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METHODICAL AND METHODOLOGICAL ASPECTS OF STUDY AND ASSESSMENT OF NEWBORNS AND INFANTS

ABSTRACT: Relations between fetal age, age after birth (chronological) and absolute age are presented. The necessity of use of absolute age instead of obstetric age categories in assessing the developmental state of neonates and infants is shown. An analysis of data on 2237 male newborns and 2423 female newborns revealed relationships between body mass and fetal age. On the basis of regression analysis, various developmental tendencies in body mass of neonates are presented. As an appendix, percentile charts of body mass applicable in assessment of the developmental state and age of newborns at the age of 32–43 weeks are included.

KEY WORDS: Neonate – Fetal age – Absolute age – Developmental age – Assessment of developmental state

THEORETICAL PART

Individual development is a function of genetic and environmental factors as well as the time that has passed since fertilization (i.e. chronological and, more precisely, absolute age). Fetal age is conventionally assessed according to the Naegely rule (menstrual age) or by other methods, including ultrasonography, that define the beginning of gestation (Klimek, 1994). Usually having no information on the date of conception, we can assume, although by a great simplification, that the chronological age of fetuses is at the same time their absolute age. We intend to distinguish this age from chronological age, established at birth. In this sense we will use the term "absolute age". We express it, obviously, in the units of astronomical time (days, weeks, months).

On account of the fact that development is a function of time, it seems that in auxology a homogenous group of newborns does not exist. The establishing of age "zero" at birth, irrespective of actual absolute age, cannot mean developmental homogeneity for a group defined in this way. This is a particularily essential note when accepting a thesis on fetuses of rapid, average and slow growth. The difference between fetuses growing most and least rapidly is 6 weeks (Klimek, 1994). Therefore, physiological parturition resulting in birth of a mature newborn can occur within the last 6 weeks of gestation. With regard to the above-mentioned facts, it also seems pointless to use obstetric categories of fetal age : "born pre-term", "born in term", "born post-term".

The statements above suggest that a description of the morphological development of neonates should similar to that of postnatal ontogenesis embrace, numerical characteristics of the examined features in the subsequent groups of absolute age. Distances between them will be determined by growth dynamics: in the initial period of prenatal growth alterations in the following days, and then in weeks or months, are of interest to us.

All individuals in the course of their ontogenesis must pass through the following developmental stages, genetically determined and common to all individuals. The stage of development, irrespective of the growth level of particular individuals, makes them resemble each other. For this purpose, to simplify description of definite common developmental processes, certain stages in ontogenesis are distinguished, and only in this context do we deal with categories of fetal age in neonatology. From the biological point of view, it seems completely unjustified to investigate the state and, even more, the growth dynamics of newborns without taking into consideration their precise absolute age. Description of the development of quantitative traits of the neonatal period in categories (or all

newborns as a group of age "zero"), instead of following weeks of absolute age, does not reflect an actual developmental state, particularly its dynamics. In other words, such a description does not include any cognitive elements. What is more, referring to the bibliographic data on newborn mass, we cannot feel sure whether they concern all the neonates delivered in a definite place, or whether only those "born in term". Subsequently, as a result of comparative analyses, authors often draw unjustified or even false conclusions regarding differences in neonatal development or developmental trends in this period of life. The latter issue has been thoroughly elaborated in a separate monography (Kaliszewska-Drozdowska, 1980). If it were a case of growth description in week-groups of absolute age, the problem would not exist and all the data would totally comparable.

This is particularily essential in the case of a study of fetal growth in primates. In relation to different lengths of gestation in particular species, fetuses or neonates should be compared exclusively in parallel groups of absolute age.

Similarly, while monitoring the development of various infant groups, their absolute age should be taken into account at least within the 1st year of life. Differences betweenthe developmental paths of a child prematurely born and one born in term will appear in a completely new light. Only then will comparative analysis of the development of these two groups of infants be justified.

