Risk-taking behavior of adolescents and young adults born preterm

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Objectives To study sexually transmitted *Chlamydia trachomatis* infections (STCTs), teenage pregnancies, and payment defaults in individuals born preterm as proxies for engaging in risk-taking behavior.

Study design Our population-based register-linkage study included all 191 705 children alive at 10 years (8492 preterm [4.4%]) born without malformations in Finland between January 1987 and September 1990 as each mother's first child within the cohort. They were followed until young adulthood. We used Cox regression to assess the hazards of STCTs, teenage pregnancies, payment defaults, criminal offending, and substance abuse by gestational age. Gestational age was considered both as a continuous and categorical (extremely, very, moderately, late preterm, early term, post term, and full term as reference) exposure.

Results A linear dose-response relationship existed between gestational age and STCT and teenage pregnancy; adjusted hazard for STCT decreased by 1.6% (95% CI, 0.7%-2.6%), and for teenage pregnancy by 3.3% (95% CI, 1.9%-4.8%) per each week decrease in gestational age. Those born extremely preterm (23-27 completed weeks) had a 51% (95% CI, 31%-83%) lower risk for criminal offending than their full-term born counterparts, and those born very preterm (range, 28-31 weeks) had a 28% (95% CI, 7%-53%) higher hazard for payment defaults than those born at full term. Gestational age was not associated with substance abuse.

Conclusions The lower risk-taking that characterizes people born preterm seems to generalize to sexual and to some extent criminal behavior. Those born very preterm are, however, more likely to experience payment defaults. *(J Pediatr 2022; ■:1-9)*.

Individuals born extremely (before 28 weeks of gestation) or very preterm (28-31 weeks of gestation), or with extremely low birth weight (<1000 g) or very low birth weight (<1500 g) more often have poorer neurocognitive function than those born at full term.[1-5] Those born preterm also tend to have a behavioral profile characterized by cautiousness in social relationships, inattention, and internalizing problems such as depression and anxiety. They, in contrast, have lower levels of externalizing problems, such as maladaptive behavior toward one's environment.[6-9] The influence of suboptimal gestational age at birth on behavioral outcomes seems to continue to some extent to adolescence.[3,6,10-13]

Preterm born individuals are as likely or less likely to commit criminal offences, and have similar or lower rates of risk-taking behaviors, namely smoking, use of illicit drugs and alcohol abuse than their term born peers.[14-23] However, less is known about risk-taking behavior in other domains of life such as in peer or partner romantic relationships and in managing personal finances among those born preterm. In this nationwide, individual-level register linkage study we assessed whether preterm born young adults have, compared with full-term born controls, lower rates of teenage pregnancies, sexually

HR	hazard ratio
SEP	Socioeconomic position
STCT	Sexually transmitted *Chlamydia trachomatis* infection

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Supported by the Academy of Finland (Skidi-Kids program for 2010-2013 and grants 127437, 129306, 130326, 134791, 263924, 274794, 315690 [to E.K.]); and the Academy of Finland (Clinical Researcher Grant 288966 [to P.Ho.]); the Academy of Finland (grant number 1324596 [to K.R.]); European Commission (Horizon 2020 award RECAP Research on Children and Adults Born Preterm grant number 733280 [to E.K., K.R., D.W.]); the Doctoral Programs of Public Health, University of Helsinki [to S.A.]; the Finnish Foundation for Pediatric Research [to E.K., P.Ho.], the Signe and Ane Gyllenberg Foundation [to S.A., E.K., P.Ho.]; the Alli Paasikivi Foundation [to P.Ho.]; the Sigrid Jusélius Foundation [to E.K.]; the Juho Vainio Foundation [to E.K., S.A.]; Norface DIAL Programme (project 462-16-040 Premlife Life Course Dynamics after Preterm Birth [to E.K., K.R., D.S., D.W., S.L.]); the Novo Nordisk Foundation [to E.K.]; the Finnish Foundation for Cardiovascular Research [to E.K., P.Ho.]; the Emil Aaltonen Foundation [to E.K., P.Ho.]; the Paulo Foundation [to S.A.]; the Finnish Medical Foundation [to S.A.]; and the Päivikki and Sakari Sohlberg Foundation [to S.A.]. The study funders had no role in design and conduct of the study; collection, management, analysis, and interpretation of the data; writing, preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Dr Hovi has received payment from Pfizer for congress expenses to participate in the Pediatric Rheumatology Congress (Genova, Italy 2016) and to cover advisory board fees to become a member of an advisory board for rheumatology. The other authors declare no conflicts of interest.

