Long-Term Outcomes of Moderately Preterm, Late Preterm, and Early Term Infants

Betty Vohr, MD

BACKGROUND

The National Institute of Child Health and Human Development panel reviewed the evidence of increased risk of infants with a gestation age of 34 to 36 weeks and changed the earlier definition of “near term” to “LPT” in 2006. Currently, MPT infants born at 32 to 33 weeks’ gestation and LPT infants born at 34 to 36 weeks’ gestation make up the largest subgroup of preterm (PT) infants and contribute to more than 80% of premature births in the United States. There are increasing numbers of reports that both MPT and LPT infants are at increased risk of having disabilities requiring early intervention, therapeutic services, and special education support services.

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KEYWORDS

- Moderate preterm
- Late preterm
- Early term
- Neurodevelopment
- Outcomes

KEY POINTS

- Brain weight at 34 weeks’ gestation is 60% of the brain weight of a full-term (FT) infant.
- Moderate preterm (MPT) (32–33 weeks) and late preterm (LPT) (34–36 weeks) survivors are at increased risk of neurologic impairments, developmental disabilities, school failure, as well as behavioral and psychiatric problems from infancy to adulthood.
- MPT and LPT infants are at increased risk of having disabilities requiring early intervention, therapeutic services, and special education support services.

The National Institute of Child Health and Human Development panel reviewed the evidence of increased risk of infants with a gestation age of 34 to 36 weeks and changed the earlier definition of “near term” to “LPT” in 2006. Currently, MPT infants born at 32 to 33 weeks’ gestation and LPT infants born at 34 to 36 weeks’ gestation make up the largest subgroup of preterm (PT) infants and contribute to more than 80% of premature births in the United States. There are increasing numbers of reports that both MPT and LPT infants are at increased risk of neonatal and postdischarge morbidity. In the United States in 2009, 12.18% of the 4,130,665 births were PT. Of these, 8.7% (357,715) were LPT. An additional 144,986 (3.5%) of births include MPT and very PT infants less than 32 weeks’ gestational age (GA). Multiple gestation, which comprises about 3% of births in the United States and is attributed in part to both delayed childbearing and assisted reproductive technology, contributes significantly to the MPT and LPT birth rate. Among twins, 14.5% are MPT and 49.8% are LPT, and among triplets, 35.5% are MPT and 43.6% are LPT.
MATERNAL FACTORS

Mothers of PT infants are more likely to have their own medical morbidities including high blood pressure, diabetes, and obesity. Some subgroups of parent-infant dyads may have greater vulnerability. Brandon and colleagues reported that mothers of LPT infants have greater emotional distress (anxiety, postpartum depression, post-traumatic stress symptoms, and worry about their infant) after delivery than mothers of FT infants. In addition, their distress remained higher than that of FT mothers 1 month after delivery. The investigators concluded that multiple factors related to alterations in labor and delivery and the health status of the infant contributed to their distress.

Postpartum depression (PPD) is a common disorder and affects an estimated 13% of mothers. Factors associated with PPD include low socioeconomic status and prior history of depression. Acute stress, posttraumatic stress disorder, and depression are common among parents in a neonatal intensive care unit (NICU). The findings of Brandon and colleagues suggest that more attention needs to be shifted to monitoring and supporting the emotional distress of mothers delivering LPT infants.

NEONATAL CHARACTERISTICS

The increased neonatal and postdischarge vulnerability of MPT and particularly LPT infants has been underestimated in the past. Their level of maturation is compromised compared to an FT infant, placing them at increased risk of a spectrum of clinical medical problems including hypothermia, respiratory disorders, hypoglycemia, jaundice, immunologic problems, and increased susceptibility to infection as well as feeding problems. LPT infants are also at increased risk of admission to a NICU, death, and severe neurologic morbidities when compared with FT infants. In one large study, LPT infants were 7 times more likely to be admitted to an NICU for more than 5 nights. In addition to underdevelopment of multiple organ systems, the second half of gestation is a critical period of brain development, and at 34 weeks, the brain weight is 60% of the FT brain weight. Between 35 and 41 weeks, there is a 5-fold increase in brain volume. Continued active brain maturation occurs during the last weeks of pregnancy with neurogenesis, synaptogenesis, and dendritic arborization. The interruption of this process by delivery removes the infant from the natural protective environment of the uterus.