Relations between fetal age, age after birth (chronological) and absolute age are presented in *Figure 1*. It seems that only absolute age gives evidence of the course of ontogenesis, while the border between fetal and chronological ages is defined by the term of delivery, which, theoretically, can take place in any gestational week. Introducing a new category of age "zero" for all neonates, independent of their absolute age (only because of the change from intrauterine to external environment), creates above-mentioned interpretative problems.

Figures 2 and 3 show percentile charts of body mass, reconstructed from two originally separate charts for neonates and infants (Cieslik et al. 1994). Such a reconstruction made it possible to introduce a scale of absolute age. At the same time, it assumes that the fetuses that leave the uterus earlier are at the same developmental point as if the premature change of environment had no influence on the shape of developmental curve. This issue most likely will never be resolved, since studies of fetuses are always of a cross-sectional, not longitudinal, character.

ANALYTICAL PART

The aim of the analysis is to present the relationships between body the mass of newborns and fetal age.

The material consists of neonates born in the years 1981–93 in Wielkopolska, Kujawy and Western Pomerania. The data gathered concern 2237 male newborns

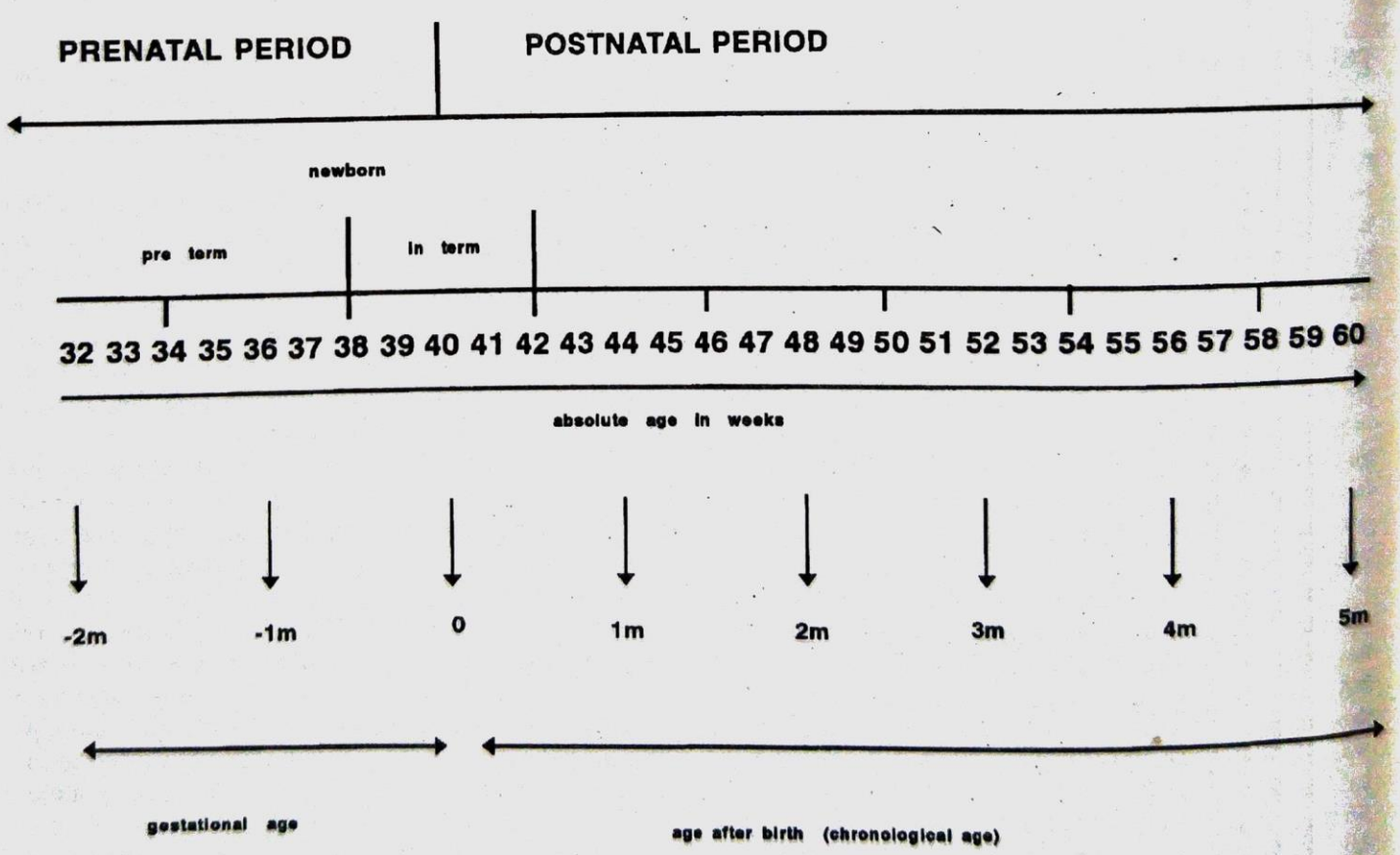

FIGURE 1. Relationship between gestational, chronological and absolute age.

and 2423 female newborns at the age of 28–44 weeks.

Numerical characteristics of body mass are presented in *Table 1*. Maximum values, included in the Table, suggest that neonates with body mass over 3 kg are delivered already in relatively early gestational weeks. If there are among them mature newborns, should they be regarded as "prematurely