

# STANDARDS OF BIRTH WEIGHT ACCORDING TO GESTATIONAL AGE IN THE NORTHWESTERN REGIONS OF UKRAINE

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**Summary.** An analysis of the neonatal registry for 2001-2010 years in Rivne and Volyn regions of Ukraine as well as 2006-2011 years of Khmelnytsky region was carried out. General information was available about body weight of 366 607 newborns, among which 188 687 were boys and 177 920 girls. Based on the analysis we developed local standards of birth body weight in relation to gestational age separately for boys and girls. Procedure for processing local standards met international standards that have been developed by the WHO. Availability of processed local standards depending on gestational age will enable neonatologists, pediatricians and researchers to clearly identify anomalies in the health of newborns in the northwestern regions of Ukraine. Therefore, identification of newborns with low or high birth weight will enable adequate and timely steps to improve their health.

**Key words:** *standards, birth weight, gestational age, the northwestern region of Ukraine*

## INTRODUCTION

One of the objective markers of the health status of newborns is the level of physical development. Anthropometric rates are considered as integral features of fetal growth [11].

Assessment of physical development of the child population is carried out by comparing individual anthropometric rates with standards. In turn, standard rates of physical development have their features and patterns defined by a complex set of local conditions: climatic and geographical, social and economic, ecological, etc. Therefore, average rates of physical development common to all regions of the country cannot be sufficiently objective. They are influenced by local features and conditions of the region (J. M. Nechytyaylo, 1999; R. V. Bohatyrova et al., 2000).

Creating standards of children physical development and their periodic renovation should be considered as a prerequisite for monitoring changes in the child organism, individual pre-

diction of health, carrying out medical and organizational, social and hygienic measures of prevention (A. L. Reznikova et al., 2002).

Early identification of infants with deviation in physical development according to regional standards and their individual assessment enable timely creation of adequate conditions for their nursing, prevent the occurrence of a number of emergency conditions in postnatal ontogenesis (A.L. Reznikova et al., 2002).

## OBJECTIVE

Create local standards of the birth weight according to gestational age for boys and girls born in the northwestern regions of Ukraine.

## MATERIALS AND METHODS

The analysis of the neonatal registry was performed for the period 2001-2011 in Rivne and Volyn regions of Ukraine as well as for the period 2006-2011 in Khmelnytsky region. Body mass indexes of infants, their gestational age, sex, presence or absence of birth defects, diseases of the mother were noted in the registry. All infants with birth weight < 1000 g and/or gestational age < 28 weeks were included in the registry since 2004. Thus, data about 388,054 infants (200 561 boys and 187 493 girls) with gestational age 25-44 weeks who were born during 2001-2011 years in Volyn, Rivne and Khmelnytsky regions were included in the study. Exclusion criteria were infants with unknown sex (1.74%) and stillbirths.

In drawing up centile tables and charts it was not taken into account the weight of children with birth defects – 14, 918 (3.84%) cases, and infants born from multiple pregnancies (without birth defects) – 6, 323 (1.63%) cases.

Overall, selected information included body weight of 366,607 newborns, among whom were 188,687 boys and 177,920 girls with gestational age from 27 to 43 weeks (Table 1).

**Table 1.** Distribution of infants in Volyn, Rivne and Khmelnytsky regions by gestational age and sex

Gestational age, weeks	Boys	Girls	Both sexes
27	101	88	189
28	104	104	208
29	136	102	238
30	283	229	512
31	252	233	485
32	470	421	891
33	486	407	893
34	818	721	1,539
35	1,105	1,013	2,118
36	1,989	1,938	3,927
37	6,639	5,940	12,579
38	19,228	17,939	37,167
39	40,110	38,127	78,237
40	93,595	87,938	181,533
41	18,513	18,207	36,720
42	4,501	4,237	8,738
43	357	276	633
Total	188,687	177,920	366,607

For processing the raw data, database in the program “Exel” was developed and statistical programs were prepared which were used in a standardized way in all parts of the study. System of control after received data included methods of internal and central validation of data collection for further promptly identifying any errors. Each research site was responsible for the collection, administration, validation and refinement of the data and creating master database locally. Each month data from research sites forwarded to form the united main file and the wider checking. About all detected errors it was reported to the research sites for their on-site correction. Meticulous execution of this algorithm led to the high quality of the received data.