POSTDISCHARGE MEDICAL PROBLEMS

After discharge from the hospital, LPT infants continue to have increased medical needs and are 2 to 3 times more likely to be rehospitalized or visit an emergency room than FT infants. In an outcome study of 26,703 infants followed up for the first 6 months of life, rehospitalization rates between 15 and 182 days after discharge were inversely related to the GA and ranged from 3.6% for infants born at or after 41 weeks; 4.4%, for 38 to 40 weeks; 5.6%, for 37 weeks; 7.3%, for 36 weeks; 6.8%, for 35 weeks; 9.1%, for 34 weeks; to 9.3%, for 33 weeks. Reasons ranged from respiratory distress, apnea, crying, fever, jaundice, vomiting, to respiratory distress. In a national cohort of commercially insured infants, 15% of LPT infants were rehospitalized in the first year of life. Boyle and colleagues provided population data for health outcomes from the United Kingdom including general health status, rehospitalization, and illness across the full range of GA groups and assessed outcomes of MPT (32–36 weeks) and early term (ET) (37–38 weeks) infants. The investigators reported a gradual gradient of increased risk of poor health outcomes at 3 and
5 years with decreasing GA. These data provide important population-based information that the increasing birth rate of MPT and LPT infants will potentially have a negative societal impact with increased demands of specialized health care provision and increased costs. Further study is needed to assess the relationship between neonatal and short-term health outcomes and neurodevelopmental outcomes for MPT and ET (37–38 weeks) infants.

NEURODEVELOPMENTAL OUTCOME STUDIES

Outcome studies of both MPT and LPT infants indicate that they are at increased risk of developmental disability, school failure, behavior problems, social and medical disabilities, and death.18–23 There are, however, a limited number of neurodevelopmental studies of MPT and LPT infants, because in the past, they have been considered low risk both as neonates and postdischarge. Most NICUs have follow-up programs for very PT infants who are considered at greatest risk of postdischarge neurodevelopmental morbidity, but do not offer these services for MPT or LPT infants. A recent review of LPT and ET by Engle24 recommended that large randomized trials are needed to test innovative diagnostic and treatment strategies to inform clinicians about optimal management of women who deliver before 39 weeks’ gestation and appropriate management of their offspring. This article reviews neurodevelopmental and behavioral outcomes of MPT and LPT infants dividing them into newborn to preschool, kindergarten to middle school, and adolescence and adult categories. In addition, there is an abbreviated discussion of the outcomes of the ET infants.

Newborn to Preschool

Reports of outcomes of MPT and LPT infants may include low-risk/non-NICU infants, NICU infants only, or a combination of low- and high-risk neonates. This will be clarified if evident in the publication. This section reviews outcomes of infants aged 0 to 5 years with reports summarized in Table 1. The first study addresses neurobehavior in the first days of life. A neonatal study of a small cohort25 of low-risk infants administered the NICU Network Neurobehavioral Scale (NNNS) at the age of 24 to 72 hours of age reported that the LPT (34–36 weeks) infants had decreased scores when compared with FT infants in several domains including attention, arousal, regulation, quality of movements, nonoptimal reflexes, and hypotonicity after adjustment for founders. This is of interest because these are low-risk LPT infants who are most often considered “normal” and discharged early.