https://doi.org/10.1016/j.jpeds.2022.09.032

transmitted infections, payment defaults, criminal offences, and care episodes for substance abuse.[24]

Methods

The data originated from 11 nation-wide administrative registers: (1) the Finnish Medical Birth Register, (2) the Central Population Register (updated through April 2012), (3) Register of Congenital Malformations (January 2015), (4) The Finnish Care Register for Health Care (December 2015), (5) Census Register (December 2014), (6) the Register on Disability Allowances (December 2015), (7) National Infectious Disease Register (December 2012), (8) Register on Induced Abortions and Sterilizations (December 2017), (9) register on credit ratings (August 2018), (10) register on crimes (February 3, 2020), and (11) register on fines and punishments (December 10, 2019). The 5 last-mentioned registers are described in the **Appendix** (available at www.jpeds.com). Other registers are described in detail elsewhere.[25,26] Register data were merged by using encrypted personal identification codes, which enable full-coverage, accurate individual linkages between registers. Based on Finnish and European Union legislation, individual consents are not required in studies based on pseudonymized register data if the registered persons are not contacted. The local ethics committees and applicable register authorities approved the study protocol. The study was approved by the Local Ethical Review Board, Helsinki (Helsinki University Central Hospital Ethics Committee Dnr: 200/13/03/00/08, and Dnr: HUS/3580/2017). The study was performed in accordance with the declaration of Helsinki.

Cohort Members

A total of 235 624 index children with valid personal identity code (99.8% of all live-born children) born in Finland between January 1, 1987, and September 30, 1990, were identified from the Medical Birth Register. Of them 7073 (3.0%) were excluded owing to missing Central Population Register data, missing or inaccurate information on gestational age, or/and major congenital anomaly (for details see **Figure 1** and the **Appendix**). Our main analysis included only each mother's first child born during the recruiting period (191 705 [83.9%]) to avoid within-family correlations and within family influences. To avoid follow-up in such ages that certain outcome events are not recorded to the official registers or are extremely unlikely to occur as a consequence of risk-taking behavior, we started the follow-up at 10, 15, or 18 years of age (depending on the outcome, as described elsewhere in this article).

Exposure, Outcomes, and Covariates

Gestational age was assessed according to ultrasound estimates and/or estimates based on maternal last menstrual period and was considered either as a continuous exposure or categorized into 7 subgroups: extremely preterm, 23-27 completed weeks; very preterm, 23-31 weeks; moderately

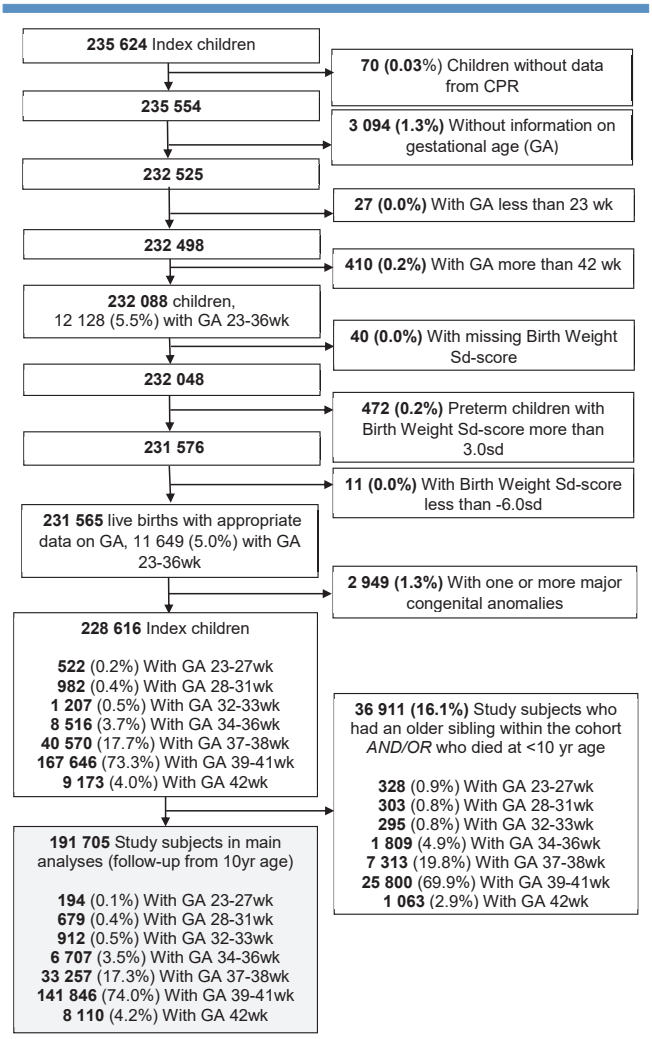

Figure 1. Study cohort. *CPR*, Central Population Register; *GA*, gestational age.

preterm, 32-33 weeks; late preterm, 34-36 weeks; early term, 37-38 weeks; full term, 39-41 weeks (reference); and post term, 42 weeks.

