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ITALIAN STANDARDS FOR WEIGHT, LENGTH AND HEAD-SIZE AT BIRTH

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Abstract: Neonatal cross-sectional standards for weight, length and head-size here discussed were based on 16336 reference babies born in six towns of North, Centre and South Italy, between 1973 and 1981, and included in an obstetric-pediatric survey, sponsored by the National Research Council (CNR – grant no. 85. 00660.56). Single liveborn infants without congenital anomalies, and whose mothers did not have any risk factor for pregnancy (such as diabetes, hypertension, previous stillbirths or abortions), were considered reference babies. They made up a sample drawn from one reference population, regardless birthplace: actually, large differences in social and environmental conditions typical to the six towns appeared to exert trifling effects on reference neonates' dimensions. So, these neonatal standards, unlike those previously published in Italy, can safely be applied by obstetricians and neonatologists to any neonate born between 32 and 43 weeks of gestation.
Key words: Head-size, Lenght, Neonatal standards, Reference neonates, Weight.

Introduction

The stage of maturity of a newborn infant, assessed by neonatal standards, provides a rough but useful indicator of risk as regards not only morbidity and mortality, but also mental and neuromotor retardation (Wong and Scott 1972, Fujimura and Seryu 1977, Brandt 1978). The importance of low birth weight infants has been recognized for many decades, and led to international agreement that babies weighing 2.5 kg or less should regarded as forming a high-risk category, and to the further concept of the small-for-dates baby, i.e. light-for-gestational-age baby (Thomson 1978). As to the other traits, special emphasis has been put on the role of length and head-size in the diagnosis of impaired growth (Lubchenco et al. 1966, Holmes et al. 1977, Olowe 1981). In particular, head-size is related to brain growth and to changes in intracranial pressure (Babson and Benda 1976, Marks et al. 1979, Maisels and Marks 1981) and may be an aid in detecting microcephaly and hydrocephalus (Usher and McLean 1969).

Standards which may apply to every Italian neonate are to date available for birthweight only (Bossi et al. 1980). Growth charts for length and head-size are few, and concern limited geographical areas, a province or a region. Particularly worth of mention are the charts published by Pantarotto et al. (1974) based on 1204 babies born in Genoa, by Castello et al. (1975) based on 4194 babies born in Rome, and by Santoiemma et al. (1981) based on 5576 babies born in Ferrara. On the other hand, length and head-size standards most widely known in Italy (Lubchenco et al. 1966, Usher and McLean 1969, Sterky 1970, Finnstromm 1971, Gairdner and Pearson 1971, Chosh et al. 1971, Miller and Hassanein 1971, Wong and Scott 1972, Babson and Benda 1976; Fujimura and Seryu 1977, Holmes et al. 1977, Olowe 1981) refer to populations with different somatic features, and environmental and nutritional conditions, so that their application to italian neonates seems inappropriate.

Cross-sectional standards for weight, length and head-size at birth discussed in this paper were based upon 16336 „reference neonates" born in six towns of North, Centre and South Italy, and selected according to strict criteria, so that they can be sensibly thought of as outcome of „ideal" pregnancies, unaffected by any apparent pathological condition and risk factor.

Subjects and Methods

Target population and selected sample

Weight, length, and head-size at birth were recorded in the „neonatal data" section of an ad hoc questionnaire of an obstetric-pediatric multicentre survey, one of the goals of which was the definition of cross-sectional standards for Italian neonates. The survey was supported by National Research Council (CNR – Target Project: Preventive Medicine and Rehabilitation, subproject SP1, grant n. 85.00660.56).

The six hospitals in which data have been collected are situated so as to supply information on health conditions and care of mothers and babies in regions of Italy which largely differ in social and demographic features and life habits, as thoroughly discussed by Milani et al. (1983) and by Cortinovis et al. (1986).

Some 45 thousands babies participate in the survey, but only 16 thousands (i.e. about 1/3) had those characteristics that we, on the basis of a wide review of obstetric literature, considered typical to a *healthy reference population.* Reference subjects were single liveborn infants, without detectable congenital anomalies; moreover, their mothers did not have any of the risk factors identified in the questionnaire (see Table 1), and which seem to impair intrauterine growth (Bossi et al. 1980). This paper deals only with „reference subjects", whose gestational age was reliably known and in the range 32–43 weeks (see Table 2).