Romeo and colleagues26 evaluated a low-risk LPT group with no evidence of brain injury compared with FT infants at 12 and 18 months of age. When comparing scores by chronological age (ChrA), the LPTs scored significantly lower; however, when comparing by corrected age (CA), there was no difference in scores compared with FT infants at either age. This raises the question of whether the examiner should be using CA for LPT infants. The findings of this study indicate that LPT infants who are most often considered “normal” and discharged early.

Most studies of LPT infants do not seem to use CA. A large study27 of 1200 LPT and 6300 FT infants from the Early Childhood Longitudinal Study, Birth Cohort reported that LPTs had significantly lower mean scores and scores less than 70 on the Bayley Scales of Infant Development Short form and derived Mental Developmental Index and Psychomotor Developmental Index at 24 months of age. The report suggests that no correction was made for prematurity and that level of risk is not specifically defined.
<table>
<thead>
<tr>
<th>Author</th>
<th>Gestation (weeks)</th>
<th>Age</th>
<th>Cognitive</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barros et al, 25 2011</td>
<td>36 Late PT: 34–36 wk</td>
<td>Newborns</td>
<td>↓ Attention $P = .04$</td>
<td>↑ Nonoptimal reflexes $P &lt; .001$</td>
</tr>
<tr>
<td></td>
<td>96 Term: 40 wk</td>
<td></td>
<td>↓ Arousal $P = .01$</td>
<td>↑ Hypotonicity $P = .029$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>↓ Regulation $P &lt; .001$</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>↓ Movements $P &lt; .001$</td>
<td></td>
</tr>
<tr>
<td>Romeo et al, 26 2010</td>
<td>61 healthy 33–36 wk</td>
<td>ChrA &amp; CA</td>
<td>PT CA MDI 97 ± 9</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>60 healthy controls</td>
<td>12 and 18 mo</td>
<td>PT ChrA MDI 88 ± 10*</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Term MDI 98 ± 8</td>
<td></td>
</tr>
<tr>
<td>Woythaler et al, 27 2011</td>
<td>1200 PT: 34–37 wk</td>
<td>ChrA, age</td>
<td>MDI 85 vs 89 $P &lt; .0001$</td>
<td>PDI 88 vs 92 $P &lt; .0001$</td>
</tr>
<tr>
<td></td>
<td>6300 Term</td>
<td>24 mo</td>
<td>MDI &lt; 70 21 vs 16% $P &lt; .0001$</td>
<td></td>
</tr>
<tr>
<td>Baron et al, 28 2009</td>
<td>34–36 wk/7 wk</td>
<td>ChrA, age</td>
<td>DAS scores vs term</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>60 NICU LPT</td>
<td>3.5–4.1 y</td>
<td>↓ Visuospatial: 0.005</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>↓ Visuomotor: 0.12</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>↓ Executive:</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Function noun: 0.02</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Action verb: 0.03</td>
<td></td>
</tr>
<tr>
<td>Baron et al, 21 2011</td>
<td>34–36 wk/7 wk</td>
<td>ChrA, age</td>
<td>LPT-NICU vs term ↓ DAS GCA,</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>90 LPT-NICU</td>
<td>3.8 y</td>
<td>nonverbal reasoning, and spatial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28 LPT non-NICU</td>
<td></td>
<td>scores; ↑ rates of nonverbal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 Term</td>
<td></td>
<td>reasoning and spatial impairments</td>
<td></td>
</tr>
<tr>
<td>Baron et al, 30 2012</td>
<td>52 ELBW: 23–33 wk</td>
<td>ChrA, age</td>
<td>Executive functions</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>196 LPT: 34–36 wk</td>
<td>3–3 y 11 mo</td>
<td>ELBW multiple weaknesses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>121 Term</td>
<td></td>
<td>LPT ↑ complex working memory</td>
<td></td>
</tr>
<tr>
<td>Morse et al, 19 2009</td>
<td>34–41 wk Low-risk singletons</td>
<td>ChrA, age</td>
<td>0–3 y ↑ developmental delay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>164,804</td>
<td>0–5 y</td>
<td>4 y ↑ disability in prekindergarten</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5 y ↑ special education</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>5 y ↑ kindergarten retention</td>
<td></td>
</tr>
<tr>
<td>Roth et al, 31 2004</td>
<td>1500–2499 g</td>
<td>Kindergarten</td>
<td>11% higher rate of special</td>
<td>↑ Costs per year of $11 million</td>
</tr>
<tr>
<td></td>
<td>N = 7432</td>
<td>5 y</td>
<td>services than FT controls</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** CA, corrected age; ChrA, chronologic age; ELBW, extremely low birth weight; GCA, General Conceptual Ability; MDI, Mental Developmental Index; PDI, Psychomotor Developmental Index; *, versus term.
The issue of degree of neonatal risk, defined as admission to a tertiary care NICU versus not admitted, was pursued in 2 studies by Baron and colleagues. In the first report in which a comparison was made between high-risk LPT and FT at the age of 3 years, the LPT group had significantly lower scores than the FT comparison group on Differential Ability Scales (DAS-II) visual spatial, visuomotor, executive function noun fluency, and executive function verb fluency. In a second report, Baron and colleagues reported on both high-risk LPT infants, defined as admitted to the NICU, and low-risk LPT infants (not admitted to an NICU) compared to FT infants and identified that only the high-risk LPT infants scored less than FT children on DAS-II subscores of General Conceptual Ability (GCA), nonverbal cluster, nonverbal reasoning, and spatial clusters. They concluded that the increased risk of developmental delay of the NICU-admitted infants is secondary to clinical instability, increased neonatal morbidities, gender effects, and lower birth weight. They suggest that both neonatal morbidities and male gender contribute to these early cognitive weaknesses. The sample size of the low-risk LPT infants, however, was only 28, indicating that assessment of these outcomes deserves further investigation. In a third study, Baron and colleagues used computerized testing to test early executive functions in subgroups of extremely low birth weight (ELBW), LPT, and FT children at 3 years of age. Executive functions are key to more complex cognitive skills required as the child advances in school and are difficult to assess at young ages. It was not unexpected that the ELBW children would have difficulty with the tests, including lower GCA, more omissions of tasks, and worse performance with both simple and complex memory than FT children. The LPT children, however, also had lower GCA scores and more omissions of tasks. Regarding executive functions, the LPT children performed poorer than controls only in the test for complex working memory compared to the ELBW children who had difficulty with both simple and complex memory. This finding in the LPT children is of concern, because it may be an early signal for neuropsychological deficits at older ages.

