Morbidity and mortality of low-birth-weight infants in Egypt

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معدلات المراضة والوفيات بين الرضع ناقصي الوزن في مصر

عصمت منصور، أشرف نبيل عيسى، ليلى محمد نوفل، إبراهيم خربوش، عايدة علي رضا

الخلاصة: يعد نقص الوزن عند الولادة، أحد المحدِّدات الرئيسية لبقاء الوِلْدان (الحديثي الولادة) على قيد الحياة، وكذلك للمراضة بعد الولادة. وقد كان الغرض من هذه الدراسة، تقييم معدلات المراضة والوفيات لدى ناقصي الوزن، وذلك خلال الأشهر الثلاثة الأولى التالية للولادة. وقد تم جمع المعطيات من 6701 مولوداً حياً، جميعهم يمثلون ولادات فردية حية، إضافةً إلى مجموعة مقارنة تمثِّل أطفالاً رضعاً ولدوا بوزن طبيعي حيث تمت متابعة حالاتهم لمدة ثلاثة أشهر. وتم جمع معطيات تمثِّل الوزن والمراضة والوفيات، باستخدام استبيان مهيكلة. وقد أوضحت النتائج أن معدلات إدخال الوِلْدان (الحديثي الولادة) لوحدات الرعاية المركزة ومعدلات الوفيات، كانت أكثر حدوثاً في الرضَّع الناقصي الوزن (31.6٪، 2٪)، مقارنة بالرضع الذين ولدوا بوزن طبيعي، (2.0٪، 0.2٪). كما أن عوامل اختطار الإصابة بيَرَقان الوليد في الشهر الأول كانت مرتفعة لدى هذه المجموعة، إضافة إلى ارتفاع عوامل اختطار الإصابة بتأخُّر النمو، وعامل اختطار أعلى بكثير من حيث التعرض للوفاة.

ABSTRACT Low birth weight is one of the major determinants of neonatal survival and postneonatal morbidity. This study assessed the morbidity and mortality of low-birth-weight (LBW) infants during the first 3 months. Data were collected for 6701 live births. All singleton liveborn LBW infants as well as a comparison group of normal-birth-weight (NBW) infants were followed up for 3 months. Data were collected on weight, morbidity and mortality using a structured questionnaire. Admission to neonatal intensive care unit and mortality were more frequent in LBW (31.6%, 2.0%) than NBW infants (2.0%, 0.2%). They also had increased risk of neonatal jaundice at 1 month, an increased risk of growth retardation and a much higher risk of mortality.

Morbidité et mortalité chez les nourrissons de faible poids de naissance en Égypte

RÉSUMÉ L'insuffisance pondérale à la naissance est un des déterminants majeurs de la survie néonatale et de la morbidité post-néonatale. La présente étude évalue la morbidité et la mortalité chez les nourrissons de faible poids de naissance durant les trois premiers mois. Des données ont été collectées pour 6701 naissances vivantes. Tous les nouveau-nés vivants de faible poids à la naissance issus d'une grossesse unique ainsi qu'un groupe témoin de nourrissons de poids de naissance normal ont été suivis sur trois mois. Des données ont été recueillies sur le poids, la morbidité et la mortalité au moyen d'un questionnaire structuré. L'admission à l'unité néonatale de soins intensifs et la mortalité étaient plus fréquentes chez les nourrissons de faible poids de naissance (31,6 %, 2,0 %) que chez les nourrissons de poids de naissance normal (2,0 %, 0,2 %). Ils avaient également un risque accru d'ictère néonatal à un mois, un risque accru de retard de croissance et un risque de mortalité bien plus élevé.

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Introduction

Low birth weight (LBW), birth weight < 2500 g [*1*], is one of the major determinants of neonatal survival as well as post-neonatal morbidity; rates of post-neonatal physical, neurological and mental handicap are known to be significantly higher in these infants [*2*].They have a far greater risk of developing immediate problems after birth, e.g. asphyxia, hyaline membrane disease, jaundice, hypoglycaemia and polycythaemia, and have greater incidence of congenital malformation than those of normal birth weight [*3*].

Sepsis is a common pathology during the neonatal period, with LBW the most important risk factor. These infants are more susceptible to conditions such as lower respiratory tract infections. They are also vulnerable to the potential side-effects of neonatal intensive care interventions. [*4,5*].

