ACTA BIOL. SZEGED. 42, pp. 225-234 (1997)

DETERMINATION OF BODY LENGTH AND AGE OF HUMAN FOETUSES AND NEWBORNS ON THE BASIS OF WEIGHTS OF LIMB BONES

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(Received: December 10, 1996)

Abstract

Weight measurements were carried out on the collection of foetal and newborn skeletons at the Department of Forensic Medicine, Albert Szent-Györgyi Medical University, Szeged, for age determination purposes.

On an automatic calibrated scale, the weight of the diaphysis of the limb bones (humerus, radius, ulna, femur, tibia and fibula) of 79 5-10 - lunar month - old foetuses and newborns (42 male, 37 female) were measured to milligram accuracy, and statistical methods were then applied to determine the relationship between the body length and age of the foetuses and the weight of the limb bones.

Linear regression did not reveal any correlation between the weights of the limb bones and the body lengths of the foetus. On the exponential regression line, however, the points fitted well. The correlation coefficients indicated a close correlation (values in the range +0.83-0.96). This means that, in the lack of other more reliable data, the limb bone weights can be considered in determination of the age of an unknown foetus/newborn.

Key words: body length and age determination of human foetuses and newborns, weights of limb bones, forensic medical and paleoanthropological practice.

Introduction

Literature data on the weights of bones of human foetuses and newborns are extremely scarce. Apart from a scholarly interest and a motive for the universal acquisition of knowledge, few researchers have carried out measurements in this field. One explanation may be that such weight measurements are only loosely connected to the development phase of foetus in intrauterine life and, especially to the increase in body length, since the increase in weight of individual foetuses can vary considerably.

Since numerous factors (genetic, environmental, various diseases, etc.) influence the weight of a foetus in the practice of forensic medicine, the body length of a foetus or newborn is taken into consideration only when estimation of the foetal age is necessary (e.g. according to the HAASE rule, a foetus with a body length of 35 cm is is around 7 lunar months old, whereas a foetus with a body length of 50 cm is around 10 lunar months old). References are of interest in this respect.

The explanation of this practical method is that the average body length of a 10 - lunar month - old foetus varies between 48 and 53 cm, whereas its weight can vary between 2500 and 4500 g. In the given phase of development, the range of variance in the case of 10 - lunar month - old foetus is only ±3 cm on average, which means that it is no greater than 10%. This would be the case if the difference from the average body length were at least ±5 cm.

Compared to the average body weight of 3500 g, however, the range of variance of ±1000 g means approximately a difference of 30% from the average weight measurement.

If for any reason the body length can not be taken into account and it is desired to estimate the age of a foetus on the basis of the weights of its bones we consider that, the body weight can provide sufficient information. For example if incomplete fragmented limb bones are available, but the fractional part can be estimated on the basis of a comparison with the diaphysis of the limb bones as it is one - third of the full length, in such cases the weight of the bone read off from a table of weights or a graph of weights may indicate a value near to the actual age of the foetus or newborn infant. Otherwise, in similar concrete cases of scanty information, it is not possible to draw a more objective and solid conclusion as concers the age from a forensic medical examination.

Another point may be mentioned in connection with of the weight correlations of the foetal bones, i. e. on the basis of the weights of the bones, conclusions may be drawn concerning the nourishment and bodily status of a foetus and whether it was under or above the average weight. Such conclusions can be drawn from the results of several examinations. On the basis of my own examinations, I find it quite likely that there is such a correlation between the sizes (weights) of the bones and the body weights.

Material and methods

In order to solve this problem in the practice of forensic medicine, we considered it necessary to carry out weight measurements on the collection of bones of foetuses and newborns in the Department of Forensic Medicine, Albert Szent-Györgyi Medical University, Szeged.

On an automatic and calibrated scale, the weight of the diaphysis of the limb bones (humerus, radius, ulna, femur, tibia and fibula) of 79 5-10 - lunar month - old foetuses (42 male and 37 female) were weighed to milligram accuracy. Various statistical procedures were then applied in order to determine the age by considering the weight correlations of the limb bones to the body length.