In a large population-based study of low-risk, defined as hospitalized for 72 hours or less, LPT (34–36 week) singleton infants and 152,661 FT infants with data from birth to the age of 5 years in the state of Florida, consistent deficits were identified. The adjusted risk for the LPT group was 36% higher for developmental delay between birth and 3 years, 15% higher for disability in prekindergarten, 12% higher for disability in kindergarten, and 13% higher for special education services in kindergarten. Although this is a retrospective analysis, it provides strong support for close surveillance and the provision of early intervention services and educational support services as needed for both low-risk and high-risk LPT infants between discharge and 5 years of age.

In a second study of the Florida birth cohort of infants born in the period September 1990 to August 1991, Roth and colleagues examined maternal and infant factors associated with kindergarten costs by birth weight group. Of the total births, 3% were receiving some special education services. In addition, 23% were receiving speech/language services. Compared to FT infants, the costs of kindergarten were 60% higher for infants weighing less than 1000 g, 31% higher for infants weighing 1000 to 1499 g, and 11% higher for infants weighing 1500 to 2499 g. The annual kindergarten costs for infants weighing less than 1000 g were $3150 with total cost per year for infants weighing less than 1000 g of $2.1 million. The largest number of PT children receiving special education, however, was in the 1500 to 2499 g group with an associated $900 additional cost per child per year and an additional $11 million for 1 year of kindergarten costs. Additional important contributors to total cost were complications of labor, poverty, and low maternal education. These data, however, demonstrate the increased early educational needs and costs of the MPT to LPT infant.
Early School Age

