

Macrosomic newborns: a 3-year review

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The objective of this study was to determine the incidence, perinatal complications and the outcome of macrosomic infants. A retrospective analysis was made of macrosomic deliveries and of those admitted into the Neonatology Unit. A control group of 854 deliveries weighing between 2500-4000 g was randomly composed. The incidence of macrosomic deliveries, stillbirth rates, sex, parity, maternal age, mode of delivery, perinatal complications like birth traumas, hypoglycemia, polycythemia, asphyxia, admission rate into the neonatal intensive care unit (NICU), and outcome were analyzed. Among a total of 11,827 deliveries, 829 (7%) were macrosomic neonates. Statistical analysis showed male predominance ($p=0.0001$), a significant increase in cesarean section ($p=0.0001$), and higher parity for the macrosomic group ($p=0.0001$). The mothers of macrosomic newborns were older ($p=0.0001$). The admission frequency of macrosomic deliveries into the NICU was almost two-fold. Birth injuries were found in 53 (6.4%) macrosomic infants, and macrosomic deliveries had a two-fold risk for birth injuries. Statistical analysis showed a significant difference between macrosomics and the control group for the frequency of birth traumas ($p=0.0007$), hypoglycemia ($p=0.0001$) and polycythemia ($p=0.0006$). There were two deaths in macrosomic group versus one among control cases. Regarding the high birth trauma and NICU admission rates of macrosomic infants, it is important to emphasize the significance of prenatal diagnosis of fetal macrosomia and of management of these high-risk pregnancies in tertiary level hospitals.

Key words: macrosomia, birth injuries, NICU admission.

The term macrosomia is used to describe a newborn with an excessive birth weight¹⁻³. However, there is no general agreement about what the weight limit should be. In various studies, birth weights above 4000, 4200 and 4500 g were used as definitions of newborn macrosomia¹⁻⁴. The most accepted definition is a birth weight greater than 4000 g²⁻⁴. The proportion of macrosomia, e.g. birth weight >4000 g, varies in different populations, ranging between 1-20%. The highest prevalence is found in the Nordic countries, where the proportion of newborns with a birth weight ≥ 4000 g is around 20%, and between 4-5% of the babies weigh ≥ 4500 g¹⁻³.

The causes of fetal macrosomia may be divided into non-modifiable and modifiable factors.

Genes would be considered non-modifiable. The other factors that may be considered non-modifiable include fetal sex, parity, maternal age, and maternal height. Modifiable factors include mainly pre-gestational maternal anthropometric characteristics, maternal nutritional intake, gestational weight gain, level of physical activity, smoking, and metabolic parameters, especially those related to maternal glucose metabolism^{3,4}. Male newborns typically weigh more than female newborns and thus comprise a greater proportion of infants with birth weights exceeding 4500 g at any gestational age²⁻⁵.

In some recent reports, it was stated that there has been rise in the prevalence of large newborns over a few decades in many parts of the world^{2,3}. Fetal macrosomia is associated with increased risk of complications both for

the mother and the fetus or neonate^{2,3}. Fetal risks associated with macrosomia include birth trauma (3-7%), including shoulder dystocia (9.2-24%), brachial plexus injuries (1-4%), perinatal asphyxia, and death (0.4%)^{2,3,4,6}. Neonatal risks associated with macrosomia include hypoglycemia (50%), hematological disturbances (i.e., polycythemia) and electrolyte disturbances (up to 50%)^{2,3,7}. In addition, a macrosomic birth is also associated with long-term health risks for the newborn²⁻⁴.

The aim of this study was to determine the incidence and perinatal outcome of the macrosomic infants weighing over 4000 g, born in our hospital's Obstetrics Department over a three-year period.

Material and Methods

This study is a retrospective analysis of all macrosomic deliveries recorded in our hospital between January 1, 2005 and December 31, 2007. For the data collection, birth registry records of the Obstetrics Department, the pediatric newborn files and the medical files of the NICU (Neonatal Intensive Care Unit) were reviewed. The birth records of the Obstetrics Department were used for the formation of a study group as well as a control group. All the deliveries with birth weight over 4000 g composed the study group, whereas subjects of the control group (n=854) were selected randomly amongst the deliveries weighing between 2500 and 4000 g. Data such as sex, mode of delivery, maternal age, birth weight, and parity were collected from these records.

For all the newborns included in this study, the pediatric newborn examination files were reviewed. The data regarding birth traumas, asphyxia, the presence of hypoglycemia and polycythemia, and the cases admitted to the NICU were recorded. The medical records of all the newborns admitted to the NICU were further evaluated for outcome.