The most useful proxies of risk-taking behavior that can be straightforwardly and reliably derived from the national registers were (1) sexually transmitted *Chlamydia trachomatis* (STCT) infections (yes vs no), (2) teenage pregnancies among females (live birth of a child or induced abortion before 20 years of age, yes vs no), (3) payment defaults (defaulting on paying back debts; yes vs no), (4) substance abuse diagnosed in a hospital inpatient or outpatient clinic (yes vs no), and (5) criminal offending (yes vs no). Detailed information on these outcomes, including precise definition of each outcome, is available in the **Appendix**, description of the outcomes, and **Table I** (available at www.jpeds.com).

The covariates in the models are described in detail elsewhere and in the **Appendix**, description of the covariates, and **Table II** (available at www.jpeds.com).[25,26] In the 4 analyses including both sexes, the sex of the study subject

was included as a stratum in the Cox model to meet the assumptions for Cox proportional hazards, and accounting for sex differences in pubertal timing, adolescent brain, and behavior.[27,28] Concerning each of the 4 outcomes the gestational age associations were similar across strata (male/female) for all of them; *P* for interaction of less than .57 (STCT), less than .58 (payment defaults), less than .76 (substance abuse), and less than .75 (criminal offending). The sex of the study subject (male vs female) originated from the Medical Birth Register, to which it is reported within first postnatal week.

The other categorical covariates covered data on parental highest ever attained level of socioeconomic position (SEP), parental ages separately, maternal marital status, smoking, and gestational disorders, severe medical conditions of the adolescent study subject, and parental behavior including substance abuse, criminal offending, and payment defaults. Missing data (**Table III**) were coded to a separate category when they were missing for 3 or more study subjects; otherwise, we applied single imputation with most likely values; data on parental payment defaults missing—no parental payment defaults; data on parental criminal offending missing—no parental criminal offending; data on parental substance abuse missing—no parental substance abuse. In analyses no data was missing for continuous variables (gestational age or birth-weight SD score).

Statistical Analyses

In the analyses on STCTs, teenage pregnancies, and substance abuse the follow-up started at 10 years of age. The follow-up started at 15 years of age when assessing criminal offending, and at 18 years of age when payment defaults were assessed. These ages were chosen because juveniles younger than 15 years of age cannot be held legally responsible for criminal behavior in Finland and therefore records are unavailable, and only those 18 years of age or older can sign financial agreements.[29] Total follow-up time varied according to outcome, owing to varying end dates of outcome data, and the birth year of the study subject. Thus, the ages of the study subjects at the end of follow-up were as follows: STCTs, mean 24.6 years; teenage pregnancies, mean, 20.0 years; payment defaults, mean 29.9 years; substance abuse mean 27.3 years; and criminal offending, mean 31.2 years. Those who emigrated or died during the follow-up, or reached the end of follow-up without an event, whichever occurred first, were considered as censored observations.

Using Cox regression, we calculated the HRs and 95% CIs in the 6 nonreference gestational age subgroups in weeks, and also modelled the log HR either as a linear or a spline function of the continuously measured gestational age in days.[30,31] We applied restricted cubic splines with 4 knots set at 28, 33, 37, and 41 weeks of gestation. Linear trend was assessed by comparing the model involving the continuous gestational age variable with a model with a constant log HR and nonlinearity by comparing the spline model to the model with a linear trend. For illustrations, we calculated 95% CIs for the estimated linear and spline functions.

We also investigated whether the gestational age category-specific HRs for any of the proxies of risk-taking behavior were dependent on age. We estimated age-dependent HRs by using the interaction terms calculated separately for the gestational age categories and a categorized age variable with cut-off points at 13, 15, 18, 22, and 25 years of age (when the cut-off point was within the follow-up period).