The following reports are all summarized in Table 2. Using the Early Childhood Longitudinal Study, Kindergarten Cohort, Chyi and colleagues used US national data to compare MPT (32–33 weeks), LPT (34–36 weeks), and FT children from kindergarten to fifth grade. In standardized tests, the MPT scores were lower than FT scores for reading in kindergarten and first and fifth grades and for math in kindergarten and first, third, and fifth grades. LPT children scored lower in reading in kindergarten and first grade. In teacher rating, MPT children were less proficient in reading in kindergarten and first, third, and fifth grades and in math in first, third, and fifth grades, whereas LPT children were less proficient in reading in kindergarten and first and fifth grades and in math in kindergarten and first grade when compared with FT infants. Both groups had increased needs for an individualized education plan and special education enrollment with the greatest needs for MPT children. In multivariable analysis, the risk for special education placement remained highly significant in third and fifth grades for MPT children but was no longer statistically significant for LPT children with odds ratios (ORs) of 1.22 (confidence interval [CI] = 0.92–1.63) and 1.28 (CI = 0.95–1.74). Overall, both MPT and LPT have academic challenges that persist in the fifth grade.

A case-control study of MPT children in the first grade identified increased rates of Wechsler performance intelligence quotient (IQ) and full scale IQ but not verbal IQ less than 85 after adjustment for confounders, in addition to increased risk of borderline clinical internalizing and borderline clinical attention problems. The investigators acknowledge that it is difficult to identify the mechanism involved in producing these cognitive and behavioral findings. The contribution of intrauterine exposure, neonatal morbidities, and extrauterine environment all seem to play some role. The exclusions from the data set included multiples and children with severe neurologic impairments including cerebral palsy (CP) and blindness, resulting in a baseline reduced risk cohort.

A follow-up of the Avon Longitudinal Study found lower verbal IQ, performance IQ, and total IQ scores at the age of 11 years in univariable analysis for MPT and LPT compared to FT children, which were no longer significant after adjusting for confounders. However, after adjustment, 2 areas of learning difficulties (word repetition and reading accuracy) were identified. In addition, the MPT and LPT children had a 56% increased risk of needing special education services. This suggests that the MPT and LPT children may be at greater risk of more discrete learning disabilities at older ages. A limitation of this study was 49% follow-up rate.

Huddy and colleagues used information obtained from parent questionnaires on health, behavior, and teacher ratings of resource needs and behavior problems with the Strengths and Difficulties Behavior Questionnaire for a cohort of combined MPT and LPT children at the age of 7 years. Approximately one-third of the children had school academic resource needs. The most commonly reported were in writing, fine motor skills, and mathematics. In addition, both teachers and parents rated about 20% of the children as having borderline or abnormal total behavior scores. The most common behavior was hyperactivity, reported by 22% of teachers and 25% of parents.

A second analysis of the Pregnancy Outcomes and Community Health (POUCH) cohort reported on child outcomes of 163 LPT children of 34 to 36 weeks’ gestation. The primary outcome was evidence of attention deficit disorder using the Conners’ Parent Rating Scale. Children with a specific diagnosis of autism were excluded. In the initial analysis of the total cohort of LPT compared to FT children, no significant
## Table 2
Early school age outcomes: kindergarten to middle school