Results and discussion

The weights of the limb bones are indicated in Tables 1 and 2. Linear regression does not indicate a close correlation between the weights of the bones and the body lengths. As regards the regression line calculated in this way, the points (reflecting the weights of the bones) for immature foetuses are located under the line, whereas for of mature foetuses the points are above the line. In Fig. 1, the humerus yields a correlation that is unacceptable from a forensic medical aspect. Linear regression calculations were carried out for each limb bone. This may by of scientific value, but in forensic medical practice the data cannot be used.

Table 1. Weights of limb bones of female fetuses and newborns in g.

Body length (cm)	Humerus (n=28)	Radius (n=37)	Ulna (n=36)	Femur (n=23)	Tibia (n=22)	Fibula (n=36)
20	0.09	0.01	0.02		0.06	0.01
25	0.17	0.05	0.05	0.28	0.15	0.03
27	0.27	0.08	0.09	0.29	0.19	0.06
28	0.29	0.09	0.12		0.32	0.06
29	0.21	0.05	0.06		0.18	0.04
30	0.43	0.13	0.18			0.09
31		0.12		0.64		0.12
32	0.35	0.10	0.12	0.53	0.30	0.06
32		0.13	0.17	0.64		0.09
33		0.11	0.13			0.08
33		0.12	0.15			0.08
35		0.16	0.24			0.16
35		0.17		0.84		0.18
36	0.48	0.16	0.21			0.12
36		0.15	0.11			
36		0.15	0.21			0.11
37		0.17	0.22	0.78	0.41	
40	1.04	0.34	0.48			0.31
40	1.91	0.52	0.81	3.91		0.44
40		0.25	0.34			0.18
41	0.76	0.27	0.38			0.20
41	0.83	0.22	0.34	1.43		0.18
41	1.46	0.46	0.67	2.68	1.56	0.38
42	0.85	0.28	0.41	1.64	0.97	0.25
44	0.76	0.19	0.28			0.10
45	1.23	0.41	0.62		1.45	0.38
45	2.15	0.65	0.99	4.09	2.57	0.59
46	2.67	0.87	1.24	4.97	3.18	0.64
47	1.69	0.66	0.75	3.28	1.93	0.50
48	1.86	0.62	0.80	2.18	2.02	0.48
48	2.30	0.64	1.03	4.18	2.49	0.46
50	1.87		0.89	3.53	2.18	0.53
50	1.90	0.59	0.88	3.51	2.08	0.49
50	2.02	0.64	0.90	3.51	2.23	0.53
51	1.63	0.52	0.72	2.78	1.62	0.37
52	2.28	0.72	1.14	4.23	2.54	0.59
53	1.73	0.54	0.81	2.97	1.91	0.43
53	2.19	0.64	0.96	3.82	2.24	0.58

Table 2. Weights of limb bones of male fetuses and newborns in g.

Body length (cm)	Humerus (n=32)	Radius (n=40)	Ulna (n=42)	Femur (n=13)	Tibia (n=24)	Fibula (n=41)
20	0.10	0.02	0.04	0.15	0.08	0.01
23	0.15	0.04	0.06	0.17	0.11	0.02
23	0.27	0.06	0.08		0.14	0.07
26	0.23	0.06	0.09		0.19	0.05
26	0.24	0.08	0.09	0.38	0.23	0.05
28	0.29	0.08	0.12			0.06
28		0.13	0.18	0.74		0.09
29	0.23	0.08	0.10		0.23	0.06
31	0.35	0.12	0.15		0.34	0.09
31			0.21	0.80		0.12
32			0.20	0.83		0.12
33	0.56	0.17	0.23			0.10
33		0.11	0.19			0.06
34		0.16	0.20			0.12
34		0.18	0.29			0.15
34		0.18	0.29			0.16
35	0.57	0.24	0.27			0.14
36	0.72	0.19	0.31		0.84	0.18
37	0.58	0.19	0.27			0.15
38	0.56	0.19	0.25			0.13
40	0.88	0.30	0.48			0.28
40		0.37	0.43			0.23
42	0.96	0.31	0.46		1.17	0.24
42	1.04	0.33	0.48			0.25
43	1.19	0.36	0.54		1.28	0.31
44		0.45	0.70		1.45	0.29
45	1.32	0.41	0.56			0.29
48	1.57	0.51	0.67		1.81	0.39
48	1.66	0.58	0.85		1.75	0.40
48	1.91	0.60	0.94	3.60	2.40	0.56
48	1.94	0.65	0.95		2.23	0.57
48	2.27	0.65	0.94	4.20	2.74	0.69
49	2.57	0.75	1.21			0.62
50	1.83	0.60	0.86	3.22	2.07	0.41
50	1.85	0.53	0.92	3.36	2.02	0.47
50	2.05	0.68	0.99		2.13	0.57
50		0.56	0.78			0.44
52	2.36	0.67	1.04	4.43	2.67	
53	3.28	0.93	1.29	5.68	3.61	0.87
54	1.79	0.57	0.86		2.06	0.44
54	2.41	0.76	1.13	4.83	2.95	0.68
56	2.96	1.00	1.32		3.11	0.64