born", only because they were delivered prior to the fixed date? Since their body masses are over 2.5 kg, perhaps they should be classified as "born in term". Perhaps they are simply mature and, if the hypothesis about critical body mass limiting int. al. the date of delivery (Kaliszewska-Drozdowska, 1980) is right, then their parturition was physiological, and absolute age is as it is and they cannot be classified in arbitraril-created age categories. Both their precise absolute age and, additionally, developmental age should be noted. The example mentioned above clearly indicates that these neonates will be developmentally older than their absolute age suggests.

Moreover, it is apparent that even in the last gestational weeks newborns with very low body masses are delivered *(Table 1)*. These do not always need to be premature. Their low body mass is not sufficient reason to classify them as "born pre-term". Delivery of such a neonate usually constitutes a medical problem, and it should be determined individually whether such a newborn is actually premature (developmentally younger) with intrauterine growth retardation or whether it is simply small.

The above examples support the thesis that the physiological term of delivery ranges within 6 weeks (Klimek, 1994).

Additionally, regression analysis of body mass and fetal age within 32-43 weeks of age has been carried out for the minimum, average, and maximum values respectively *(Figures 4 and 5)*. Regression equations are as follows:

boys: y_{min}	$= 101.41 + 45.38\times$	$r = 0.53438$
girls: y_{min}	$= 184.63 + 47.83\times$	$r = 0.73760$
boys: $y\bar{x}$	$= -2392.29 + 143.54\times$	$r = 0.98421$
girls: $y\bar{x}$	$= -2508.68 + 144.60\times$	$r = 0.97354$
boys: y_{max}	$= -2514.45 + 183.50\times$	$r = 0.93137$
girls: y_{max}	$= -5813.75 + 263.81\times$	$r = 0.87405$

