Late-Preterm Birth and Lifetime Socioeconomic Attainments: The Helsinki Birth Cohort Study

WHAT'S KNOWN ON THIS SUBJECT: More than 70% of all preterm deliveries are late-preterm (34–36 weeks of gestation). Compared with those born at term, those born late-preterm have higher risk for medical and neurodevelopmental disabilities and suffer more often from mental and behavioral problems.

WHAT THIS STUDY ADDS: Late-preterm birth is associated with considerable lifetime socioeconomic disadvantages across the adult years. These disadvantages are not explained by childhood parental socioeconomic position.

OBJECTIVE: We examined if those born late-preterm (at 34 to 36 weeks of gestation) differed from those born at term in their maximum attained lifetime socioeconomic position (SEP) across the adult years up to 56 to 66 years, and in intergenerational social mobility from childhood parental SEP to own attained SEP.

METHODS: Participants were 8993 Finnish men and women of the Helsinki Birth Cohort Study born between 1934 and 1944. Gestational age was extracted from hospital birth records and socioeconomic attainments from Finnish National Census.

RESULTS: Compared with those born at term, those born late-preterm were more likely to be manual workers, have a basic or upper secondary level of education, belong to the lowest third based on their incomes, and less likely to belong to the highest third based on their incomes. Late-preterm individuals were also less likely to be upwardly mobile and more likely to be downwardly mobile; they were less likely to have higher occupations and more likely to have lower occupations than their fathers. They were also less likely to be upwardly mobile if incomes were used as the outcome of own attained SEP, and men were more likely to be downwardly mobile if education was used as the outcome of own attained SEP.

CONCLUSIONS: This study demonstrates that there are considerable long-term socioeconomic disadvantages associated with late-preterm birth, which are not explained by the parent-of-origin SEP.
According to a recent World Health Organization report, approximately every 10th birth worldwide is premature (before 37 weeks of gestation), a total of 14.9 million each year. Apart from posing a severe risk of mortality and morbidity, the effects of preterm birth in those who survive may continue throughout the lifetime. The existing evidence points to deficits in a wide spectrum of outcomes, including cardio-metabolic and mental health, cognitive functioning, and socioeconomic attainment. Much of this evidence is derived from studies comparing preterm infants born at the lower end of the gestational age or birth weight distribution with those born at term and/or with normal birth weight. Yet, more than 70% of all preterm deliveries are late-preterm, defined as delivery at 34 weeks 0 days through 36 weeks 6 days of gestation. The extent to which individuals born late-preterm are at risk of adversities in subsequent life is less well understood, however.

The existing evidence suggests that already in infancy those born late-preterm have higher short-term mortality and suffer more often from medical complications of immaturity than their term-born peers. In childhood and/or adolescence, they display an increased risk of medical and neurodevelopmental disabilities, perform poorer in academic achievement and cognitive tests, suffer more often from school-related problems, and display more often behavioral, emotional, and attention problems. In adulthood, they display an increased risk of all-cause mortality and schizophrenia, and perform poorer on intelligence tests. The evidence is, however, partially mixed.

To the best of our knowledge, only 1 study to date has examined the socioeconomic attainments of individuals born late-preterm. Moster et al reported that at age 20 to 36 years individuals born late-preterm had more often low job-related incomes, medical disabilities affecting working capacity, and received more often social security benefits than their term-born peers. No differences were found in educational attainments.

Individuals may not have achieved their maximum lifetime socioeconomic positions (SEPs) by early/middle adulthood. Hence, the first objective of this study was to examine the lifetime socioeconomic attainments of men and women of the Helsinki Birth Cohort Study (HBCS) born late-preterm between 1934 and 1944. We hypothesized that those born late-preterm belong more likely to the lowest and less likely to the highest SEP category than those born at term. Furthermore, as previous studies suggest that preterm births are more common in lower SEPs, and there is at least moderate intergenerational stability in SEP, the second objective of this study was to examine intergenerational social mobility, namely upward and downward mobility from childhood parental SEP to own SEP in adulthood, in relation to late-preterm birth. We hypothesized that those born late-preterm are more likely to be downwardly and less likely to be upwardly mobile than those born at term.

METHODS

Our study cohort was the HBCS, which comprises all 13,345 singleton live births (all white 6975 men) at the 2 public maternity hospitals in Helsinki, Finland, between 1934 and 1944. The HBCS, described in detail elsewhere, has been approved by the Ethics Committee of the National Public Health Institute. Data were linked with permission from the Ministry of Social and Health Affairs.