<table>
<thead>
<tr>
<th>Author</th>
<th>Gestation</th>
<th>Age</th>
<th>Sample Size</th>
<th>Cognitive</th>
<th>School Outcomes</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chyi et al,18 2008</td>
<td>32–36 wk</td>
<td>5 y</td>
<td>MPT 203</td>
<td>MPT: ↓ reading &amp; math in fifth grade</td>
<td>MPT: ↑ special education in kindergarten, first, third, and fifth grades</td>
<td>NA</td>
</tr>
<tr>
<td>LPT 767</td>
<td>LPT ↓ reading fifth grade</td>
<td>FT 13,671</td>
<td>LPT: ↑ special education in kindergarten and first grade</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Talge et al,32 2010</td>
<td>LPT: 34–36 wk</td>
<td>6–7 y</td>
<td>LPT 168</td>
<td>FSIQ &lt;85</td>
<td>NA</td>
<td>After adjustment ↑ internalizing</td>
</tr>
<tr>
<td>FT: 37–41 wk</td>
<td>LPT: 21%</td>
<td>PIQ &lt;85</td>
<td>LPT: 12%</td>
<td></td>
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<td></td>
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<tr>
<td>FT: 168</td>
<td>FT: 12%</td>
<td>LPT: 20%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FT: 13%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Huddy et al,34 2001</td>
<td>32–35 wk</td>
<td>7 y</td>
<td>MPT = LPT 117</td>
<td>NA</td>
<td>1/3 Resource needs</td>
<td>20% Behavior problems</td>
</tr>
<tr>
<td>Talge et al,35 2012</td>
<td>34–36 wk</td>
<td>3–9 y</td>
<td>LPT 152</td>
<td>NA</td>
<td>NA</td>
<td>↑ Attention problems on Conners</td>
</tr>
<tr>
<td>FT 610</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipkind et al,37 2012</td>
<td>MPT: 32–35 wk</td>
<td>Third grade</td>
<td>MPT: 2332</td>
<td>Math test standard deviation % vs FT</td>
<td>Special education vs FT</td>
<td></td>
</tr>
<tr>
<td>LPT: 34–35 wk</td>
<td>MPT: 10.4%</td>
<td>MPT OR = 1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FT: 37–42 wk</td>
<td>LPT: 6.7%</td>
<td>LPT OR = 1.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Odd et al,33 2012</td>
<td>32–36 wk vs 37–42 wk</td>
<td>8–11 y</td>
<td>742 Late PT Total: 8878</td>
<td>Similar IQ scores</td>
<td>↑ Risk special education</td>
<td></td>
</tr>
<tr>
<td>After adjustment for confounders ↓ Scores for one word repetition and reading accuracy</td>
<td>OR 1.56 (1.18–2.07)</td>
<td>NA</td>
<td></td>
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<td></td>
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</tbody>
</table>

**Abbreviations:** FSIQ, Full Scale Intelligence Quotient; OR, odds ratio; PIQ, Performance Intelligence Quotient.
group differences in Conners’ scores were found. The LPT children were then divided into a medically indicated (MI) delivery group (induced before PT labor, such as hyperten-
sion) and a spontaneous labor group. MILPT children aged 3 to 5 years had signif-
icantly higher scores for inattention and MILPT children aged 6 to 9 years had
significantly higher scores for inattention, hyperactivity, and total problems. These
differences compared to FT children persisted after adjustment for multiple confounders
but not after mothers with hypertension or placental problems associated with hyper-
tension were removed from the model. The investigators conclude that hypertensive
disorders resulting in medical intervention may contribute to behavioral disorders in
the LPT children.

A cohort analysis of 215,138 children born in New York City between 1914 and
1998 compared MPT and LPT children to FT children in the third grade and found
a 50% adjusted increased odds of needing special education services for MPT and
a 34% increased odds of needing special education for LPT children. MPT and
LPT children had adjusted English language scores 6% and 4% of a standard devi-
ation lower than FT peers and math scores 10% and 7% of a standard deviation lower.
Generalized linear models estimated increases in adjusted mean test scores for
English and math of 0.73% and 0.12%, respectively, of a standard deviation for
each 1 week increase in GA after adjusting for confounders. The investigators relate
the continued increase in scores for children born between 37 and 41 weeks’ gesta-
tion to the continued increase in brain growth and organization in the last 4 weeks of
pregnancy.