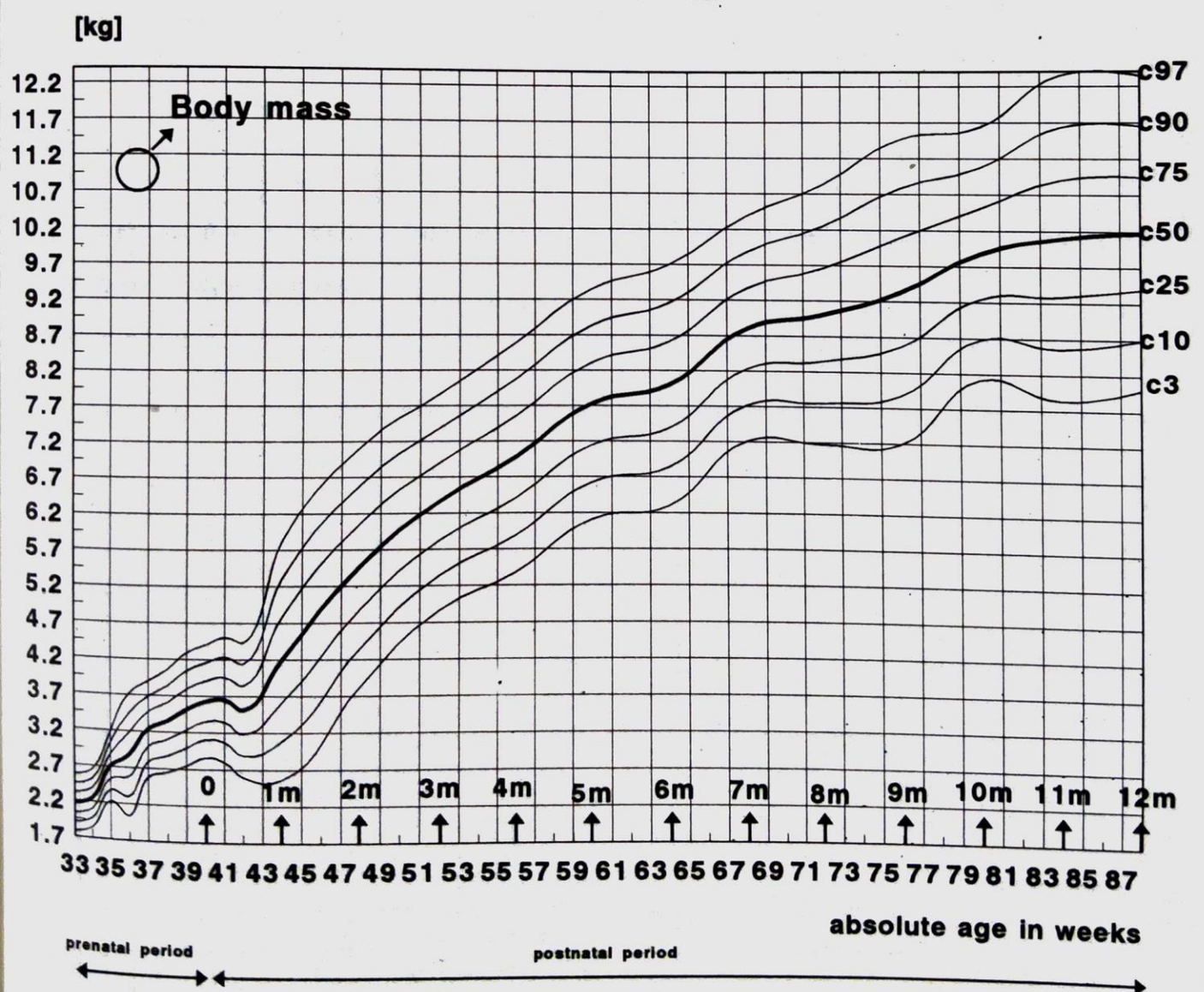

FIGURE 2. Males newborns and infants: percentile chart of body mass (× – axis: absolute age).