We excluded 1893 participants who were born before 34 or after 41 weeks of gestation or had missing or imprecise data on gestation, 862 who emigrated, and 159 who died before their 40th birthday. We also excluded 115 participants with no information on adult SEP, 358 with missing data on childhood parental SEP, and 965 with missing data on birth order, maternal age at childbirth, and/or maternal BMI. Thus, the analytic sample comprised 8993 participants (4768 men).

Compared with the included, the 4352 excluded participants had smaller birth weight (mean difference = 28.9 g, standard error difference = 10.5 g, \( P = .001 \)), were more often born late-preterm (7.4% vs 5.4%, \( P < .001 \)) and had an earlier year of birth (\( P = .001 \)), were more likely to be women (49.9% vs 47.0%, \( P = .01 \)), and had fathers with higher SEP (53.9% vs 61.4% manual workers, 24.3% vs 25.3% junior clerical, and 21.8% vs 13.4% senior clerical, \( P < .001 \)).

**Gestational Age**

We calculated length of gestation by subtracting mother’s last date of menstruation from the date of birth, both extracted from hospital birth records. We excluded participants born earlier than late-preterm (≤33 weeks 6 days of gestation) or post term (≥42 weeks 0 days). In line with our previous study on prematurity and diabetes, we also excluded preterm participants (≤36 weeks 6 days of gestation) with disproportionally large birth weight for length of gestation (>2 SD) by gender, because this may indicate erroneous recording of length of gestation. Finally, we constructed 2 categories: those born late-preterm (34 weeks 0 days to 36 weeks 6 days) and term (37 weeks 0 days to 41 weeks 6 days).

**SEP in Childhood and in Adulthood**

SEP in childhood, defined as father’s highest attained occupational status, was extracted from birth, child welfare,
Intergenerational Social Mobility

Intergenerational social mobility was defined as a change from 3-level father’s occupational category to 3-level maximum adult occupation, educational attainment, and income. Mobility variables were coded as stable (ie, maintaining the childhood hierarchy level), upwardly mobile (ie, moving upward from childhood manual worker or junior clerical SEP to adulthood SEP), and downwardly mobile (ie, moving downward from childhood senior or junior clerical SEP to adulthood SEP).

Covariates

Data on year of birth, gender, birth weight, and birth order, and maternal age, height, and weight before delivery were extracted from birth records. Birth weight adjusted for gestational age was calculated by linear regression and expressed in SD units. Maternal BMI was calculated as kg/m².

Statistical Analyses

Differences were examined by using the χ² test (categorical variables) and the Student’s t test (continuous variables). Logistic regression analyses were used to test if late-preterm and term infants differed in their odds (odds ratio [OR], 95% confidence interval [95% CI]) for belonging to the lowest (lowest versus middle/high adult SEP category) or the highest (highest versus middle/low) SEP category, and in their odds for downward (downward versus stable/upward) or upward (upward versus stable/downward) social mobility from childhood to adulthood. All regression models included gender and year of birth (Model 1). Analyses were further adjusted for birth order, maternal BMI, maternal age at delivery, and father’s occupational status (Model 2), and for birth weight adjusted for gestational age (Model 3). In the analyses of intergenerational social mobility, father’s occupational status in childhood was included already in Model 1 as intergenerational social mobility categories combine 2 different childhood SEP categories from which downward or upward mobility might differ. Finally, we tested if any of the associations were moderated by gender, by including an interaction term “late-preterm/term birth × gender” in the regression equation. Analyses were performed with SPSS for Windows, version 18.0 (IBM SPSS Statistics, IBM Corporation, Chicago, IL).

RESULTS

Table 1 presents the study cohort. Analyses of gender differences showed that compared with women, men weighed more at birth (P < .001), and had more often fathers with senior clerical occupations (P = .02), and had attained more often highest and lowest occupational status (49.4% vs 41.5% manual workers, 27.5% vs 51.9% junior clerical, and 23.1% vs 6.6% senior clerical workers among men versus women, respectively, P < .001) and higher education levels (64.5% vs 70.0% basic or upper secondary, 22.8% vs 22.0% lower tertiary, 12.7% vs 8.0% higher tertiary, P < .001). Incomes were standardized by gender and therefore gender differences were not tested.

