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Keywords
late preterm.morbidity, NICU, limited resource country

Abbrevations: NICU -Neonatal Intensive Care Unit
LP -Late Preterm
RDS-Respiratory Distress Syndrome
TTN-Transient Tachypnea of the Newborn
ALL- Albanian Lek
GA-Gestational Age
LGA-Large for Gestational Age
SGA-Small for Gestational Age
AGA-Apropriate for Gestational Age
IUGR-Intrauterine Growth Restriction

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Morbidity and Healthcare Burden of Late Preterm Infants: A Prospective Cohort Study from a Tertiary Center in Albania

Abstract

Background: Late preterm infants (34⁰/₇–36⁶/₇ weeks of gestation) account for a substantial proportion of preterm births and are at increased risk of morbidity compared to term neonates, particularly in resource-limited settings.

Objectives: To assess the incidence, maternal and neonatal morbidity, and associated healthcare burden of late preterm infants in a tertiary center in Albania.

Methods: A prospective cohort study was conducted at the University Obstetric and Gynecological Hospital "Koço Gliozheni", Tirana, Albania, from January 2014 to January 2016. All infants born between 34⁰/₇ and 36⁶/₇ weeks of gestation were included and stratified into three groups (34, 35, and 36 weeks). Maternal, perinatal, and neonatal data were analyzed using SPSS 20.0. Statistical significance was set at $p \leq 0.05$.

Results: Among 8,843 total births, 586 (6.6%) were late preterm infants, representing 66.1% of all preterm births. Lower gestational age was significantly associated with higher NICU admission rates (56.8% at 34 weeks vs. 21.6% at 36 weeks, $p < 0.001$), increased respiratory morbidity, including transient tachypnea and respiratory distress syndrome ($p < 0.05$), and higher rates of suspected and confirmed sepsis ($p < 0.05$). Hyperbilirubinemia was more frequent in infants born at 34 weeks (48.5%) compared to 36 weeks (19.7%) ($p < 0.001$). Birth weight, Apgar scores, and length of hospital stay differed significantly across gestational age groups ($p < 0.05$). Among maternal variables, only antenatal corticosteroid use showed a significant association ($p < 0.001$). The estimated cost per case was approximately 130 USD.

Conclusions: Late preterm infants, particularly those born at earlier gestational ages, remain at significant risk for morbidity and increased healthcare utilization. These findings underline the importance of optimized perinatal management and resource planning in low- and middle-income countries.

Introduction

Late preterm infants, defined as those born between 34⁰/₇ and 36⁶/₇ weeks of gestation, represent a substantial and increasing proportion of all preterm births worldwide (1). Although often considered physiologically similar to term infants, it is demonstrated that late preterm infants are at significantly higher risk of morbidity and mortality compared to those born at term (2,3). Globally, late preterm births account for approximately 70–75% of all preterm deliveries, contributing considerably to neonatal healthcare burden (4). These infants are particularly vulnerable due to physiological and metabolic immaturity, affecting multiple organ systems, including respiratory, neurological, and metabolic functions (5). Respiratory complications such as transient tachypnea of the newborn (TTN) and respiratory distress syndrome (RDS) are among the most common causes of morbidity in this population, largely due to delayed

lung maturation and surfactant deficiency (6,8). In addition, late preterm infants are at increased risk for hypoglycemia, hyperbilirubinemia, feeding difficulties,
temperature instability, and sepsis, all of which frequently necessitate hospitalization and, in many cases, admission to the Neonatal Intensive Care Unit (NICU) (7–10). The risk of adverse outcomes in late preterm infants is inversely related to gestational age, with those born at 34 weeks experiencing significantly higher morbidity compared to those born at 35 or 36 weeks (11). This gradient of risk highlights the importance of stratifying outcomes within the late preterm subgroup rather than considering it as a homogeneous category. Maternal, obstetric, and socioeconomic factors also play an important role in the occurrence and outcomes of late preterm birth. Advanced maternal age, maternl comorbidities, inadequate prenatal care, and lower socioeconomic status have all been associated with increased risk of preterm delivery and poorer neonatal outcomes (12,13). In recent years, interest has increased in optimizing perinatal management strategies for late preterm pregnancies, including the use of antenatal corticosteroids, which have been shown to reduce respiratory morbidity when administered prior to anticipated late preterm delivery (14). However, variations in clinical practice persist, particularly in low- and middle-income settings. Despite the rising data of international evidence, data from middle-income European countries, including Albania, remain limited. Understanding the burden of disease and specific risk factors in local settings is essential for improving neonatal care and guiding evidence-based clinical practice. Therefore, the aim of this study was to evaluate the morbidity and healthcare burden of late preterm infants in a tertiary care center in Albania, with particular focus on gestational age subgroups and associated maternal and neonatal factors