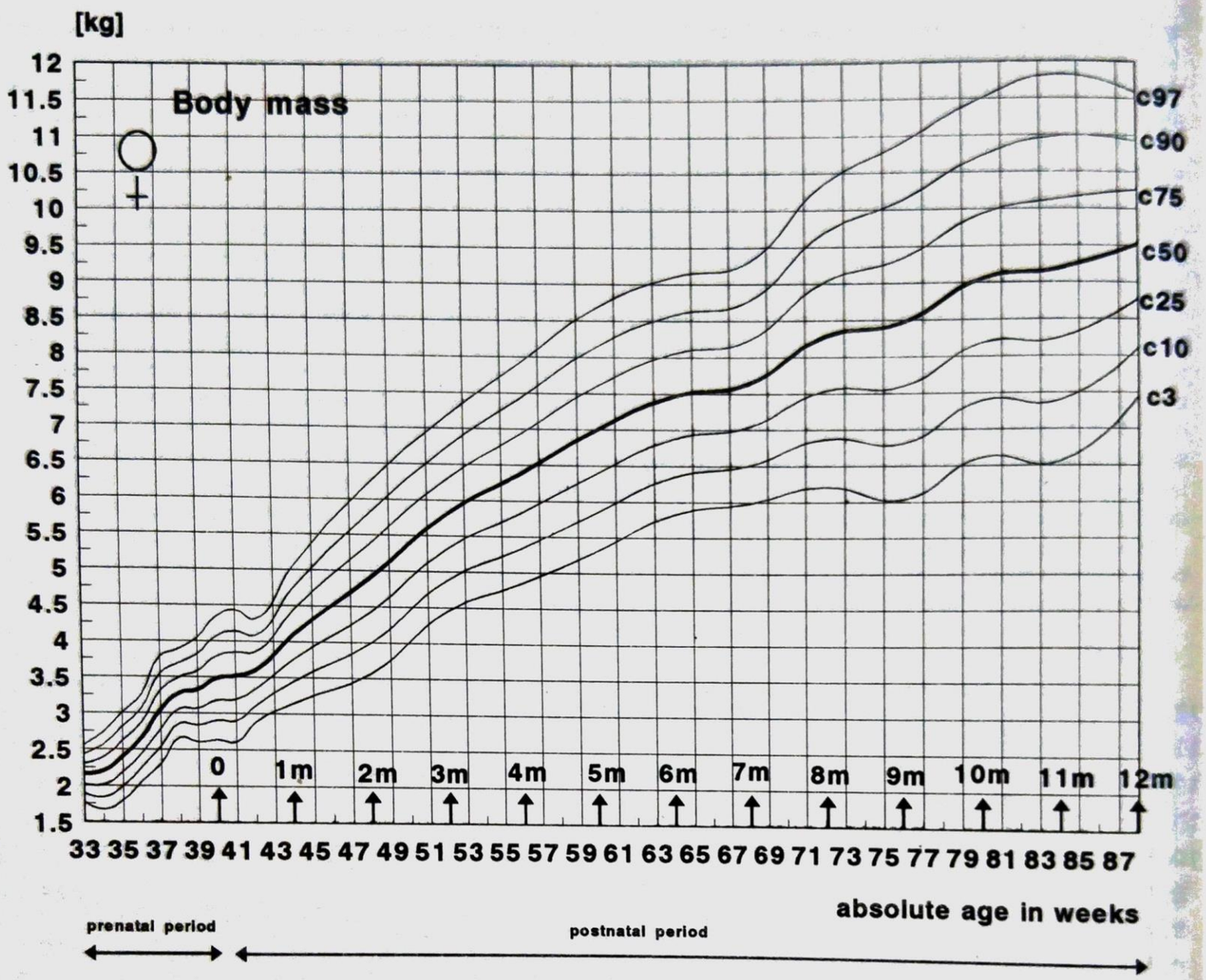

FIGURE 3. Females newborns and infants: percentile chart of body mass (x – axis: absolute age).

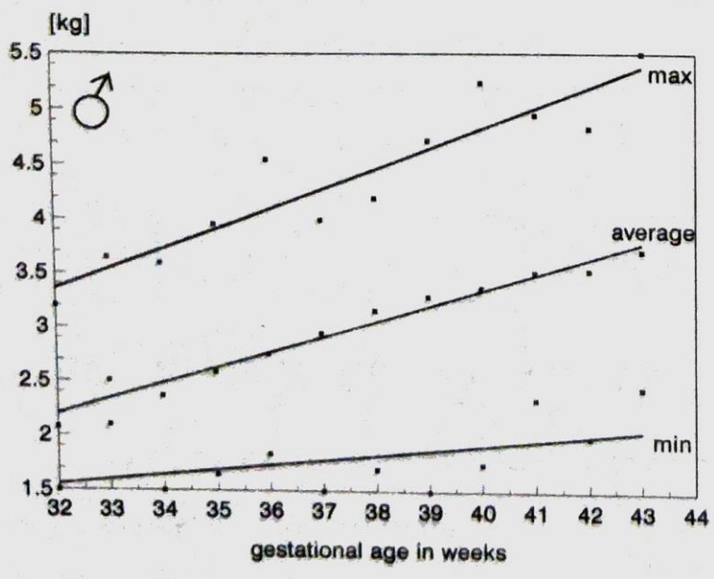

FIGURE 4. Linear regression of body mass against gestational age (boys).