Statistical Analysis

Statistical calculations were performed with GraphPad Prisma V.3 program for Windows. In addition, standard descriptive statistical calculations (mean, standard deviation, median, frequency distribution) for continuous random variable unpaired t-test (according to

Levene's test criteria) were used to compare the control and macrosomic groups. Chi-square test and odds ratio (OR) were performed during the evaluation of qualitative data. Statistical significance level was established at $p < 0.05$.

Results

A total of 11,827 deliveries took place throughout the study period, 829 (7%) of which were macrosomic deliveries. Among these, the rate of newborns with birth weight ≥ 4500 g was 1.3% (n=158) and of the extreme macrosomic infants (≥ 5000 g) was 0.2% (n=25) (Fig. 1).

Of a total of 829 macrosomic deliveries, 6 were stillbirths (0.7%). In the control group, there were 6 stillbirths (0.7%) among 854 deliveries. The statistical analysis revealed no difference regarding the incidence of stillbirth between the two groups ($p=0.959$) (OR: 1.03, 95% confidence interval [CI]: 0.3-3.2).

Among the 829 macrosomic newborns recorded during the study period, there were 550 (66.3%) males and 279 (33.7%) females. Male/female ratio was 1.97. The control group was comprised of 854 deliveries, of which 438 (51.3%) were male and 416 (48.7%) female, with a male/female ratio of 1.05. Statistical analysis showed significant male predominance of macrosomic deliveries compared to normal subjects ($p=0.0001$) (OR: 1.9, 95% CI: 1.5-2.3).

The cesarean section rate was 37.3% (n: 309) for the study group and 25.3% (n: 211) for the control group. The mean birth weight of the study group was 4294.88 ± 275.5 g (range: 4010-

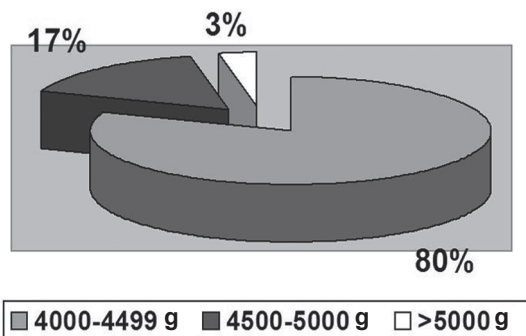


Fig. 1. The distribution of macrosomic newborns according to birth weight.

6100 g and median: 4200 g) and of the control group was 3310.48 ± 359.3 g (range: 2500-4000 g, median: 3320 g). The comparison of the mode of delivery of the macrosomic newborns and the control group revealed a statistically significant predominance of cesarean section deliveries within the macrosomic group ($p=0.0001$) (OR: 1.75, 95% CI: 1.4-2.16).

The mean birth parity in the macrosomic group was 2.6 ± 0.07 (median: 2) and of the control group was 2.1 ± 0.04 (median: 1). The analysis of the parity distribution showed a significant difference ($p=0.0001$). The risk of macrosomic deliveries increased with multiparity.

The mean maternal age was 28.3 ± 5.6 years (range: 17-53, median: 28 years) in the study group and 26.66 ± 5.28 years (range: 17-44, median: 26 years) in the control group. A comparison of the two groups revealed a significant difference ($p=0.0001$) with respect to maternal age. The mothers of the macrosomic newborns were older. Those 35 years and older formed 11.9% (n: 99) of macrosomic deliveries and 7.4% (n: 63) of the control group, and the statistical comparison showed a significant difference ($p=0.002$) (OR: 1.7, 95% CI: 1.2-2.4).

Among the 11,575 live births over the three-year period, 1350 infants were admitted to the NICU for various reasons. Of the total 823 liveborn macrosomic infants, 75 cases (9.1%) were admitted into the NICU. Among the 848 liveborn control subjects, only 39 (4.6%) were admitted. Statistical analysis showed a significant difference between macrosomics and the control group ($p=0.0004$) (OR: 2.08,

95% CI: 1.4-3.1). The admission frequency of macrosomic deliveries into the NICU was almost two-fold that of the controls.

Birth injuries were diagnosed in 53 (6.4%) of the macrosomic infants and in 24 (2.8%) control cases, and statistical analysis revealed a significant difference between the study group and the controls ($p=0.0007$) (OR: 2.36, 95% CI: 1.4-3.8). Risk for birth injuries for macrosomic deliveries was found to be two-fold. The distribution of birth injuries in macrosomic newborns was as follows: 15 clavicle fractures (1.8%), 1 humerus fracture (0.1%), 7 brachial plexus palsies (0.8%), 3 facial palsies (0.4%), and 27 cephalhematomas (3.3%). Distribution of birth injuries in the control group included: 4 clavicle fractures (0.5%), 1 humerus fracture (0.1%), 2 brachial (0.2%) and 1 facial palsy (0.1%), and 16 (1.9%) cephalhematomas (Table I).

