nature like ours Andrea Prader Center, are valid provided that they are not overestimate and especially the evolution of bone maturation periodically check instruments.

Dr. B. Ebrí encourage and daughter Dr. Immaculate Ebrí did his doctorate on the subject, to continue these research studies, make them manageable in numerous consultations that have to make quick decisions. But mostly I encourage anyone interested in this subject not only to read this book if not many other publications of this persistent, admirable researcher is Dr. Bernardo Ebrí.

For my part I convey to you my admiration and gratitude for your enormous work, knowing you are going to continue that. Congratulations and forth.

Angel Ferrández Longás

Director of Andrea Prader Center

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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