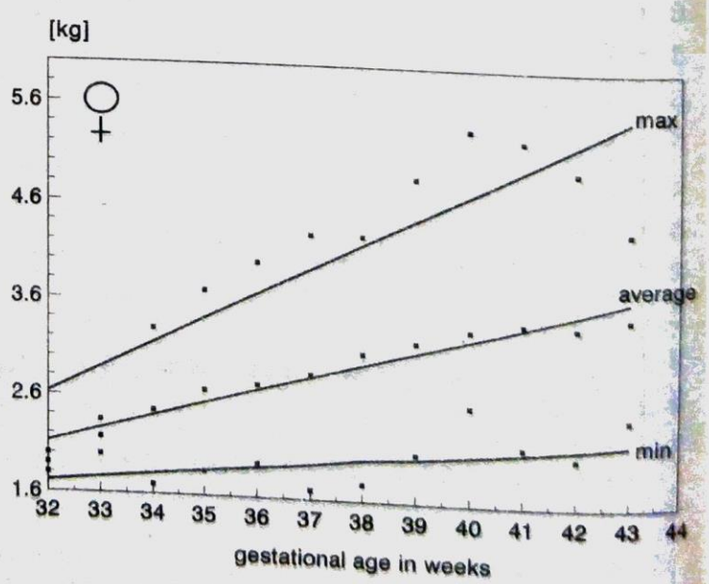

FIGURE 5. Linear regression of body mass against gestational age (girls).

TABLE 1. Body mass of newborns.

n	$\bar{x}$	S	min	max	Gestational age	n	$\bar{x}$	S	min	max
BOYS						*GIRLS*				
1	1650.0	-	-	-	28	2	1950.0	1484.9	900	3000
1	1650.0	-	-	-	29	-	-	-	-	-
2	1605.0	360.6	1350	1860	30	2	2450.0	494.9	2100	2800
5	2002.0	1140.9	1250	3900	31	10	2379.0	657.6	1340	3200
6	2075.0	606.4	1500	3200	32	2	1900.0	141.4	1800	2000
7	2507.1	558.6	2100	3650	33	2	2175.0	247.5	2000	2350
18	2370.5	502.3	1500	3600	34	16	2459.4	463.4	1700	3300
27	2594.1	551.4	1650	3960	35	22	2683.2	446.2	1850	3700
70	2765.0	549.3	1840	4550	36	63	2748.4	372.5	1950	4000
103	2958.5	432.0	1500	4000	37	139	2869.6	473.7	1700	4300
257	3170.5	437.0	1700	4200	38	244	3103.2	475.2	1780	4300
381	3297.8	455.5	1500	4720	39	372	3234.4	422.5	2100	4900
666	3376.8	453.6	1750	5240	40	685	3374.6	446.2	2060	5400
420	3519.1	458.5	2350	4950	41	494	2456.9	447.2	2200	5300
248	3536.2	480.6	2000	4830	42	227	3432.7	453.7	2100	5000
24	3713.7	790.9	2250	5500	43	31	3527.7	487.1	2500	4400
1	4000	-	-	-	44	2	3600.0	424.3	3300	3900

They show different developmental tendencies in body mass. The maximum body mass is characterized by the greatest dynamics expressed indirectly by the highest regression coefficients. The minimum body mass (relatively low growth dynamics) is least correlated with age. Additionally, this proves that the confidence intervals for regression coefficients calculated for the minimum and maximum values are completely separate on the level a ≤ 0.05. Moreover, total increments of body mass within the studied period for the minimum, average and maximum values have been calculated:

	boys	girls
$x_{\min_{43}} - x_{\min_{32}}$	750.0 g	700.0 g
$\bar{x}_{43} - \bar{x}_{32}$	1638.7 g	1627.7 g
$x_{\min_{43}} - x_{\min_{32}}$	2300.0 g	2400.0 g

The minimum increment is more than 3 times lower than the maximum increment.