Materials and Methods

Study Design and Setting

This prospective cohort study was conducted at the University Obstetric and Gynecological Hospital "Koço Gliozheni", Tirana, Albania, over a two-year period from January 2014 to January 2016.The study protocol was approved by the Ethics committee of UHOG Koço Gliozheni and hospital administration.Personal data were coded to mask patients identities ,and stored in a secured database.

Study Population

All infants born between **34⁰/₇ and 36⁶/₇ weeks of gestation** during the study period were eligible for inclusion. Gestational age was determined based on the first day of the last menstrual period or, when unavailable, by first-trimester ultrasound. In uncertain cases, postnatal assessment was performed using the New Ballard Score.

Inclusion and Exclusion Criteria

All late preterm infants born within the study period were included.

Infants with **major congenital anomalies, genetic syndromes, or chromosomal abnormalities** were excluded from the study.

Data Collection

Data were collected prospectively using standardized clinical records and included maternal, perinatal, and neonatal variables.

Maternal Variables

- Age
- Marital status
- Parity
- Perinatal infections
- Preeclampsia
- Gestational hypertension
- Diabetes mellitus
- Premature rupture of membranes
- Antibiotic use during pregnancy

Neonatal Variables

- Gestational age
- Mode of delivery
- Sex
- Birth weight

Late preterm infants were stratified into three groups:
1. 34⁰/₇–34⁶/₇ weeks
2. 35⁰/₇–35⁶/₇ weeks
3. 36⁰/₇–36⁶/₇ weeks

Neonatal Outcomes

The following neonatal morbidities were assessed:

- Transient tachypnea of the newborn
- Respiratory distress syndrome
- Hyperbilirubinemia
- Hypoglycemia
- Suspected and confirmed neonatal sepsis
- Pneumonia
- Meningitis
- Polycythemia
- Hypothermia
- Apgar score at 1 and 5 minutes

Criteria for NICU Admission

Admission to the neonatal intensive care unit (NICU) was based on the following criteria:

- Birth weight <1900 g
- Respiratory distress or transient tachypnea
- Apnea
- Hypoglycemia
- Temperature instability
- Hyperbilirubinemia requiring treatment
- Neurological complications
- Clinical or laboratory suspicion of sepsis
- Feeding difficulties requiring intravenous fluids
- Birth asphyxia

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA).
Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean ± standard deviation.
Comparisons between groups were performed using:Chi-square test for categorical variables ,Mann–Whitney U test for non-normally distributed variables ,One-way ANOVA with Bonferroni post hoc correction for continuous variables
A p-value ≤0.05 was considered statistically significant.

Results
During the study period, a total of **8,843 deliveries** were recorded. Among these, **586 infants were classified as late preterm**, corresponding to an incidence of **6.6%**.
Late preterm infants accounted for **66.1% of all preterm births** during the study period.

Distribution by Gestational Age
The distribution of late preterm infants according to gestational age was as follows:
- 34 weeks: 206 infants (35.2%)
- 35 weeks: 121 infants (20.6%)
- 36 weeks: 259 infants (44.2%)

Maternal and Demographic Characteristics
Analysis of maternal demographic characteristics showed a **statistically significant difference in marital status** among gestational age groups (p = 0.022), with a higher proportion of married women in the 34–35 weeks subgroup.
No statistically significant differences were observed between groups regarding:Educational level (p = 0.095) mode of delivery (p = 0.813) health insurance status (p = 0.3347) are presented in Table 1.