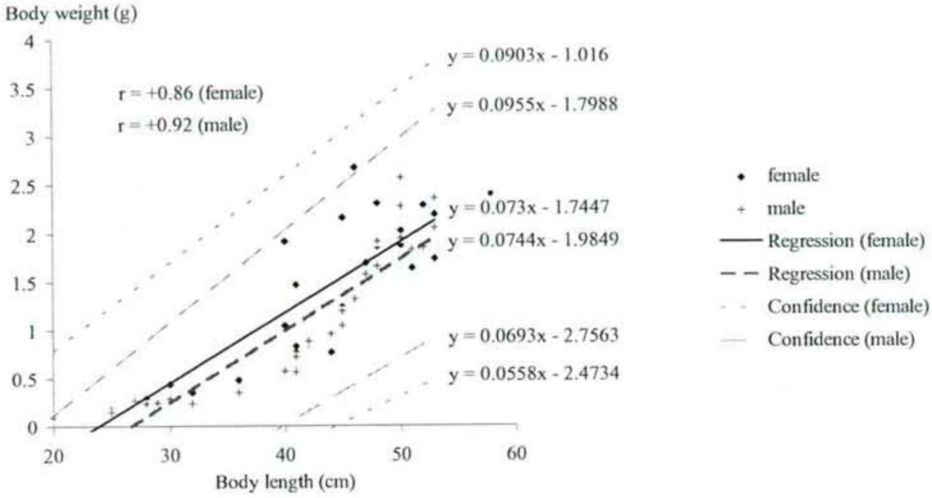

Fig. 1. Linear regression diagram for the humerus weight measurements.

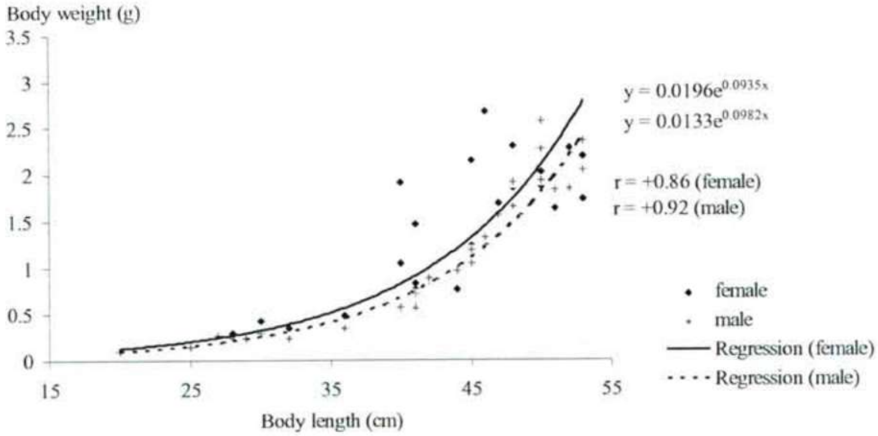

Fig. 2. Exponential regression diagram for the humerus weight measurements.