Very-low-birth-weight (VLBW) infants, birth weight < 1500 g [*1*], have a higher risk of acquiring nosocomial infection during neonatal intensive care. In addition, the retina is easily damaged by high levels of oxygen and there is a risk of intracranial bleeding as a result of birth trauma [*6–8*].

The association between LBW and neurodevelopment problems such as cerebral palsy and seizure disorders are well documented [*9*]. The prevalence of most recognized impairments at or shortly after birth rises very sharply as birth weight and gestational age fall [*10*].

Infants with LBW are at much higher risk of severe morbidity than full term, full sized infants, both during the neonatal period and into infancy and childhood. They are more likely to be malnourished at 1 year. By the age of around 5 years, the LBW child, probably having had more cyclic episodes of infection and malnutrition, may be severely stunted [*8*]. The rate of LBW within a country largely influences perinatal, neonatal and infant morbidity and mortality rates [*2*].

In industrialized regions of the world, neonatal mortality is the most significant component of infant mortality and the proportion of VLBW infants is a principal predictor of neonatal mortality. Although there is limited availability of data in developing countries, LBW is known to be one of the major causes of both infant and neonatal deaths, accounting for about 15%–50% of all neonatal deaths [*11*].

There are insufficient birth-weight-specific mortality data available for developing countries to examine the risk of death from LBW. Moreover, the attributable risk of LBW to morbidity is not well established, primarily because of definition bias and lack of population-based morbidity data. Recent studies have focused on the outcomes of VLBW infants in particular hospitals and there are few outcome studies for all LBW infants [*11*].

This study, which is a part of a larger study of LBW in Egypt, aims at assessing morbidity and mortality of LBW infants during the first 3 months of life.

Methods

The fieldwork for this study was conducted during the period 1995–1997. Both a cross-sectional and a follow-up approach were used [*12*]. To ensure proper representation of the different areas in Egypt, a multistage, stratified, random sampling technique was used in the cross-sectional study. The 26 governorates were divided into 4 groups: urban, Lower Egypt, Upper Egypt and frontier governorates. Two governorates were randomly selected from each, excluding the frontier governorates for logistics reasons (low population density and the largely desert nature of the ter-

rain). One district was randomly selected from each of the 6 selected governorates. The target population of the study was infants of mothers living in that district only.

Assuming a 95% confidence interval, a prevalence of 15.7% for LBW [*13*] and a precision of ± 0.025, the target sample size per governorate was calculated as 813 births, which was rounded to 1000. The cross-sectional study included 6701 live births. Multiple births (303) were excluded giving a total of 6398 singleton live births.

Health facilities that actually practise deliveries represented the study setting in each district. Deliveries attended by active *dayat* (traditional birth attendants) or a member of the family in each district were also identified and included. Data were collected from mothers within 36 hours of delivery. Weight measurement and collection of data for home deliveries were done by health workers from local health facilities during home visits. About 40% of all deliveries (including stillbirths) were attended by *dayat* and only 0.4% by family members.

A structured questionnaire was used to collect sociodemographic data, maternal data and delivery data, as well as data about the newborn.

A follow-up study was done to gain more information. Mothers in 2 out of the 6 districts we studied in Cairo and Port Said governorates were followed up from mid and late gestation, and their deliveries were included in the cross-sectional study. In order to ensure achievement of the required sample size (2000 deliveries) a larger number of women (2870) were included to compensate for dropouts.

The sample which was used in this part of the study included a follow-up study of normal-birth-weight (NBW) and LBW infants. All singleton liveborn LBW infants identified in the cross-sectional study as well as a comparison group of singleton liveborn NBW infants identified in the cross-sectional study were included in the follow-up study. A total of 646 LBW singleton live births were identified from the cross-sectional study. Thirteen infants died during the first 36 hours and so there were 633 LBW infants in the follow-up. The number of NBW infants was 1448. Both groups were followed up at 1 month and 3 months after delivery. At the first visit, 185 LBW and 27 NBW infants had died. At the second visit 11 NBW were lost to follow-up, resulting in a final sample size of 448 LBW and 1410 NBW infants.

A structured questionnaire was used to collect data about infant morbidity history [admission to the neonatal intensive care unit (NICU), jaundice, vomiting or diarrhoea, acute respiratory infection, umbilical infection and vaccination] and infant mortality. In addition, infant weight was measured in each visit.