Table 1.Maternal Sociodemographic and Delivery Characteristics by Gestational Age

Variable	34–35 weeks (n=206)	35–36 weeks (n=121)	36–37 weeks (n=259)	Total (n=586)	p-value*
Mode of delivery					0.813
Vaginal delivery	108 (52.4%)	61 (50.4%)	128 (49.4%)	297 (50.7%)	
Cesarean section	98 (47.6%)	60 (49.6%)	131 (50.6%)	289 (49.3%)	
Health insurance					0.337
Yes	40 (19.4%)	23 (19.0%)	66 (25.5%)	129 (22.0%)	
No	166 (80.6%)	98 (81.0%)	193 (74.5%)	457 (78.0%)	
Marital status					0.022
Single	72 (35.0%)	65 (53.7%)	128 (49.4%)	265 (45.2%)	
Married	134 (65.0%)	56 (46.3%)	131 (50.6%)	321 (54.8%)	
Maternal education					0.095
Primary (8–9 years)	75 (36.4%)	47 (38.8%)	92 (35.5%)	214 (36.5%)	
Secondary	103 (50.0%)	55 (45.5%)	108 (41.7%)	266 (45.4%)	
Higher education	28 (13.6%)	19 (15.7%)	59 (22.8%)	106 (18.1%)	

*Chi -square test

Maternal-Related Factors
Maternal clinical characteristics are presented in Table 2.
No statistically significant differences were observed between gestational age groups for:
- Antenatal care
- Premature rupture of membranes
- Previous cesarean section
- Chorioamnionitis
- Antibiotic use
- Induction of labor
- Preeclampsia/gestational hypertension
- Placenta previa

Table 2.Maternal and Antenatal Characteristics by Gestational Age

Variable	34–35 weeks (n=206)	35–36 weeks (n=121)	36–37 weeks (n=259)	Total (n=586)	p-value*
Antenatal care					0.838
Yes	138 (67.0%)	98 (81.0%)	196 (75.7%)	432 (73.7%)	
No	68 (33.0%)	23 (19.0%)	63 (24.3%)	154 (26.3%)	
Premature rupture of membranes (PROM)					0.938

Variable	34–35 weeks (n=206)	35–36 weeks (n=121)	36–37 weeks (n=259)	Total (n=586)	p-value*
Yes	71 (34.5%)	52 (43.0%)	99 (38.2%)	222 (37.9%)	
No	135 (65.5%)	69 (57.0%)	160 (61.8%)	364 (62.1%)	
Previous cesarean section					0.499
Yes	13 (6.3%)	11 (9.1%)	16 (6.2%)	40 (6.8%)	
No	193 (93.7%)	110 (90.9%)	243 (93.8%)	546 (93.2%)	
Chorioamnionitis					0.789
Yes	2 (1.0%)	2 (1.7%)	2 (0.8%)	6 (1.0%)	
No	204 (99.0%)	119 (98.3%)	257 (99.2%)	580 (99.0%)	
Maternal antibiotic use					0.273
Yes	57 (27.7%)	27 (22.3%)	44 (17.0%)	114 (19.5%)	
No	149 (72.3%)	94 (77.7%)	215 (83.0%)	472 (80.5%)	
Antenatal corticosteroids					<0.001
Yes	44 (21.4%)	14 (11.6%)	10 (3.9%)	68 (11.6%)	
No	162 (78.6%)	107 (88.4%)	249 (96.1%)	518 (88.4%)	
Labor induction					0.701
Yes	12 (5.8%)	10 (8.3%)	23 (8.9%)	45 (7.7%)	
No	194 (94.2%)	111 (91.7%)	236 (91.1%)	541 (92.3%)	
Preeclampsia / Hypertension					0.751
Yes	23 (11.2%)	19 (15.7%)	31 (12.0%)	73 (12.5%)	
No	183 (88.8%)	102 (84.3%)	228 (88.0%)	513 (87.5%)	
Placenta previa					0.382
Yes	4 (1.9%)	1 (0.8%)	2 (0.8%)	7 (1.2%)	
No	202 (98.1%)	120 (99.2%)	257 (99.2%)	579 (98.8%)	

*Chi-square test

However, a **statistically significant difference** was found in the use of **antenatal corticosteroids** ($p < 0.001$), with higher administration in the 34-week group (21.4%) compared to 35 weeks (11.5%) and 36 weeks (3.86%).