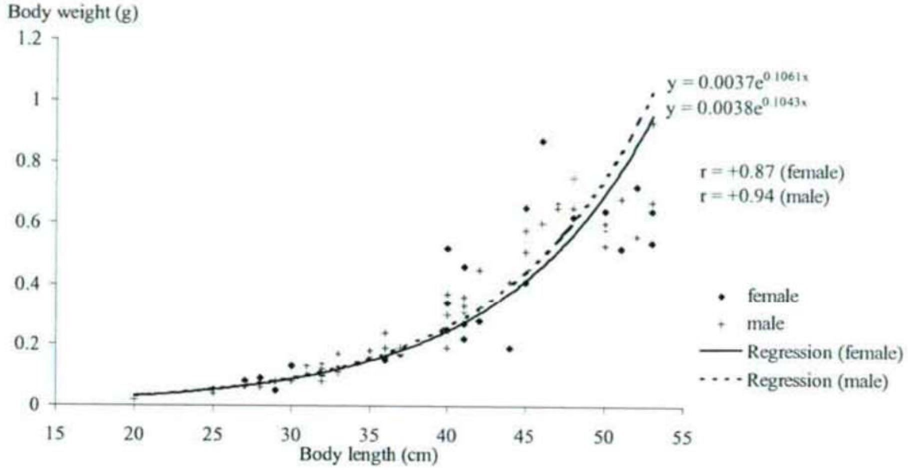

Fig. 3. Exponential regression diagram for the radius weight measurements.

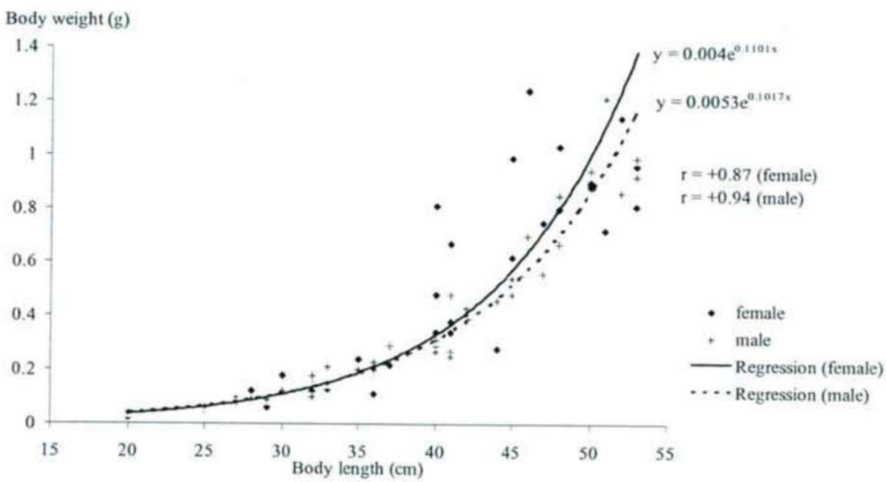

Fig. 4. Exponential regression diagram for the ulna weight measurements.

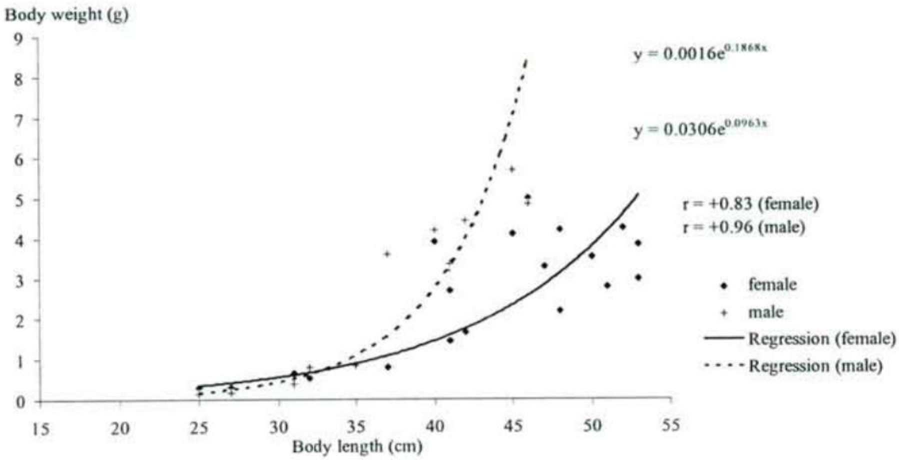

Fig. 5. Exponential regression diagram for the femur weight measurements.