Table 1. Risk-factors for pregnancy and outcome adopted as criteria for selecting reference neonates

Maternal history	
– Uterine fibroids	– Renal diseases
– Uterine surgery	– Hypertension
Previous pregnancies	
– Spontaneous abortions	– Low-birthweight-babies
– Stillbirths	
Present pregnancy	
– Lues	– Hypertension
– Urinary infections	– Eclamptic Strokes
– Tuberculosis	– Epilepsy
– Asthma	– Vaginal bleeding
– Jaundice	– Placental abruptio
– Diabetes	– Isoimmunization
– Endocrine diseases	– Intrauterine transfusion
– Heart diseases	– Smoking ⩾ 10 cgts/day

Table 2. Whole sample size and reference set size according to centre and sex (data collected between 1973 and 1981)

Centres		Whole Sample		Reference Set	
		Girls	Boys	Girls	Boys
Trieste	(North-East)	5121	52	1881	1994
Milan	(North)	6022	6590	1707	1920
Parma	(North)	3227	3344	1430	1479
Rome	(Centre)	3475	3777	1535	1673
Naples	(South)	1707	1835	507	520
Bari	(South)	2078	2274	863	827
Total		21630	23282	7923	8413

Variables

All measures were taken within one hour of delivery, as a part of routine care. Weight was recorded to the nearest 10 g. Crown-heel length was measured with baby flat on its back and both legs extended in a measuring device containing a built-in centimetre rule; head-size was measured by a tape at the largest occipito-frontal circumference. Length and head-size measures were recorded to the nearest centimetre. The measuring error, including both „between-nurses" and „within nurse" components, was less than 2% (Bossi and Milani 1980).

Gestational age was expressed as completed weeks since the first day of the last menstrual priod. The estimate of gestational age was considered reliable if the date of beginning of the last menstrual period was recorded accurately, the period itself was normal with respect to flow, duration and expected date, and menstrual cycles preceding pregnancy were regular (within 5 of 28 days).

Statistical analysis

Distributional aspects of the above traits at each gestation week have been previously investigated (Marubini et al. 1978; Bossi and Milani 1980; Bossi and Milani 1985). No significant departure from the Gaussian distribution was found, but small sample size for preterm and postterm babies limits normality tests' power. Moreover, between-subjects variability tends to decrease with increasing gestational age, mainly for length and head-size. Therefore, it seemed sensible to compute the prefixed quantiles of the empirical distributions and their confidence limits, by nonparametric method (Conover 1971): this makes no distributional assumption, and hence is a more general and safe method to adopt (Solberg 1981), although its efficiency is somewhat lower, chiefly for extreme centiles (Healy 1974). The estimates of quantiles were then smoothed, so as to reduce random variability and elicit the shape of the relationship of traits to gestational age. Weighted moving averages (Kenney and Keeping 1954) of the quantiles of three contiguous weeks were used as smoothed values, weights being the product of sample size by binomial coefficient, i.e. 1, 2, 1, in the case of 3 values. Such a simple technique was preferred to polynomial regression, because low degree polynomials fit well the relationship of weight to gestational age, but not those of length and head-size.

Results

From left to right, Figure 1 shows neonatal standards of Italian *girls* for weight, length and head-size, as a function of gestational age. Most of births (some 90%) occurred between 37 and 41 gestation weeks, so that the quantiles for the other weeks could be estimated on few scores of babies only. Dotted lines denote estimates with poor precision, i.e. with 95% confidence interval not included in the range ±5% about the estimated quantile. In the range 32–36 weeks, poor precision affects estimates of quantiles, chiefly those of weight.

Median increments, in the interval between 32 and 41 weeks of gestation, were quite small both for length (4–5cm) and head-size (3–4cm), i.e. about 10% with respect to values observed at 32 weeks. In the same interval, increments of weight were 1.1 kg (girls) and 1.5 kg (boys), i.e. about 50 and 70% with respect to values at 32 weeks. Actually, it is well-known that prenatal growth in size precedes growth in weight: e.g. length of a 20 weeks fetus is a half of birthlength, whilst its weight is still one tenth of birthweight (Gramellini et al. 1984).