Among the macrosomic newborns, 24 (2.9%) infants had polycythemia, 38 (4.6%) had hypoglycemia, and 8 (0.97%) were admitted for asphyxia. Two cases died (0.2%) within a week after admission. In the control group, 5 (0.6%) cases with polycythemia, 2 (0.2%) with hypoglycemia, and 4 with asphyxia (0.5%) were observed. One case (0.1%) died within a week after admission. Statistical analysis showed a significant difference between macrosomics and the control group in terms of hypoglycemia ($p=0.0001$) (OR: 20.5, 95% CI: 4.9-85.2) and polycythemia ($p=0.0006$) (OR: 5.06, 95% CI: 1.9-13.3). No statistical difference was found regarding early neonatal mortality ($p=0.979$) and asphyxia ($p=0.102$) (Table II).

Table I. The Distribution of Birth Injuries in Macrosomic and Control Group Neonates

	Macrosomic (>4000 g) n: 823		Control (2500-4000 g) n: 848		p	OR (95 CI%)
	n	%	n	%		
Fractures						
Clavicle fracture	15	1.8	4	0.5	0.017	3.9 (1.3-11.8)
Humerus fracture	1	0.1	1	0.1	0.983	1.03 (0.64-16.5)
Palsy						
Brachial plexus	7	0.8	2	0.2	0.166	3.6 (0.75-17.52)
Facial	3	0.4	1	0.1	0.595	3.1 (0.33-29.8)
Cephalhematoma	27	3.3	16	1.9	0.101	1.76 (0.94-3.3)
Total Birth Injuries	53	6.4	24	2.8	0.0007	2.36 (1.44-3.86)

OR: Odds ratio. CI: Confidence interval.

Table II. The Perinatal Complications in the Macrosomics and Control Group

	Macrosomic (>4000 g) n: 823		Control (2500-4000 g) n: 848		p*	OR (95 CI%)
	n	%	n	%		
Stillbirth	6	0.7	6	0.7	0.959	1.03 (0.33-3.2)
Birth injuries	53	6.4	24	2.8	0.0007	2.36 (1.44-3.86)
Asphyxia	8	0.97	4	0.5	0.102	4.15 (0.87-19.6)
Polycythemia	24	2.9	5	0.6	0.0006	5.06 (1.9-13.34)
Hypoglycemia	38	4.6	2	0.2	0.0001	20.5 (4.92-85.2)
Early neonatal mortality	2	0.2	1	0.1	0.979	2.06 (0.18-22.8)

Statistical significance level was established at $p < 0.05$.

OR: Odds ratio. CI: Confidence interval.

Discussion

Macrosomia is associated with a number of maternal and neonatal complications. There is increased risk of cephalopelvic disproportion and shoulder dystocia in macrosomic deliveries that leads to traumatic birth injury and asphyxia. These risks are higher in infants of diabetic mothers than in infants of women without diabetes whose children have a similar birth weight^{2,3}. Macrosomic infants are at risk for birth traumas such as Erb palsy and clavicle fracture^{3,4,6}. Erb palsy has the potential for a long-term morbidity since the neurologic deficit may be permanent in approximately 5% to 15% of cases. The rate of Erb palsy in macrosomic, vaginally delivered infants weighing ≥ 4500 g is 5%, compared with 0.7% in those weighing < 4500 g. Additional neonatal complications associated with shoulder dystocia include neonatal depression and a greater incidence of an Apgar score < 7 ^{2,3,4,6}.

The macrosomia incidence is generally reported differently according to climate and racial conditions and presence of local factors in different regions^{2,3,7}. Fakhri⁷ from Iran found the macrosomia incidence to be 4.3%. In his study, 70% of the macrosomic infants were found to be males⁷. The incidence of macrosomic births was reported by Tomic⁸ from Bosnia as 13.1%, Westerway⁹ from Australia as 14%, Navti¹⁰ from the United Kingdom as 1.4%, and by Wollschlaeger¹¹ from Germany as 9.1%, who also found a male predominance. In the study of Mathew¹² from the Sultanate of Oman, the rate of macrosomic deliveries was 3.7% and of deliveries ≥ 4500 g was 0.5%.

Berard¹³ from France reported a rate of 0.9% for infants weighing > 4500 g. In the United States, in 1998, 1.5% of all neonates had a birth weight ≥ 4500 g¹.