Maximum-Attained Lifetime SEP

Table 2 shows that compared with those born at term, those born late-preterm had higher odds of belonging to the manual worker category, to have attained only a basic level of education, and to belong to the lowest income category. They also had lower odds of belonging to the highest income category.
### TABLE 1 Characteristics of the Study Cohort According to Length of Gestation

<table>
<thead>
<tr>
<th></th>
<th>Late Preterm (34 wk 0 d to 36 wk 6 d), n = 486 (5.4%)</th>
<th>Term (37 wk 0 d to 41 wk 6 d), n = 8507 (94.6%)</th>
<th>P Value (t test or ( \chi^2 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, women</td>
<td>Mean/n 224 46.1%</td>
<td>Mean/n 4001 47.0%</td>
<td>.69</td>
</tr>
<tr>
<td>Birth weight, g(^a)</td>
<td>Mean/n 2939 475</td>
<td>Mean/n 3426 442</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Relative birth weight, SD(^b)</td>
<td>Mean/n 0.12 1.1</td>
<td>Mean/n 0.05 1.0</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Gestational wk</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34 wk 0 d to 34 wk to 6 d</td>
<td>88 1.0</td>
<td>0</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>35 wk 0 d to 35 wk to 6 d</td>
<td>147 1.6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>36 wk 0 d to 36 wk to 6 d</td>
<td>251 2.8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>37 wk 0 d to 37 wk to 6 d</td>
<td>0 0</td>
<td>1256 6.8</td>
<td></td>
</tr>
<tr>
<td>38 wk 0 d to 38 wk to 6 d</td>
<td>0 0</td>
<td>2427 14.0</td>
<td></td>
</tr>
<tr>
<td>39 wk 0 d to 39 wk to 6 d</td>
<td>0 0</td>
<td>2622 27.0</td>
<td></td>
</tr>
<tr>
<td>40 wk 0 d to 40 wk to 6 d</td>
<td>0 0</td>
<td>1608 29.2</td>
<td></td>
</tr>
<tr>
<td>41 wk 0 d to 41 wk to 6 d</td>
<td>0 0</td>
<td>594 17.9</td>
<td></td>
</tr>
<tr>
<td><strong>Year of birth</strong></td>
<td></td>
<td></td>
<td>&lt; .001</td>
</tr>
<tr>
<td>1934–1935</td>
<td>43 8.8%</td>
<td>510 6.0%</td>
<td></td>
</tr>
<tr>
<td>1936–1937</td>
<td>67 13.8%</td>
<td>885 10.4%</td>
<td></td>
</tr>
<tr>
<td>1938–1939</td>
<td>66 15.6%</td>
<td>1246 14.6%</td>
<td></td>
</tr>
<tr>
<td>1940–1941</td>
<td>148 30.5%</td>
<td>1919 22.6%</td>
<td></td>
</tr>
<tr>
<td>1942–1943</td>
<td>108 22.2%</td>
<td>2885 31.6%</td>
<td></td>
</tr>
<tr>
<td>1944</td>
<td>54 11.1%</td>
<td>1282 14.8%</td>
<td></td>
</tr>
<tr>
<td><strong>Birth order, first born</strong></td>
<td>275 56.6%</td>
<td>4148 48.8%</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Mother’s age, ya</strong></td>
<td>27.8 5.8</td>
<td>28.4 5.4</td>
<td>.014</td>
</tr>
<tr>
<td><strong>Mother’s BMI at the delivery(^c)</strong></td>
<td>25.5 2.8</td>
<td>26.2 2.8</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Father’s occupational status(^d)</strong></td>
<td></td>
<td>.008</td>
<td></td>
</tr>
<tr>
<td>Manual worker</td>
<td>319 63.8%</td>
<td>5208 61.2%</td>
<td></td>
</tr>
<tr>
<td>Junior clerical</td>
<td>119 24.5%</td>
<td>2155 25.3%</td>
<td></td>
</tr>
<tr>
<td>Senior clerical</td>
<td>57 11.7%</td>
<td>1144 13.4%</td>
<td></td>
</tr>
<tr>
<td><strong>SEP in adulthood</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation(^e)</td>
<td></td>
<td>&lt; .001</td>
<td></td>
</tr>
<tr>
<td>Manual worker</td>
<td>98 21.5%</td>
<td>1183 14.8%</td>
<td></td>
</tr>
<tr>
<td>Junior clerical</td>
<td>170 37.4%</td>
<td>3142 39.3%</td>
<td></td>
</tr>
<tr>
<td>Senior clerical</td>
<td>187 41.1%</td>
<td>3669 45.9%</td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td>Basic or upper secondary</td>
<td>353 72.6%</td>
<td>5678 66.7%</td>
<td></td>
</tr>
<tr>
<td>Lower tertiary</td>
<td>89 18.3%</td>
<td>1927 22.7%</td>
<td></td>
</tr>
<tr>
<td>Higher tertiary</td>
<td>44 9.1%</td>
<td>902 10.6%</td>
<td></td>
</tr>
<tr>
<td><strong>Income tertiles(^f)</strong></td>
<td></td>
<td>.002</td>
<td></td>
</tr>
<tr>
<td>Lowest</td>
<td>191 39.5%</td>
<td>2722 32.1%</td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>157 32.5%</td>
<td>2905 34.3%</td>
<td></td>
</tr>
<tr>
<td>Highest</td>
<td>135 28.0%</td>
<td>2842 33.6%</td>
<td></td>
</tr>
<tr>
<td><strong>Social mobility from father’s occupational category in childhood to adult SEP category</strong></td>
<td></td>
<td></td>
<td>.23</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td>.29</td>
<td></td>
</tr>
<tr>
<td>Downward</td>
<td>35 7.7%</td>
<td>499 6.2%</td>
<td></td>
</tr>
<tr>
<td>Stable</td>
<td>150 33.0%</td>
<td>2467 30.9%</td>
<td></td>
</tr>
<tr>
<td>Upward</td>
<td>270 59.3%</td>
<td>5028 62.9%</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td>Downward</td>
<td>114 25.5%</td>
<td>2049 24.1%</td>
<td></td>
</tr>
<tr>
<td>Stable</td>
<td>300 61.7%</td>
<td>4988 58.6%</td>
<td></td>
</tr>
<tr>
<td>Upward</td>
<td>72 14.8%</td>
<td>1470 17.3%</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td>Downward</td>
<td>70 14.4%</td>
<td>1168 13.7%</td>
<td></td>
</tr>
<tr>
<td>Stable</td>
<td>210 43.2%</td>
<td>3212 37.8%</td>
<td></td>
</tr>
<tr>
<td>Upward</td>
<td>206 42.4%</td>
<td>4126 48.5%</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Mean (SD).