For length and head-size, between-subjects variability is larger at 34 weeks than at 40 weeks. At 34 weeks, intervals between 5th and 95th quantiles were 1.5 times wider

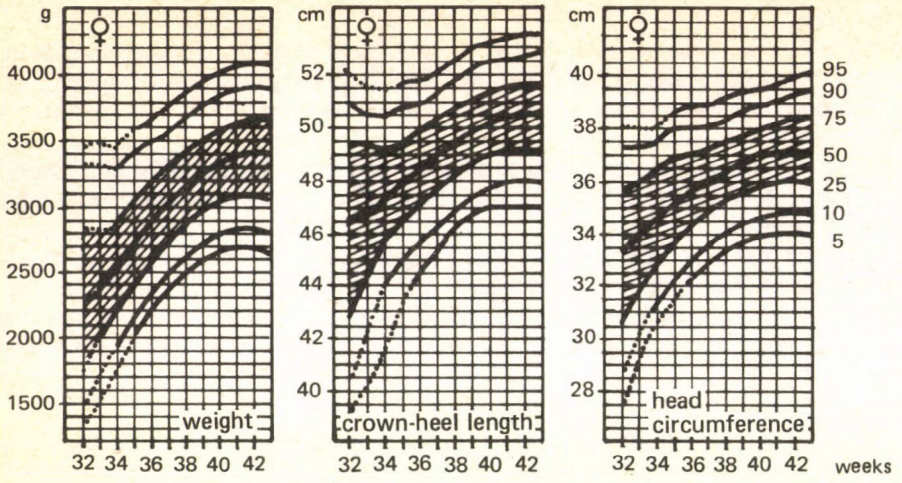

Fig. 1: Italian standards for weight, length, and head-size, as a function of gestational age: (GIRLS). Dotted lines denote estimates with poor precision, i.e. with 95% confidence interval not included in the range ± 5% about computed quantile

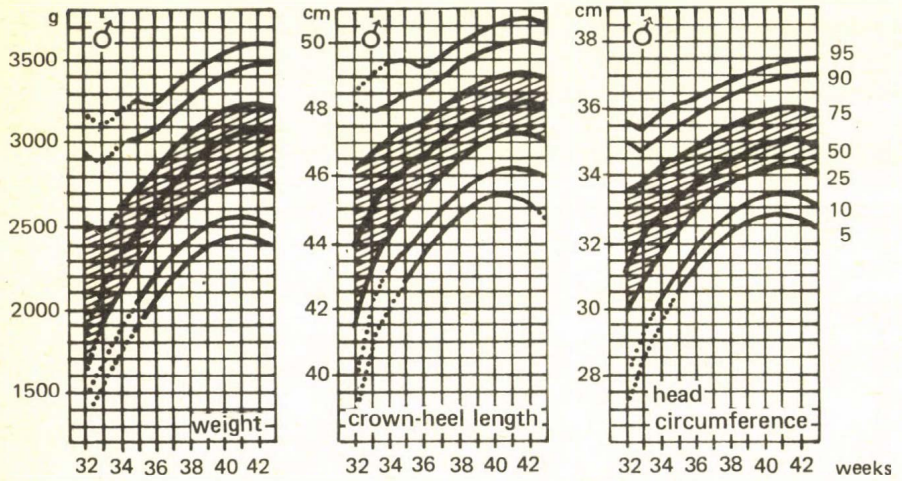

Fig. 2: Italian standards for weight, length, and head-size, as a function of gestational age: (BOYS). Dotted lines denote estimates with poor precision, i.e. with 95% confidence interval not included in the range ± 5% about computed quantile.

than at 40 weeks: from 9 to 6 cm for length, and from 6 to 4 cm for head-size. As regards weight, by contrast, interval between 5th and 95th quantiles was only 1.2 times larger at 34 weeks than at 40 weeks: from 1.7 to 1.4 Kg. Thus, low growth rate and large biological variability seem to limit the importance of knowing gestational age in the assessment of length and head-size at birth, but not in the assessment of weight.