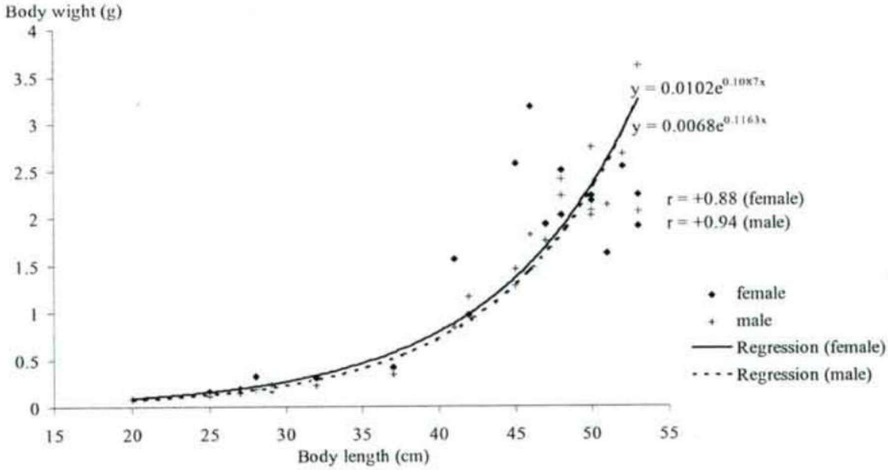

Fig. 6. Exponential regression diagram for the tibia weight measurements.

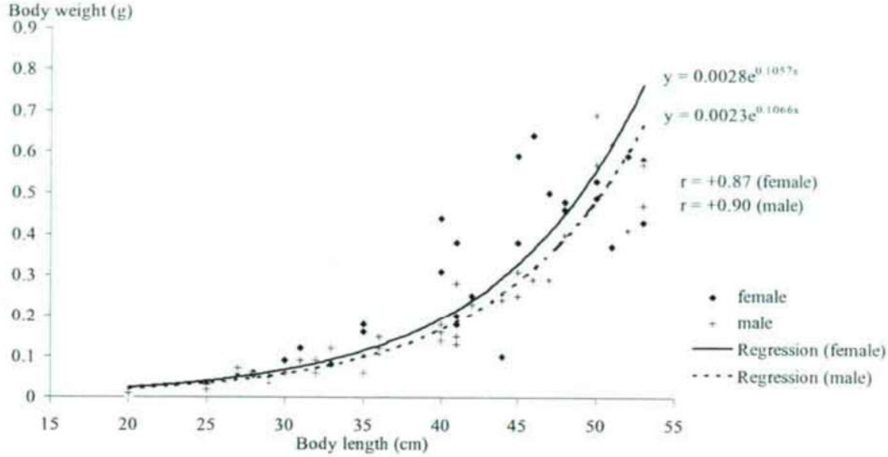

Fig. 7. Exponential regression diagram for the fibula weight measurements.

Table 3. Correlation of weight measurements of limb bones to body length.

	males	females
Humerus	+0.92	+0.86
Radius	+0.94	+0.87
Ulna	+0.94	+0.87
Femur	+0.96	+0.83
Tibia	+0.94	+0.88
Fibula	+0.90	+0.87

However the exponential regression line fits the measured points well. From the exponential regression line for the measured limb bone the body length of the foetus and its age can be read off, and therefore its age can be estimated (Figs 2-7), provided that the weights of the bones are known. In the knowledge of the regression equation, the weights of the bones can be calculated, which otherwise show a close correlation with the body length (Table 3). We have no explanation as to why this correlation is closer for boys than for girls. When the biological samples are taken into account, both examined relations exhibit a close correlation, which can be considered in forensic medical and paleoanthropological practice. Our experience so far indicates that, in a determination of the ages of foetuses and newborns, we should first take into account the lengths of the bones, whenever possible, but the weights of the limb bones can also yield good results with acceptable accuracy in the age determination of foetuses and newborns.

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