Infants with NBW and LBW were compared for growth, morbidity and mortality during the first and second visits using the chi-squared test of significance. Multiple logistic regression analysis was used to control for the following potential confounding factors: place of residence, maternal age, maternal education, paternal education, maternal work, crowding index, place of delivery, sex of newborn, parity, and spacing. Analysis was performed both with and without obstetric history so that primigravidae could be considered in calculating adjusted risk (excluding spacing).

Growth of infants was analysed using the *Epinut* software of *Epi-Info*, version 6.04. Two cut-off points were used: –2 and –3 standard deviations (Z-scores) of the reference population.

For all analyses, a 5% level of significance was used.

Results

Mortality and admission to the NICU for infants in the cross-sectional study

Mortality during the first 36 hours among LBW infants was 10 times greater than mortality among NBW infants. The total number of singleton live births was 6398, of which 646 were LBW. Thirteen of these (2.0%) died within 36 hours compared to 12 (0.2%) of the 5752 NBW infants ($P < 0.05$).

Admission to NICU was 204 (31.6%) for LBW compared to 117 (2.0%) for NBW infants ($\chi^2 = 1063.3$, $P < 0.05$).

Admission to the NICU of the infants in the follow-up study

The rate of admission to NICU for LBW infants was 43.1% compared to 5.8% for NBW infants. The risk of admission associated with LBW was 7.4 times greater than with NBW (Table 1). No significant difference was detected regarding length of stay in NICU.

The main cause of admission to NICU among LBW infants was low birth weight (64.4%) while among NBW infants it was disease (55.4%). A significant difference was found in the distribution of cause of admission between the two groups ($\chi^2 = 97.3$) (data not shown).

In the follow-up study, the mortality rate among LBW infants admitted to NICU was 80 of 233 (34.3%) compared to 11 of 83 (13.8%) for NBW infants ($\chi^2 = 13.3$, $P < 0.05$).

Table 1 **Distribution of infants according to birth weight and admission to neonatal intensive care unit (NICU)**

Admission to NICU[a]	Low birth weight		Normal birth weight	
	No.	%	No.	%
No	308	56.9	1360	94.2
Yes	233	43.1	83	5.8
Total	541	100.0	1443	100.0
Mean duration (SD) (hours)	62.28 (87.75)		62.39 (59.68)	

[a]Including infants admitted after the first 36 hours.
$\chi^2 = 97.3$, P < 0.05.
SD = standard deviation.

Morbidity status

Table 2 shows morbidity rates during the neonatal period for several disorders. Incidence of jaundice was found to be higher (35.6%) in LBW infants compared to NBW infants (16.9%) with a higher risk, which was statistically significant (relative risk = 2.1, 95% CI: 1.8–2.5). The risk remained significant even after adjusting for selected factors that could affect the outcome (Table 3).

No significant difference was found regarding risk of diarrhoea/vomiting or umbilical infection, and although acute respiratory infection showed a significant difference in crude risk between LBW and NBW infants, this risk was not significant after adjustment for all variables but was significant after adjustment excluding spacing (Table 3).

A similar pattern of morbidity was observed between LBW and NBW during the second visit. Diarrhoea/vomiting showed no significant difference and risk of acute respiratory infection was not found to differ significantly for both crude and adjusted risk.

There was no difference between the 2 groups for vaccination; uptake was close to 100% for both.

Infant growth

Table 4 gives a comparison of the underweight status (below –2 and –3 standard deviations) of NBW and LBW infants at the first and second visits. At the first visit a

Table 2 **Frequency (%) of certain disorders by birth weight in infants followed for the first 3 months**

Disorder	Low birth weight	Normal birth weight	Relative risk	95% CI
1st visit[a]	(***n*** = 356)	(***n*** = 1436)		
Jaundice	35.6	16.9	2.11	1.8–2.5
Umbilical infection	15.0	14.2	1.06	0.9–1.3
Diarrhoea/vomiting	13.8	16.0	0.86	0.8–1.1
Acute respiratory infection	25.3	18.8	1.32	1.1–1.6
2nd visit[a]	(***n*** = 385)	(***n*** = 1312)		
Diarrhoea/vomiting	32.2	29.6	1.09	0.9–1.3
Acute respiratory infection	30.6	30.3	1.01	0.9–1.2

[a]***Numbers differ because of drop-outs and missing information on some questionnaires.***
CI = confidence interval.

higher proportion of LBW infants were below –2 standard deviations of weight-for-age compared to NBW infants but the difference was not statistically significant. However, severe underweight (below –3 standard deviations) was found to be significantly higher among LBW infants compared to NBW infants.