\(^b\) Relative birth weight refers to birth weight adjusted length of gestation by linear regression, expressed in SD units.

\(^c\) Highest occupational status as obtained from birth, child welfare clinic, and school health care records.

\(^d\) Missing n = 544.

\(^e\) Missing n = 41.
 Analyses addressing moderation by gender showed that in comparison with women born at term, women born late-preterm were particularly likely to belong to the manual worker category (adjusted odds ratio [aOR] = 2.37, 95% CI 1.05–5.36, P < .01 for Model 1; P < .001 for Models 2 and 3). A similar difference in the likelihood of belonging to the manual worker category existed between men born late-preterm and at term, although it was less pronounced (aOR = 1.37, 95% CI 1.01–1.81, P = .04 for Model 1; P < .03 for Models 2 and 3) (late-preterm/term × gender − interaction Ps < .05).

**Intergenerational Social Mobility**

Table 3 shows that in comparison with those born at term, those born late-preterm had higher odds of being downwardly mobile in occupational status, and had lower odds of being upwardly mobile in occupational status and incomes. Adjustments did not change these results.

Analyses addressing moderation by gender showed that in comparison with men born at term, men born late-preterm had higher odds of being downwardly mobile in education (aOR = 1.48, 95% CI 1.02–2.14, P = .04 for Model 1; P < .04 for Models 2 and 3). Women born at term and late-preterm did not differ in downward mobility in education (aOR = 0.77, 95% CI 0.47–1.25, P = .29 for Model 1; P < .34 for Models 2 and 3) (late-preterm/term × gender − interaction Ps < .05).

**DISCUSSION**

We found in a large epidemiologic cohort of 8993 Finnish men and women that those born late-preterm differed from those born at term in their maximum attained lifetime SEP across the adult years, and in intergenerational social mobility from childbirth parental SEP to own SEP in adulthood. Compared with those born at term, those born late-preterm were more likely to belong to the lowest SEP category in adulthood; they were more likely to be manual workers, have a basic or upper secondary level of education, and belong to the lowest third based on their incomes. They were also less likely to belong to the highest third based on their incomes. Those born late-preterm were also less likely to be upwardly mobile and more likely to be downwardly mobile in comparison with those born at term; they were less likely to have higher occupations and more likely to have lower occupations than their fathers. They were also less likely to be upwardly mobile if incomes were used as the outcome of own attained SEP, and men were more likely to be downwardly mobile if education was used as the outcome of own attained SEP.

Our findings are in partial agreement with the previous Norwegian register study that reported that at age 20 to 36 years, those born late-preterm have more often low job-related incomes.
and have a higher risk for medical disabilities affecting working capacity. In contrast to our findings, they did not find differences in educational attainments or in attainment of high incomes. However, they relied on 1 sweep of data obtained at the age of 20 to 36 years, when it is likely that not all individuals have had a possibility to reach their maximum SEPs. By contrast, we were able to follow our participants across 4 decades and 8 data sweeps. Indeed, in our study, at the age of 26 to 36 years, 37.5%, 9.4%, and 39.3% had not yet reached their maximum occupation, education, and income. Further, no previous study has tested if late-preterm birth is associated with intergenerational social mobility. Preterm births occur more frequently in families with lower SEPs and there is at least moderate intergenerational stability in SEP. As those born late-preterm were both less likely to be upwardly mobile and more likely to be downwardly mobile from childhood parental SEP, our results suggest that late-preterm birth exerts an independent effect on own maximum attained SEP across the life span that is not explained by the parent-of-origin SEP.