Although not statistically significant, vaginal delivery was slightly more frequent in the 34-week group (52.4%) compared to 35 weeks (50.4%) and 36 weeks (49.4%). This pattern may reflect emergency obstetric conditions such as preeclampsia or failed induction, which may increase cesarean delivery rates in later gestational ages.

Neonatal Outcomes in Late Preterm Infants

Neonatal outcomes are summarized in Table 3

NICU Admission

Admission to the NICU was significantly higher in infants born at earlier gestational ages ($p < 0.001$), with:

- 56.8% in the 34–35 weeks group
- 42.9% in the 35–36 weeks group
- 21.6% in the 36–37 weeks group

Respiratory Morbidity

A statistically significant difference was observed for:Transient tachypnea of the newborn (TTN) ($p < 0.001$) ,respiratory distress syndrome (RDS) ($p = 0.017$) .Both conditions were more frequent in infants of lower gestational age, confirming the role of pulmonary immaturity.

Infectious Morbidity

There were significant differences between groups for:Sepsis evaluation ($p < 0.001$) Confirmed sepsis ($p = 0.006$) .Infants born at 34 weeks had the highest rates:Sepsis evaluation: 22.3% Confirmed sepsis: 3.9% .This was also reflected in higher antibiotic use (8.3%).

Hyperbilirubinemia

Hyperbilirubinemia requiring treatment differed significantly across groups ($p < 0.001$):48.5% in 34 weeks ,41.3% in 35 weeks ,19.7% in 36 weeks

Other Outcomes

No statistically significant differences were observed for:Hypoglycemia ,hypothermia feeding difficulties ,polycythemia

Fetal Growth

A significant difference was found in fetal growth patterns ($p = 0.031$), with a higher proportion of IUGR infants in the 34-week group (27.7%).