By the second visit, the proportion of infants below –2 standard deviations of weight-for-age decreased to 8.1% for NBW infants and 12.5% for LBW infants, with the difference statistically significant. Severe underweight also decreased in both groups but the difference was not statistically significant.

Mean weight-for-age Z-score was also calculated and found to be significantly lower in LBW infants compared to NBW infants. This improved from the first to the

Table 3 **Low birth weight as a risk factor for certain disorders among infants followed up for 2 visits**

Disorder	1st visit				2nd visit			
	Risk[a]	95% CI	Risk[b]	95% CI	Risk[a]	95% CI	Risk[b]	95% CI
Neonatal jaundice	4.0	2.9–5.5	3.2	2.5–4.2				
Umbilical infection	1.2	0.8–1.8	1.1	0.8–1.5				
Diarrhoea/vomiting	0.8	0.6–1.3	0.8	0.6–1.1	1.0	0.7–1.4	1.2	0.9–1.5
Acute respiratory infection	1.3	0.9–1.7	1.5	1.2–1.9	1.1	0.8–1.5	1.0	0.8–1.3

[a]***Adjusted to all variables.***
[b]***Adjusted to all variables excluding spacing.***
CI = confidence interval.

Table 4 **Frequency (%) of underweight (assessed by weight-for-age Z-score) according to birth weight among infants followed up for the first 3 months**

Z-score weight-for-age	Low birth weight	Normal birth weight	Test of significance
1st visit	(***n*** = 584)	(***n*** = 1374)	
< –2 SD	17.8	14.9	$\chi^2 = 2.8$
< –3 SD	3.8	1.6	$\chi^2 = 8.8$*
Mean (SD)	–1.08 (1.08)	–0.91 (1.06)	***F*** = 10.22*
2nd visit[a]	(***n*** = 44)	(***n*** = 1224)	
< –2 SD	12.5	8.1	$\chi^2 = 7.4$*
< –3 SD	0.7	0.7	
Mean (SD)	–0.67 (1.05)	–0.56 (0.97)	***F*** = 3.92

[a]***Numbers differ because of drop-outs and missing information on some questionnaires.***
Significant at** P **< 0.05.
SD = standard deviation.

second visit, but the score for LBW infants was still significantly lower (Table 4).

The association between infant growth and birth weight did not change after adjustment for potentially confounding variables except when considering the model with spacing (Table 5).

Mortality

Mortality rate among LBW infants during the neonatal period was found to be significantly higher than among NBW infants: LBW infants had a 15 times higher risk (Table 6). This risk was also significant after adjustment for other factors (Table 7).

Mortality rate at the second visit (3 months) was also found to be significantly higher among LBW infants compared to NBW infants, a 2-fold higher risk (Table 6). This was also significant after adjustment for other factors (Table 7).

Discussion

Low-birth-weight neonates represent a heterogeneous group of term and preterm infants with varying risks in later life. The adverse consequences of LBW relate to survival, growth, development and even

Table 5 **Low birth weight as a risk factor for underweight among infants followed up for 2 visits**

Weight-for-age Z-score	1st visit				2nd visit			
	Risk[a]	95% CI	Risk[b]	95% CI	Risk[a]	95% CI	Risk[b]	95% CI
<–2 SD	0.9	0.7–1.3	1.2	0.9–1.6	1.5	0.9–2.4	1.5	1.1–2.2
< –3 SD	1.3	0.5–3.1	2.6	1.4–4.8	0.9	0.2–4.9	1.2	0.3–4.7

[a]***Adjusted for all variables.***
[b]***Adjusted for all variables excluding spacing.***
SD = standard deviation.
CI = confidence interval.