Several mechanisms may underlie these associations. First, a significant amount of development of the brain takes place during the last weeks of pregnancy. At 34 weeks of gestation, the brain weighs only 65% of the brain weight at 40 weeks of gestation. At birth, the brain of the late-preterm infant is thus still immature and vulnerable. Second, those born late-preterm are at an increased risk for problems in neurocognitive functioning, and have a higher risk for medical disabilities affecting working capacity. In contrast to our findings, they did not find differences in educational attainments or in attainment of high incomes. However, they relied on 1 sweep of data obtained at the age of 20 to 36 years, when it is likely that not all individuals have had a possibility to reach their maximum SEPs. By contrast, we were able to follow our participants across 4 decades and 8 data sweeps. Indeed, in our study, at the age of 26 to 36 years, 37.5%, 9.4%, and 39.3% had not yet reached their maximum occupation, education, and income. Further, no previous study has tested if late-preterm birth is associated with intergenerational social mobility. Preterm births occur more frequently in families with lower SEPs and there is at least moderate intergenerational stability in SEP. As those born late-preterm were both less likely to be upwardly mobile and more likely to be downwardly mobile from childhood parental SEP, our results suggest that late-preterm birth exerts an independent effect on own maximum attained SEP across the life span that is not explained by the parent-of-origin SEP.

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differed in general in their maximum-attained SEP and in the levels of their fathers’ occupations. Earlier study on socioeconomic attainment of those born late-preterm did not find gender differences.17

The strength of this study is in the ability to use register data, which excludes the possibility of self-reporting bias. We could also control for several perinatal (eg, birth weight and birth order) and parental variables (eg, maternal age and BMI), which are related either to preterm birth or socioeconomic attainments. This increases internal validity and ensures that the found differences are most likely true and not a result of a third factor. There are also limitations. The preterm birth register studies lack the detailed information on the potential impairments and their severity.48 The registers also lack information of socio-environmental variables (eg, substance abuse), which may alter SEP outcomes. Although our study cannot rule out this possibility, previous studies suggest that substance abuse is less frequent in those born preterm than term.49,50 Further, gestational age was based on last menstrual date of the mother. However, we excluded preterm participants with disproportionally large birth weight for length of gestation to minimize the misclassification of term birth to preterm birth.51 All participants in the current study were also singletons. However, as preterm birth is more likely in multiple than in singleton pregnancies, this limitation may have reduced rather than amplified our ability to detect significant associations.

Further, SEP in childhood was based on father’s occupational status only; however, it corresponds highly with the census data of the rooms available for the family and the density of inhabitants in the household.55 Yet, people born to single mothers were excluded. Moreover, the excluded participants were more often women, born late-preterm, and had an earlier year of birth, and their father had a higher occupational status, limiting the generalizability of the findings. Finally, findings in individuals born between 1934 and 1944 may not be generalized to cohorts born more recently in high-resource settings. However, at that time, the vast majority of infants in Helsinki were born in hospitals and preterm infants were generally treated at pediatric wards.52 Yet, the neonatal mortality in Helsinki was still 40% between 1935 and 1943.53 Further, obstetric care was more expectant than today and induction of delivery was rare. Thus, people in our cohort are more likely to represent spontaneous rather than induced preterm births; the results may therefore be particularly relevant in today’s low-resource settings.54 However, if the aim is to understand lifetime socioeconomic attainment of those born late-preterm, this limitation cannot be overcome in the close future. Nevertheless, studies on neurocognitive functioning in young adulthood of those born late-preterm more recently could cast light on their future socioeconomic attainments.55

Finally, the historical context of the HBCS has to be kept in mind.55 During World War II, men served in the army and their SEP may have been compromised. After the war, Finland changed rapidly toward a modern welfare state, meaning more equal education opportunities.

CONCLUSIONS

We found that those born late-preterm attained lower SEP across life than those born at term. They were also less likely to be upwardly mobile and more likely to be downwardly mobile from their childhood parental SEP. This suggests that the 10 million people born late-preterm each year may be at risk for suffering from lifetime socioeconomic disadvantage, which is not explained by the parent-of-origin SEP.

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