Table 3. Neonatal Morbidity by Gestational Age

Variable	34–35 weeks (n=206)	35–36 weeks (n=121)	36–37 weeks (n=259)	Total (n=586)	p-value*
Fetal growth					0.031
AGA	138 (67.0%)	87 (71.7%)	181 (69.9%)	406 (69.1%)	
IUGR	57 (27.7%)	22 (18.3%)	47 (18.1%)	126 (21.6%)	
LGA	5 (2.4%)	6 (5.0%)	9 (3.5%)	20 (3.4%)	
SGA	6 (2.9%)	6 (5.0%)	22 (8.5%)	34 (5.8%)	
Respiratory distress syndrome (RDS)					<0.001
Yes	117 (56.8%)	52 (43.0%)	56 (21.6%)	225 (38.4%)	
No	89 (43.2%)	69 (57.0%)	203 (78.4%)	361 (61.6%)	
Transient tachypnea of the newborn (TTN)					<0.001
Yes	51 (24.8%)	28 (23.1%)	25 (9.7%)	104 (17.8%)	
No	155 (75.2%)	93 (76.9%)	234 (90.3%)	482 (82.2%)	
Respiratory distress (other)					0.017
Yes	21 (10.2%)	9 (7.4%)	9 (3.5%)	39 (6.7%)	
No	185 (89.8%)	112 (92.6%)	250 (96.5%)	547 (93.3%)	
Pneumonia					0.552
Yes	3 (1.5%)	3 (2.5%)	1 (0.4%)	7 (1.2%)	
No	203 (98.5%)	118 (97.5%)	258 (99.6%)	579 (98.8%)	
Respiratory failure					0.382
Yes	1 (0.5%)	2 (1.7%)	1 (0.4%)	4 (0.7%)	
No	205 (99.5%)	119 (98.3%)	258 (99.6%)	582 (99.3%)	
Pneumothorax					0.563
Yes	2 (1.0%)	2 (1.7%)	1 (0.4%)	5 (0.9%)	
No	204 (99.0%)	119 (98.3%)	258 (99.6%)	581 (99.1%)	
Sepsis evaluation					<0.001
Yes	46 (22.3%)	20 (16.5%)	21 (8.1%)	87 (14.9%)	
No	160 (77.7%)	101 (83.5%)	238 (91.9%)	499 (85.1%)	
Confirmed sepsis					0.006
Yes	8 (3.9%)	1 (0.8%)	0 (0.0%)	9 (1.5%)	
No	198 (96.1%)	120 (99.2%)	259 (100.0%)	577 (98.5%)	
Meningitis					0.382
Yes	1 (0.5%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	
No	205 (99.5%)	121 (100.0%)	259 (100.0%)	585 (99.8%)	
Hyperbilirubinemia					<0.001
Yes	100 (48.5%)	50 (41.3%)	51 (19.7%)	201 (34.3%)	
No	106 (51.5%)	71 (58.7%)	208 (80.3%)	385 (65.7%)	
Antibiotic use					0.008
Yes	17 (8.3%)	7 (5.8%)	2 (0.8%)	26 (4.4%)	
No	189 (91.7%)	114 (94.2%)	257 (99.2%)	560 (95.6%)	
Hypoglycemia					0.205
Yes	9 (4.4%)	2 (1.7%)	3 (1.2%)	12 (2.0%)	
No	197 (95.6%)	119 (98.3%)	256 (98.8%)	574 (98.0%)	
Hypothermia					0.920
Yes	1 (0.5%)	1 (0.8%)	1 (0.4%)	3 (0.5%)	
No	205 (99.5%)	120 (99.2%)	258 (99.6%)	583 (99.5%)	
Feeding difficulties					0.425
Yes	3 (1.5%)	5 (4.1%)	5 (1.9%)	13 (2.2%)	

Variable	34–35 weeks (n=206)	35–36 weeks (n=121)	36–37 weeks (n=259)	Total (n=586)	p-value*
No	203 (98.5%)	116 (95.9%)	254 (98.1%)	573 (97.8%)	
Polycythemia					0.085
Yes	5 (2.4%)	1 (0.8%)	0 (0.0%)	6 (1.0%)	
No	201 (97.6%)	120 (99.2%)	259 (100.0%)	580 (99.0%)	

*Chi-Square test

6.5 Continuous Variables Analysis (ANOVA)

ANOVA analysis (Table 4) showed statistically significant differences between gestational age groups for:

- **Maternal age** ($p = 0.006$):
  Younger mothers were more frequent in the 35–36 weeks group, while older mothers were more represented in the 36–37 weeks group.
- **Birth weight** ($p < 0.001$):
  Lowest in 34–35 weeks (2028.49 ± 601.29 g) and highest in 36–37 weeks (2691.62 ± 534.53 g).
- **Apgar score at 1 minute** ($p < 0.001$):
  Lower in 34–35 weeks group.
- **Apgar score at 5 minutes** ($p < 0.001$):
  Also lower in earlier gestational ages.
- **Length of hospital stay** ($p = 0.003$):
  Longest in 34–35 weeks group (7.20 ± 6.28 days) and shortest in 36–37 weeks group (4.59 ± 4.97 days).

Table 4. Continuous Maternal and Neonatal Characteristics by Gestational Age

Variable	34–35 weeks (n=206)	35–36 weeks (n=121)	36–37 weeks (n=259)	Total (n=586)	p-value*
Maternal age (years), mean ± SD	28.70 ± 5.57	26.94 ± 5.36	28.91 ± 5.31	28.39 ± 5.45	0.006
Gravidity, mean ± SD	1.42 ± 0.80	1.40 ± 0.72	1.53 ± 0.78	1.47 ± 0.78	0.279
Birth weight (g), mean ± SD	2028.49 ± 601.29	2524.75 ± 477.45	2691.62 ± 534.53	2424.55 ± 623.21	<0.001
Apgar score at 1 minute, mean ± SD	7.31 ± 1.66	8.03 ± 1.22	8.16 ± 1.23	7.84 ± 1.45	<0.001
Apgar score at 5 minutes, mean ± SD	8.55 ± 0.75	8.78 ± 0.80	8.86 ± 0.77	8.74 ± 0.78	<0.001
Length of hospital stay (days), mean ± SD	7.20±6.28	5.69±5.22	4.59±4.97	6.21±5.84	0.003

* Anova test

Economic Burden

The economic cost of late preterm infants was estimated using the Astraia software system implemented in our institution.