Measurement of birth weight was carried out in the first day after birth. In all research sites were used the same equipment. Body weight was measured using medical electronic baby balance. Gestational age was assessed according to clinical examination at childbirth and date of the first day of the last menstruation.

In the sample were included live births of singleton pregnancies. The exclusion criteria from the study were stillborn children, persons of unknown sex, newborns from multiple pregnancies, newborns with congenital malformations or dimorphism, and newborns in gestational age of 25, 26 and 44 weeks due to lack of their number.

Constructing growth curves included determining the type of distribution and an optimal smoothing technique. Therefore, we have determined that the obtained raw data most relevant to Box-Cox distribution (Box-Cox power exponential) [1], and smoothing curves best carried out by way of a polynomial smoothing according to polynomial of 3rd degree [2].

The process of selecting the best model in constructing growth curves included, first, the choice of the best model within a class of models and, secondly, the best model among different classes of models. To select the best model within a class of models we used Akaike criteria and their generalized version [3]. In order to determine the degree of polynomial we used worm plots [4] and Q-tests [5]. However, when choosing the best model we have worked out the differences between empirical and smoothed percentiles and calculations of the expected particle of children who find themselves outside the standard parameters. In general, we choose a sequence of actions to determine the type of distribution and select the optimal smoothing techniques to meet international standards that have been developed by WHO [6].

## RESULTS

During the performance, we calculated the standard body weight of boys at birth according to gestational age in the northwestern regions of Ukraine, as shown in table 2 and figure 1. These data allow us to easily determine whether birth weight of individual child, depending on gestational age and sex, is normal or vice versa – too high or low for gestational age. Achieved data allows comparing the weight of a newborn with standard parameters.

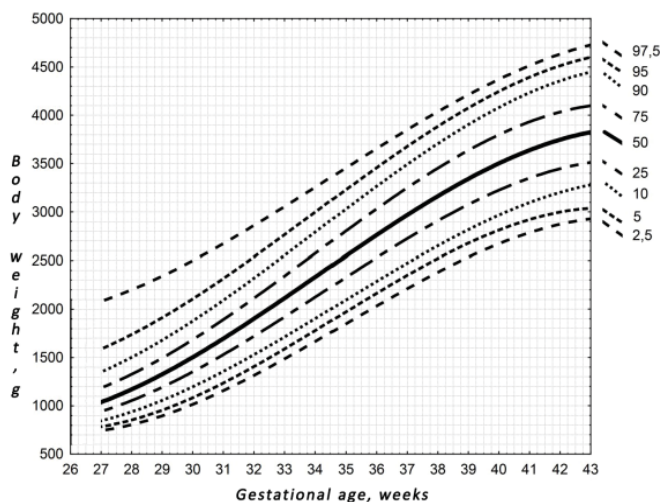
Due to received data it is possible to determine whether weight of the newborn boy meets local standard rates in the northwestern region of Ukraine or not. Through detailed calculations with definition of 2.5th, 5th, 10th, 25th, 75th, 90th, 95th, 97.5th centile and median, there is an opportunity to classify newborns in one of the following groups: medium, higher/lower than medium; high or low; as well as very high or very low birth weight, according to the algorithm shown in table 3 [7]. This methodology can be used for children born full-term, preterm and post-term.

**Table 2.** Standard body weight of newborn boys according to gestational age in the northwestern regions of Ukraine

Gestational age, weeks	Centile, gram								
	2,5	5	10	25	50	75	90	95	97,5
27	750	790	850	940	1030	1180	1340	1590	2070
28	810	850	930	1050	1180	1320	1500	1730	2200
29	890	950	1050	1190	1320	1500	1680	1910	2320
30	1010	1090	1200	1340	1500	1680	1890	2100	2490
31	1160	1240	1350	1530	1690	1890	2090	2310	2670
32	1310	1400	1530	1710	1900	2100	2310	2530	2860
33	1490	1590	1700	1910	2110	2320	2550	2770	3060
34	1660	1790	1900	2110	2320	2580	2790	3000	3250
35	1850	1970	2090	2320	2530	2800	3030	3220	3450
36	2030	2170	2280	2520	2760	3030	3260	3460	3660
37	2210	2340	2470	2720	2970	3240	3490	3680	3830
38	2380	2510	2660	2900	3160	3450	3710	3890	4030
39	2530	2680	2810	3080	3340	3630	3900	4080	4210
40	2670	2810	2980	3220	3500	3800	4090	4250	4370
41	2780	2910	3090	3340	3640	3930	4230	4390	4510
42	2870	3000	3200	3450	3750	4030	4350	4510	4630
43	2930	3040	3280	4010	3830	4100	4440	4600	4730