Table 6 **Mortality rate (%) by birth weight in infants followed for the first 3 months**

Mortality rate	Low birth weight	Normal birth weight	Relative risk	95% CI
1st visit	(***n*** = 633)	(***n*** = 1448)		
Mortality rate	29.2	1.9	15.2	10.3–22.5
2nd visit[a]	(***n*** = 448)	(***n*** = 1410)		
Mortality rate	15.8	7.3	2.16	1.6–2.98

[a]***Eleven infants lost to follow-up.***
CI = confidence interval.

the development of disease in adult life. These infants can suffer growth retardation which persists until adulthood. Growth-retarded adult women are likely to give birth to LBW babies, thereby perpetuating a vicious cycle through generations [*14*].

We examined the growth performance of infants and its relationship to birth weight status. The proportion of underweight (< –2 standard deviations) was significantly higher in LBW than NBW infants in the first 3 months (Table 4). LBW infants had a higher risk of being underweight, even after controlling for confounders (Table 5). This (for NBW infants) was higher at the first visit (1 month) but lower at the second visit (3 months) than the figure reported in the *Egypt demographic and health survey 1997* [*15*] which gives 11.7% as < –2 standard deviations for all children under 5 years of age.

Both during the neonatal period and into infancy and childhood, LBW infants are at much higher risk of mortality and severe morbidity than full-sized infants are [*8*]. Low birth weight is a significant contributor to neonatal death in both industrialized and developing countries [*11*]. Our results showed a higher mortality rate in LBW than NBW infants and a much higher adjusted risk for neonatal death, even after controlling for confounders. This risk dropped considerably by the end of the third month.

Our results are consistent with reported higher perinatal [*16*], neonatal [*17*] or early neonatal [*18,19*] mortality risks for LBW infants in some developing countries. Neonatal mortality related to LBW was found to carry a 7-fold increased risk in Dar es Salaam, Tanzania [*17*]. It was reported that the risk of neonatal death in LBW infants is 40 times higher than NBW infants. In the

Table 7 **Low birth weight as a risk factor for mortality among infants followed up for 2 visits**

Mortality	1st visit				2nd visit			
	Risk[a]	95% CI	Risk[b]	95% CI	Risk[a]	95% CI	Risk[b]	95% CI
Low birth weight	24.8	14.3–42.9	23.7	15.4–36.3	2.7	1.7–4.2	2.3	1.6–3.3

[a]***Adjusted for all variables.***
[b]***Adjusted for all variables excluding spacing.***
CI = confidence interval.

post neonatal period, LBW infants continue to have an increased risk of death [*11*].

Low birth weight itself is regarded as a major risk factor for other perinatal conditions [*11*]. In infants whose birth weight is very low, the suckling and swallowing reflexes are poorly developed and there is a risk of intracranial bleeding resulting from birth trauma. [*8,20*]. Many survivors of LBW suffer both immediate and long-term morbidity. [*11*] Most studies on the follow-up of LBW infants include as a poor outcome an excess of hospitalization, particularly in the first year of life [*10*]. This was manifested in our study by the high rate of NICU admission. This is in conformity with the significant increase in the incidence of perinatal morbidity found among LBW infants reported by McIntire et al. [*21*]. A 3-fold increase in neonatal morbidity was also reported among LBW infants in Tanzania [*17*].

Low-birth-weight infants are susceptible to kernicterus and neonatal jaundice [*11*], which is reported in our study. This could be one of the reasons for the high rate of admission to NICU.

On the other hand, little is known about the impact of LBW on the prevalence of common infections. Since immune function is severely compromised in LBW infants, it is reasonable to expect that they will have more illness than NBW infants will [*22*]. In addition, premature infants face a variety of physiological handicaps resulting from functional immaturity [*20*].

Low-birth-weight infants are more susceptible to conditions such as lower respiratory tract infections. Much of the excess hospitalization of LBW infants is attributable to treatment for respiratory infection [*10*]. Incidence of respiratory disease has been directly related to both birth weight and gestational age [*21*]. There is some evidence for increased risk of acute respiratory infection among LBW infants in our results, however, we did not observe a higher risk for diarrhoea. This could be due to the short period of follow-up in this study, since the incidence of diarrhoea is rather low in the first months of life [*15,23*].

It can be concluded that LBW babies are at a higher risk of remaining underweight during the first months of life. They are also at a higher risk of morbidity, including neonatal jaundice and admission to NICU, and mortality, especially during the neonatal period.

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