Thus at least 3 groups of fetuses can be distinguished: those of slow, average and rapid growth. The developmental paths of these fetuses follow different levels of the

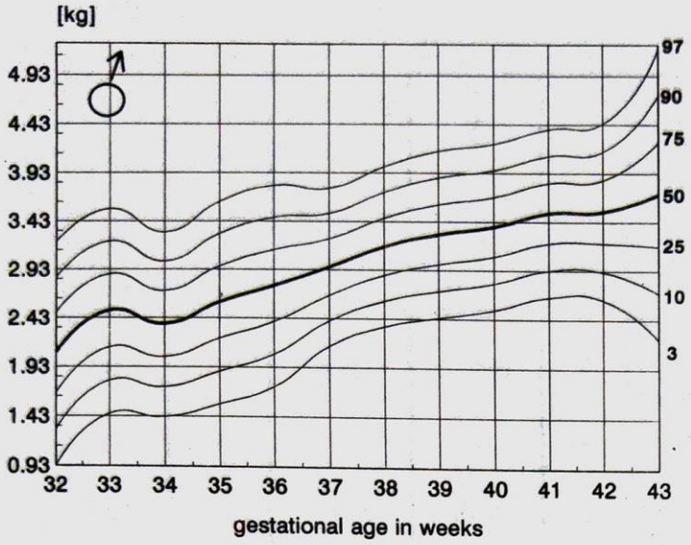

FIGURE 6. Male newborns: percentile chart of body mass (× – axis: gestational age).

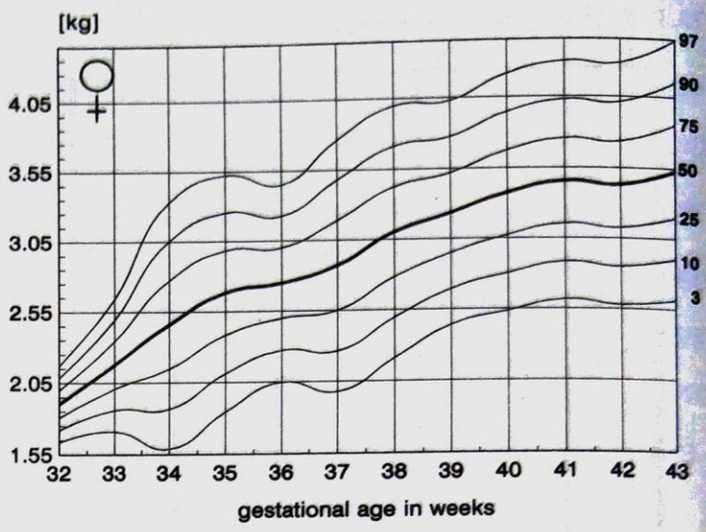

FIGURE 7. Females newborns: percentile chart of body mass (× – axis: gestational age).

adaptive norm of a population, but, compared to their calendar counterparts, they remain at the same place in every age. According to the idea of multi-level development of an individual and a population, they represent a stable model. Researches hitherto carried out indicate that only part of the individuals in each population follow this developmental model. The development of others will be progressive, regressive, or, most frequently, multi-level (Cieslik 1979). These are models of development that represent the entire variability of individual developmental paths followed within the frames of the adaptive norm of a population. These possibilities should be taken into consideration when monitoring gestation course by the ultrasonographic method.

As an appendix, percentile charts of body mass are included so that they can be applied while assessing the state of development and developmental age of newborns at the age of 32-43 weeks *(Figures 6 and 7).*

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