In our study, we found the rate of infants with birth weights > 4000 g to be 7% and ≥ 4500 g to be 1.3%. Oral et al.¹⁴ from İstanbul found the rate of macrosomic deliveries in 2001 to be 6.2% and of those weighing ≥ 4500 g to be 1.0%. Extreme macrosomia (birth weight ≥ 5000 g) in our study was found to be 0.2%. According to the National Vital Statistics in 2002 in the United States, the prevalence of newborns weighing > 4000 g was 9.2% and of those weighing > 5000 g was 0.13%^{1,15}.

There was a male predominance (66%) in our study group, similar to the reports of other researchers. Jazayeri² stated in his review that male newborns typically weigh more than female newborns and thus comprise a greater proportion of infants with birth weights exceeding 4500 g at any gestational age. This was also reported by Tomic⁸ from Bosnia and Wollschlaeger¹¹ from Germany.

In the study of Wollschlaeger¹¹, mothers delivering macrosomic infants were significantly older. This finding is similar to our finding of significantly older mothers in the macrosomic group versus the control group ($p = 0.0001$). On the other hand, in a study from Nigeria, Adesina et al.¹⁶ reported that there were no significant differences in maternal age or height. Furthermore, similar to the results of our study, maternal age over 35 years was a significant risk factor for macrosomic deliveries, as reported by Oral et al.¹⁴

Mulik¹⁷ reported a higher incidence of NICU admissions for neonates with a birth weight >4500 g compared with newborns with a birth weight of <4000 g (9.3% vs 2.7%). In our study, the admission rate of the macrosomic infants (>4000 g) born in our hospital to our NICU was 9.1%. The admission frequency of macrosomic deliveries to the NICU was almost two-fold compared to controls.

In a large study by Raio¹⁸ et al., neonates with birth weights >4500 g were studied. Shoulder dystocia and brachial plexus injuries occurred in about 10% and 3% of the newborns, respectively. The rates of brachial plexus palsy, clavicle fracture and asphyxia in our study were 0.8%, 1.8% and 0.97%, respectively. Oral¹⁴ reported brachial plexus palsy, clavicle fracture and asphyxia prevalences as 2.4%, 2.3%, and 1.4%, respectively. Navti¹⁰ from the United Kingdom reported an asphyxia rate of 13.6%, and Boyd¹⁹ reported a rate of 9.1%. In our study, the cesarean delivery rate in the study group was 37.3%. Fakhri⁷ from Iran reported this rate to be 15.5%, Oral¹⁴ from İstanbul reported a rate of 28.8%, and Nassar²⁰ from Beirut reported 27.3%. The low rate of the birth traumas and asphyxia found in our study may be explained by the high rate of cesarean delivery in our Obstetrics Department.

When associated with diabetes, fetal macrosomia indicates poor maternal glucose control, and these infants are at risk of stillbirth. In the literature, stillbirth rates in macrosomic infants are twice as high as those in control subjects, irrespective of diabetes. In our study, the stillbirth rate in macrosomic deliveries was 0.72%, and in the control group this rate was 0.7%; there was no statistical difference between the two groups. In the study of Oral¹⁴, the early neonatal mortality rate was 0.5%. In our study, early neonatal death among macrosomics was 0.2% .

Because macrosomic fetuses are at an increased risk for immediate complications related to birth injury and/or hypoglycemia and polycythemia as well as for potential long-term consequences such as diabetes, overweight, metabolic syndrome, asthma, persistent plexus injuries, and cancer, measures for prevention of macrosomia have been recommended^{2,3,4,7}. The medical literature confirms that prediction of fetal macrosomia is difficult^{3,15,19}. A consensus

has not yet been reached regarding management strategies to reduce the risk of macrosomia. Cesarean delivery to reduce the risk associated with macrosomia places the mother at risk. Not all cases of nerve injuries can be prevented by cesarean delivery since some occur *in utero*². Induction of labor for probable macrosomia has not been proven to significantly alter outcomes^{2,3,15,19}.

Although no intervention has been proven to significantly reduce the risk of macrosomia, tight glucose control during pregnancy in both diabetic mothers and in those with gestational diabetes and prevention of maternal obesity before pregnancy with appropriate education of mothers are among the several potentially useful strategies that may be helpful to reduce the incidence of macrosomia^{2,3,15,19}.

This study has some limitations. The data were collected retrospectively from the hospital medical records. Some factors that could be related to fetal birth weight like history of a previous macrosomic delivery, maternal weight before pregnancy and the effect of smoking could be evaluated if the study was conducted prospectively.

To conclude, regarding the high birth trauma and NICU admission rates of macrosomic infants, it is important to emphasize the significance of proper diagnosis of fetal macrosomia prenatally and of management of these high-risk pregnancies in tertiary level hospitals capable of a perinatal multidisciplinary team approach.

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