**Table 3.** Proposed assessment scale of newborn weight with method of centile standards

Body weight assessment	Centile standards
Very high	> 97,5 centiles
High	90-97,5 centiles
Higher than medium	75-90 centiles
Medium	25-75 centiles
Lower than medium	25-10 centiles
Low	10-2,5 centiles
Very low	< 2,5 centiles



**Fig. 1.** Standard body weight of newborn boys according to gestational age in the northwestern regions of Ukraine

It was established that the median birth weight of boys ranging from 1030 g (at 27 weeks of gestation) to 3830 g (at 43 weeks of gestation). However, full-term newborn boys had median body weight in the range from 2970 g (37 weeks) to 3750 g (42 weeks).

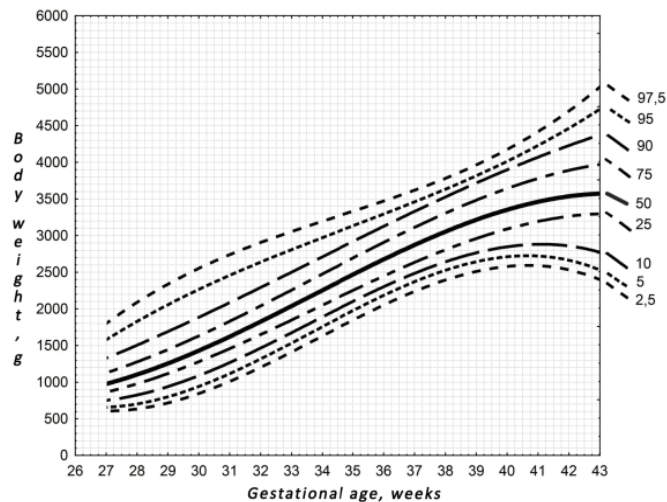
Very low body weight in boys was stated when analyzed index was lower than 750 g at 27 weeks of gestation and less than 2930 g at 43 weeks of gestation.

Very high body weight in newborn boys was diagnosed in cases where the birth weight of 2070 g prevails at 27 weeks of gestation and 4730 g at 43 weeks of gestation.

Similarly, having the data for boys, we calculated the standard body weight of girls at birth according to gestational age in the northwestern regions of Ukraine, as shown in table 4 and in fig. 2.

**Table 4.** Standard body weight of newborn girls according to gestational age in the northwestern regions of Ukraine

Gestational age, weeks	Centile, gram								
	2,5	5	10	25	50	75	90	95	97,5
27	610	650	750	870	970	1120	1330	1570	1800
28	630	690	830	980	1100	1280	1500	1830	2090
29	700	800	940	1110	1260	1440	1680	2050	2330
30	850	940	1090	1280	1440	1630	1890	2280	2550
31	1010	1110	1280	1470	1620	1830	2080	2470	2740
32	1190	1320	1470	1640	1830	2030	2290	2630	2900
33	1410	1530	1670	1850	2040	2240	2500	2810	3060
34	1630	1750	1890	2040	2260	2470	2700	2980	3190
35	1850	1980	2100	2250	2470	2690	2920	3130	3330
36	2050	2180	2310	2440	2670	2900	3120	3300	3480
37	2230	2370	2490	2640	2880	3110	3330	3460	3610
38	2390	2520	2640	2810	3060	3310	3520	3630	3790
39	2510	2640	2770	2970	3200	3490	3710	3820	3970
40	2570	2700	2850	3090	3360	3640	3900	4010	4160
41	2580	2710	2890	3190	3470	3790	4060	4220	4420
42	2530	2660	2860	3270	3530	3900	4220	4460	4700
43	2400	2540	2780	3300	3570	3980	4380	4720	5020



**Fig. 2.** Standard body weight of newborn girls according to gestational age in the northwestern regions of Ukraine

It was found that almost all indicators of body mass in girls were lower than the same measures in boys, with the exception of some indicators at 95 and 97.5 percentile. It was determined that the median birth weight of girls ranging from 970 g (at 27 weeks of gestation) to 3570 g (at 43 weeks of gestation). However, full-term newborn girls had median body weight ranging from 2880 g (37 weeks) to 3530 g (42 weeks).