An analysis of the databases of the Kaiser Permanente Medical Care Program using
International Classification of Diseases (ICD) documented diagnoses of CP, mental
retardation (MR), and seizure disorders at 2 visits at least 6 months apart for
141,321 children born at or before 30 weeks’ gestation and identified a similar linear
relationship with GA. The cohort was divided into 30 to 33 weeks, 34 to 36 weeks,
and 37 to 41 weeks. Decreasing GA was related to increasing rates of CP and MR
for all PT children. The adjusted hazard ratios for CP and MR were 7.87 and 1.90,
respectively, for 30 to 33 weeks and 3.39 and 1.25, respectively, for 34 to 36 weeks.

Adolescents and Adults

Summary data are shown in Table 3. There are few studies that follow-up MPT and
LPT children to adolescence or adult age. The first study in this review evaluated
18-year-old boys registered in the Medical Birth Registry of Norway (1967–1979)
whose data were linked to the Norwegian Conscript Service for 1984 to 1999. Intelli-
gence scores increased with each year of GA. After adjusting for social confounders
and adult body size, the OR for low adult intelligence scores for LPT versus FT
19-year-olds remained significant (OR = 1.21 [CI ±1.15–1.27]).

In a large Swedish register study of 119,664 boys aged 18 to 19 years conscripted
for military service, mean cognitive test scores decreased in a stepwise manner for GA
groups of 39 to 41, 37 to 38, 35 to 36, 33 to 34, and 24 to 32 weeks. Units of decrease
in stanine test scores for the GA categories 24 to 32, 33 to 34, 35 to 36, and 37 to 38
weeks relative to 39 to 41 weeks were −0.42, −0.17, −0.11, and −0.02, respectively,
after adjusting for multiple confounders. A stanine score is the equivalent of 7 points of
standard score, so the effects of GA are modest at best for the MPT and ET subjects.
Socioeconomic status was a significant modifier, and effects of GA were reduced by
26% to 33% after adjustment. This study and the prior Norwegian cohort reflect boys
only and boys with no significant disabilities. Both studies stress the importance of
adjusting for social and environmental factors. On the other hand, the data support
a role for the long-term effects of GA at birth.
<table>
<thead>
<tr>
<th>Author</th>
<th>Gestation Age</th>
<th>Sample Size</th>
<th>Cognitive</th>
<th>School Outcomes</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ekeus et al. 39</td>
<td>24–32 wk</td>
<td>Swedish</td>
<td>MPT: 1088&lt;br&gt;LPT: 94821&lt;br&gt;FT: 3918</td>
<td>↓ Cognition scores with ↓ GA</td>
<td>NA</td>
</tr>
<tr>
<td>Lindstrom et al.40</td>
<td>24–28 wk 29–32 wk 33–36 wk</td>
<td>Adolescents/young adults up to 29 y Sweden</td>
<td>545,628</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Moster et al.41</td>
<td>25–276/7 wk 28–306/7 wk 31–336/7 wk 34–366/7 wk ≥37 wk</td>
<td>Adults born in the period 1967–1983 Norway</td>
<td>867,692</td>
<td>↑ OR for MR MPT 2.1 LPT 1.6</td>
<td>Hazard ratio for psychiatric disorders 24–32 wk: 1.68 25–276/7 wk: 10.6% 28–306/7 wk: 8.2% 31–336/7 wk: 4.2% 34–366/7 wk: 2.4% ≥37 wk: 1.7% 30% ↑ risk schizophrenia &amp; 40%–50% ↑ risk psychiatric disorders</td>
</tr>
<tr>
<td>Dalziel et al.42</td>
<td>32–35 wk</td>
<td>Adults born in the period 1969–1974 31 y</td>
<td>MPT/LPT-112</td>
<td>No differences in cog function, working memory, or attention</td>
<td>No differences in anxiety or schizoid behavior</td>
</tr>
</tbody>
</table>
A Swedish national cohort of 545,628 births in the period 1973 to 1979 was used to estimate the hazard ratios of hospital admissions for psychiatric disorders and alcohol/illicit drug use for a cohort consisting primarily of adolescents and young adults. A total of 5.2% of subjects having GA 24 to 28 weeks and 3.5% having GA 29 to 32 weeks were hospitalized for a psychiatric disorder. The hazard ratios for hospitalization for a psychiatric disorder were 1.68 at 24 to 28 weeks, 1.21 at 33 to 36 weeks, and 1.08 at 37 to 38 weeks (ET), resulting in an increasing rate of psychiatric disorders with decreasing GA. MPT and ET births accounted for 85% of the risk.