The calculated cost was relatively low (approximately **15,592 ALL ≈ 130 USD per case**) compared to international studies. This discrepancy is likely due to:

- Exclusion of several hospital service costs
- Reuse of medical equipment
- Lack of cost accounting for sterilization processes
- Underestimation of treatments such as phototherapy

Discussion

In our study, late preterm infants accounted for 6.6% of total births and 66.1% of all preterm births. These findings are consistent with recent global estimates indicating that late preterm infants constitute approximately 70–80% of all preterm births (1,4,24). Variations across studies may reflect differences in obstetric practices, population characteristics, and healthcare systems.

Regarding maternal demographic characteristics, no statistically significant differences were observed for maternal age, insurance status, or education level. However, the lower proportion of highly educated mothers in the 34-week group may suggest a potential association between socioeconomic status and earlier delivery, as supported by recent epidemiological studies (2,24).

A significant difference was observed in the administration of antenatal corticosteroids, with higher use at earlier gestational ages ($p<0.001$). This reflects current clinical practice and aligns with recent guidelines and evidence demonstrating reduced respiratory morbidity following antenatal corticosteroid administration in late preterm pregnancies (14,18).

Mode of delivery did not differ significantly between groups, consistent with recent studies suggesting that delivery mode alone is not a primary determinant of neonatal outcomes in late preterm infants (3,24).

Birth weight increased progressively with gestational age, as expected, confirming findings from recent cohort studies (2,6). The higher incidence of intrauterine growth restriction (IUGR) in infants born at 34 weeks is also consistent with previous reports (2,25).

NICU admission rates in our cohort (38.4%) were comparable to those reported in contemporary studies,

with a clear inverse relationship between gestational age and need for intensive care (1,2,25). Infants born at 34 weeks had the highest admission rates, highlighting their increased vulnerability (7).

Length of hospital stay was significantly longer in infants born at 34 weeks (p=0.003), reflecting increased morbidity and healthcare utilization. This finding is consistent with recent studies emphasizing the economic and clinical burden associated with late preterm birth (7,21,25).

Lower Apgar scores in 34-week infants further confirm the increased risk of perinatal compromise in this subgroup, as described in recent literature (2).

Respiratory morbidity remained one of the most prominent complications. The higher incidence of transient tachypnea of the newborn (TTN) and respiratory distress syndrome (RDS) in infants born at 34 weeks is in agreement with recent studies identifying respiratory complications as the leading cause of NICU admission in late preterm infants (6,8,19,20).

Hyperbilirubinemia demonstrated a clear decreasing trend with increasing gestational age ($p<0.001$), reflecting hepatic immaturity and consistent with existing evidence (9,25). In contrast, hypoglycemia did not differ significantly between groups, which is also supported by recent studies (10,23).

The higher incidence of sepsis and increased need for antibiotic therapy in earlier gestational age groups reflects the immaturity of the neonatal immune system, as confirmed by recent studies (2,27).

Importantly, accumulating evidence suggests that late preterm infants are also at increased risk of adverse long-term outcomes, including neurodevelopmental delay and cognitive impairment, further emphasizing the clinical significance of early neonatal morbidity (11,12,16,22).

In conclusion, our findings confirm that late preterm infants—particularly those born at 34 weeks—experience significantly higher morbidity, increased NICU admission rates, and longer hospital stays. These outcomes translate into a substantial healthcare burden, consistent with the latest international literature (2,5,25). Targeted perinatal management strategies and optimized neonatal care are essential to improve outcomes in this vulnerable population.

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