Very low weight of girls was stated when analyzed index was lower than 610 g at 27 weeks of gestation and less than 2400 g at 43 weeks of gestation.

Very high body weight in newborn girls was diagnosed in cases where the birth weight at 27 weeks of gestation was greater than 1800 g or greater than 5020 g at 43 weeks of gestation.

**Table 5.** Standardized median (50th centile) of body weight of newborn boys in the northwestern regions of Ukraine in comparison with other studies

Gestational age, weeks	Our study	Denver, Colorado, USA, 1961		Hamilton, Ontario, Canada, 1984		Malta, 2009		INTERGROWTH-21st Project, 2014	
	BW	BW	%	BW	%	BW	%	BW	%
23	n.d.	n.d.	—	n.d.	—	472	—	n.d.	—
24	n.d.	830	—	n.d.	—	614	—	n.d.	—
25	n.d.	880	—	n.d.	—	757	—	n.d.	—
26	n.d.	965	—	n.d.	—	903	—	n.d.	—
27	1030	1080	+4,85	n.d.	—	1056	+2,52	n.d.	—
28	1180	1205	+2,12	n.d.	—	1218	+3,22	n.d.	—
29	1320	1330	+0,76	n.d.	—	1390	+5,30	n.d.	—
30	1500	1465	-2,33	n.d.	—	1572	+4,80	n.d.	—
31	1690	1600	-5,33	n.d.	—	1764	+4,38	n.d.	—
32	1900	1760	-7,37	n.d.	—	1964	+3,37	n.d.	—
33	2110	1970	-6,64	n.d.	—	2171	+2,89	1950	-7,58
34	2320	2220	-4,31	n.d.	—	2381	+2,63	2220	-4,31
35	2530	2520	-0,40	n.d.	—	2590	+2,37	2470	-2,37
36	2760	2745	-0,54	2885	+4,53	2793	+1,20	2690	-2,54
37	2970	2930	-1,35	3100	+4,38	2986	+0,54	2890	-2,69
38	3160	3080	-2,53	3290	+4,11	3159	-0,03	3070	-2,85
39	3340	3200	-4,19	3430	+2,69	3308	-0,96	3240	-2,99
40	3500	3290	-6,00	3530	+0,86	3431	-1,97	3380	-3,43
41	3640	3330	-8,52	3615	-0,69	3525	-3,16	3510	-3,57
42	3750	3310	-11,73	3685	-1,73	3603	-3,92	3620	-3,47
43	3830	n.d.	—	n.d.	—	n.d.	—	n.d.	—

Note: n.d. – no data

The study found that received standardized median (50th centile) of birth weight of newborn boys in the northwestern regions of Ukraine was somewhat different from those in other studies. The focus of differences in most cases was diverse in nature: for example, at 33 weeks of gestation median body weight according to our research was 2110 g, according to American authors – 1970 g, which was on average 6.64% lower compared to our results, while according to the international standards described in the “INTERGROWTH-21st Project” median body weight at 33 weeks gestation was 1950 g, which in turn was 7.58% lower compared to our data. The same trend was observed for gestational weeks 30 to 42 for the US data and from 33 to 42 weeks of gestation for international standards. However, according to the data from a study in Malta, all indexes were in varying degrees greater than our rates. For example, the same index at 33 weeks of gestation was 2171 g, which in turn was 2.89% higher.

However, it is advisable to note that at gestational age of 27-29 weeks the standardized median of body weight in boys of northwestern regions of Ukraine were lower compared with the results in Denver, where the latter exceeded our results by 0,76- 4,85%. Then, other results were greater than ours in almost all cases, and accounted for gestational weeks 27 to 37 week +0,54 – +5,30% in the Maltese work, and for 36 to 40 weeks of gestation – +0,86 – +4.53% in a Canadian study. Overall, most of our results were recorded at 29 weeks of gestation. According to the results of our work, median weight of boys at birth was 1320 g, whereas in the Maltese it was 1390 g, which was greater than our results by 5.30%.

It was found that at 38 weeks of gestation the standardized median body weight of boys in the northwestern regions of Ukraine and Malta were almost identical – 3160 g and 3159 g, respectively. Analyzing all indicators it was observed that the discordance between our results and other authors' data was fixed at 42 weeks of gestation, according to the results of our work median body weight of newborn boys was 3750 g, whereas according to US researchers it was 3310 g, which was on average 11.73% lower than our results.