Data from a national compulsory database in Norway examined the relationship between GA and outcomes of 867,692 adults. There was a significant inverse relationship between GA and a spectrum of medical disabilities including CP, MR, autism spectrum, other psychological disorders, other major disabilities, and any medical disability affecting working capacity. In all analyses, MPT and LPT had increased odds of the adverse outcome. This extended to decreased rates of graduating from high school, graduating from college, holding a high-income job, achieving biologic parenthood, and several additional demographic variables.

Dalziel and colleagues completed a comprehensive evaluation on 126 MPT adults (median gestation 34 weeks) at 31 years of age in New Zealand and found no differences compared to FT adults in cognitive function, educational achievement, marital status, working memory, attention, anxiety, or schizoid behaviors. Limitations in these findings were the 69% follow-up rate and small sample size.

**EARLY TERM INFANTS**

ET gestation is defined as deliveries occurring at 37 to 38 weeks of gestation. Although FT deliveries have traditionally been defined as births after 36 weeks, the FT category has been further divided to include ET (37–38 weeks), term (39–41 weeks), and late term or postterm (42–44 weeks). The focus of recent reports has been on the increased vulnerability of ET infants. A report on US births between 1992 and 2002 indicated an 8.9% increase in ET births over a 10-year period, with the increase attributable to elective deliveries. There is limited information on long-term outcomes of these infants. A large population-based study linked school census data to birth data registries that included maternal characteristic and birth data to determine the association between GA at birth and special education needs for children between 4 and 19 years. As expected, below 36 weeks, the lower the GA, the greater the percentage of children receiving special services. Of interest, however, is that this increased rate, which was inversely related to gestation, extended to infants at 39, 38, and 37 weeks. The multivariable ORs, compared to delivery at 40 weeks, were as follows: for 24 to 27 weeks, 6.92 (CI, 5.58–8.58); for 28 to 32 weeks, 2.66 (CI, 2.38–2.97); for 33 to 36 weeks, 1.53 (CI, 1.43–1.63); for 37 weeks, 1.36 (CI, 1.27–1.45); for 38 weeks (CI, 1.19; CI, 1.14–1.25), and for 39 weeks, 1.09 (CI, 1.04–1.14). Because of the substantial number of deliveries at ET within this cohort, the ET infants accounted for 39.6% of special education services at school age. In the United States, there is currently a nationwide effort to decrease elective deliveries at 37 to 39 weeks gestation.

**SUMMARY**

There is increasing evidence that MPT infants are at increased risk of a spectrum of developmental and behavioral morbidities that extend from birth to adult age. There is also an increasing body of evidence of the vulnerability of the LPT infant, particularly those who require NICU care, for postdischarge sequelae. The data on increased risk
of behavioral and psychiatric morbidities for both MPT and LPT infants are of particular concern. Current evidence indicates that close surveillance of medical status, growth, neurologic status, behavior, and development, in conjunction with family-centered support after discharge and referral to early intervention, behavioral, and support services is needed. Because of the level of risk, NICUs should consider referring MPT and selected LPT infants for high-risk follow-up evaluation. Further investigation is needed to identify the most vulnerable infants and to provide the appropriate support for the infant and family.

REFERENCES