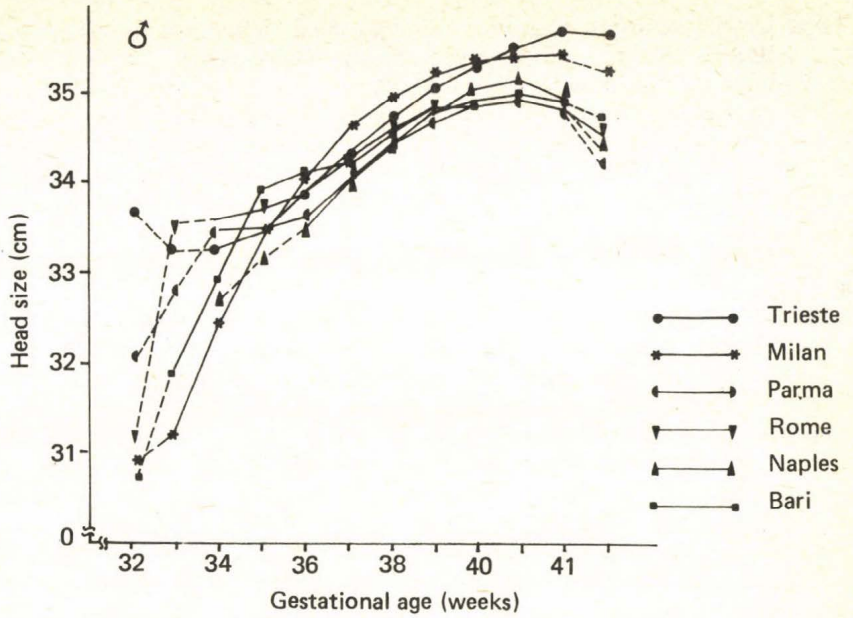

Fig. 3: Between-centres differences in median head-size of boys. Dotted lines denote estimates with poor precision, i.e. with 95% confidence interval not included in the range ±5% about computed medians.

On the average, postterm *male neonates* displayed values slightly lower than babies born at 41 weeks (see Figure 2). This finding, as well as many analogous results given in literature (Usher and McLean 1969, Sterky 1970, Ghosh et al. 1971, Miller and Hassenein 1971, Wong and Scott 1972, Pantarotto et al. 1974, Castello et al. 1975, Santoiemma et al. 1981), is quite paradoxical, mainly for length and head-size. So, it should be ascribed to either undetected errors in the assessment of gestational age, or unidentified pathological conditions occurred in pregnancy, despite the strict criteria adopted to select reference set. All traits were in boys consistently larger than in girls: 5th and 90th quantiles of boys correspond to 10th and 95th quantiles of girls, respectively.

Italian standards here described were based on the whole set of reference subjects, regardless of birthplace, so as to reduce irregularities due to sampling errors. This way of proceeding seemed to be sensible, because no systematic difference have emerged between values of the reference babies born in six centres under study. Actually, large differences are very rare and regard only those estimates that have poor precision (Bossi et al. 1980, Bossi and Milani 1986). As an example, Figure 3 shows between-centres differences in median head-size of boys. In the interval between 35 and 42 weeks of gestation, medians differ by 1 cm or less: the largest difference (3 cm at 32 weeks) is between Trieste (6 boys) and Bari (3 boys only!).

Comments

Cross-sectional standards, derived from anthropometric measures of neonates with different gestational ages, should be regarded mainly as a tool for evaluating body size and proportion of neonates, rather than as growth standards for monitoring fetal develop-

ment. As to length and width measures, standards more appropriate to this latter aim, should be preferably based upon ultrasound studies, since prenatal growth of fullterm babies may have a pattern different from that shown by measures taken at birth on premature children (Falkner 1985). Longitudinal intrauterine standards are claimed as fundamental to a good obstetric management of any pregnancy (Deter et al. 1982): as far we know (Keen and Peers 1985), unfortunately, new techniques in fetal ultrasonography have not until now provided longitudinal growth data sufficient to replace cross-sectional standards.

In any case, the standards here presented possess two features particularly worth of mention.

First, the set of babies used to construct standards may be though of as a sample drawn from a target population defined on the basis of clear-cut a-posteriori criteria (Siest 1981), i.e. a reference population according to the acceptation introduced by Alstrom (1981), in the field of Clinical Chemistry. Selection criteria adopted in this study reflect a goal-oriented concept of reference values (Grasbeck 1981): not only stillbirths and neonates with congenital anomalies were excluded, but also all babies whose mothers had any known risk factor for pregnancy and outcome, connected with impaired fetal growth. Hence, the reference population so defined is expected to have perinatal morbidity and mortality risks lower than those of the entire population of neonates, so that these standards fit well the ultimate goal of a standard, i.e. as emphasized by Babson and Benda (1972), „to serve as a screening test to identify otherwise unrecognized diseases, such as fetal malnutrition, metabolic and endocrine disorders, and infective diseases".

Second, the standards can be safely applied by obstetricians and neonatologists to the large majority of Italian neonates born between 32 and 43 weeks of gestation. In fact, between-centres differences of weight, length and head-size at birth were rather large in the unselected sample, but negligible in the reference set (Bossi et al. 1980, Bossi and Milani 1980), likely because prevalence of risk-factors related to fetal growth, rather than fetal growth itself, is affected by social and environmental conditions typical to different Italian areas and by heterogeneity of hospital populations included in this study.

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