Similar to data on boys, the obtained standardized median (50th centile) body weight in girls was compared with the results given by other authors, as shown in table 6.

It was found that received standardized median (50th centile) of body weight of newborn girls in the northwestern regions of Ukraine did not significantly differ from those in other studies. The focus of differences in most cases had versatile character meaning that our results were in between the values of other works.

However, it is advisable to note that at age of 27 and 28 gestational weeks the standardized median body weight of girls in the northwestern regions of Ukraine were the lowest compared to all other studies: results in Denver exceeded ours by +6.70% and by +3.64%, respectively, while the Maltese results were higher than ours by +1.86% and +3.55%, respectively. Overall, most of our results were recorded at gestational age of 27 weeks; according to the results of our work median body weight of newborn girls was 970 g, whereas according to Canadian researchers it was 1035 g, which was higher than our results by +6.70%.

Similarly, it was found that the standardized median body weight of girls in the northwestern regions of Ukraine at gestational age of 40-42 weeks were the highest compared to all other studies: the US results were by -5.95% – -9.07% lower than ours; Canadian -0.15% – -1.15%; Maltese -1.73% – -2.25%, and international standards „INTERGROWTH-21st Project“ – -1.98% – -2.98%.

At gestational age of 42 weeks, median body weight of newborn girls was 3530 g, whereas according to American researchers it was 3210 g, which was on -9.07% lower than our results.



**Table 6.** Standardized median (50th centile) of body weight of newborn girls in the northwestern regions of Ukraine in comparison with other studies

Gestational age, weeks	Our study	Denver, Colorado, USA, 1961		Hamilton, Ontario, Canada, 1984		Malta, 2009		INTERGROWTH-21st Project, 2014	
	BW	BW	%	BW	%	BW	%	BW	%
23	n.d.	–	–	n.d.	–	424	–	n.d.	–
24	n.d.	760	–	n.d.	–	564	–	n.d.	–
25	n.d.	845	–	n.d.	–	704	–	n.d.	–
26	n.d.	935	–	n.d.	–	844	–	n.d.	–
27	970	1035	+6,70	n.d.	–	988	+1,86	n.d.	–
28	1100	1140	+3,64	n.d.	–	1139	+3,55	n.d.	–
29	1260	1255	-0,40	n.d.	–	1299	+3,10	n.d.	–
30	1440	1380	-4,17	n.d.	–	1471	+2,15	n.d.	–
31	1620	1515	-6,48	n.d.	–	1654	+2,10	n.d.	–
32	1830	1675	-8,47	n.d.	–	1849	+1,04	n.d.	–
33	2040	1875	-8,09	n.d.	–	2052	+0,59	1860	-8,82
34	2260	2155	-4,65	n.d.	–	2260	+0,00	2130	-5,75
35	2470	2410	-2,43	n.d.	–	2468	-0,08	2380	-3,64
36	2670	2630	-1,50	2785	+4,31	2671	+0,04	2600	-2,62
37	2880	2800	-2,78	2985	+3,65	2862	-0,63	2800	-2,78
38	3060	2940	-3,92	3130	+2,29	3033	-0,88	2970	-2,94
39	3200	3060	-4,38	3245	+1,41	3180	-0,63	3130	-2,19
40	3360	3160	-5,95	3355	-0,15	3301	-1,76	3260	-2,98
41	3470	3210	-7,49	3430	-1,15	3392	-2,25	3370	-2,88
42	3530	3210	-9,07	3495	-0,99	3469	-1,73	3460	-1,98
43	3570	n.d.	–	n.d.	–	n.d.	–	n.d.	–

Note: n.d. – no data

## CONCLUSIONS

Based on analysis of newborn body weight in the northwestern regions of Ukraine we developed local standards of newborn weight in relation to gestational age for boys and girls.

It was established that full-term newborn boys had median body weight in the range from 2880 g (37 weeks) to 3530 g (42 weeks). However, full-term newborn girls had median body weight in the range from 2880 g (37 weeks) to 3530 g (42 weeks).

Availability of processed local standards depending on gestational age will enable neonatologists, pediatricians and researchers to clearly identify anomalies in the health of newborns in this region of Ukraine. Therefore, separation of newborns with low or high birth weight will enable operational assign of adequate and timely steps to provide them neonatal care and improve their health.



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