Because some evidence exist on associations between birth weight and behavioral problems in adolescence, we examined potential interactions between gestational age and fetal growth (for which birth-weight SD score served as a proxy) by introducing the corresponding interaction term in the models (**Appendix**).[32-34]

SPSS 26 (IBM Corp) was the main statistical software. R software (R Foundation for Statistical Computing) version 3.6.0 with packages "survival" and "rms" was employed to estimate the linear and spline regression models.[31,35,36]

Results

The study population in main analyses with follow-up from 10 years of age consisted of 191 705 individuals (**Table III**). In comparison with full-term born study subjects, those born preterm had a lower birth-weight SD score and were more likely to have severe medical conditions in adolescence. The mothers of those born preterm were more likely to have a gestational disorder, smoke during pregnancy, and be unmarried. Both the mothers and the fathers of those born preterm were older. They were also more likely to have blue collar SEP, payment defaults, and substance abuse as compared with the parents of full-term born study subjects ($P < .001$; χ^2 or t test). The rates of parental criminal offending were similar between the groups ($P < .12$; χ^2 test).

The age period and gestational age category-specific HRs for each of the proxies of risk-taking behavior indicated that the effect of gestational age was consistent across the 6 predefined age periods (cut-off points at 13, 15, 18, 22, and 25 years when applicable). Therefore, the age period-specific estimates are not shown. **Table IV** (available at www.jpeds.com) shows that the risk-taking-related outcomes were associated with male sex (except STCT), maternal smoking, younger age of parents, and parental SEP of blue collar class.

STCTs

Table V shows the proportion of individuals with STCT by gestational age category. In the fully adjusted model, gestational age as a categorical variable was not statistically significantly associated with STSC (**Figure 2**, A, **Table VI**; available at www.jpeds.com). However, a linear dose-response relationship was statistically significant, corresponding with a 1.6% (95% CI, 0.7%-2.6%) decrease in the hazard per each week decrease in gestational age (**Figure 2**, A, **Table VII**; available at www.jpeds.com).

Table III. Background characteristics of the study participants alive at 10 years of age according to gestational age (completed weeks) category

Characteristics	Extremely preterm 23-27 weeks (n = 194)	Very preterm 28-31 weeks (n = 679)	Moderately preterm 32-33 weeks (n = 912)	Late preterm 34-36 weeks (n = 6707)	Early term 37-38 weeks (n = 33 257)	Full term 39-41 weeks (n = 141 846)	Postterm 42 weeks (n = 8110)	Total cohort 23-42 weeks (n = 191 705)
Gestational age, weeks	26.3 ± 1.2	30.3 ± 1.1	33.0 ± 0.6	35.9 ± 0.8	38.2 ± 0.5	40.3 ± 0.8	42.2 ± 0.2	39.8 ± 1.6
Male sex	109 (56.2)	397 (58.5)	507 (55.6)	3643 (54.3)	17 588 (52.9)	71 739 (50.6)	4183 (51.6)	98 166 (51.2)
Birth weight, grams	898 ± 185	1444 ± 313	1976 ± 396	2716 ± 480	3323 ± 475	3671 ± 459	3851 ± 463	3566 ± 544
Birth weight SD score, (SD)*	0.24 ± 1.36	−0.20 ± 1.50	−0.35 ± 1.51	−0.18 ± 1.31	0.00 ± 1.16	0.03 ± 1.02	−0.02 ± 1.01	0.01 ± 1.06
Small for gestational age (birth weight SD score <−2)	11 (5.7)	96 (14.1)	136 (14.9)	584 (8.7)	1265 (3.8)	2816 (2.0)	191 (2.4)	5099 (2.7)
Alive at 15 years of age	194 (100.0)	677 (99.7)	909 (99.7)	6703 (99.9)	33 232 (99.9)	141 769 (99.9)	8105 (99.9)	191 589 (99.9)
Alive at 18 years of age	194 (100.0)	677 (99.7)	908 (99.6)	6697 (99.9)	33 198 (99.8)	141 657 (99.9)	8096 (99.8)	191 427 (99.9)
Emigrated during follow-up	7 (0.8)†		5 (0.5)	60 (0.9)	387 (1.2)	1555 (1.1)	90 (1.1)	2104 (1.1)
Severe medical condition‡	29 (14.9)	54 (8.0)	18 (2.0)	69 (1.0)	211 (0.6)	714 (0.5)	52 (0.6)	1147 (0.6)
Mothers, n	193	679	912	6706	33 255	141 831	8108	191 684
Maternal smoking during pregnancy§	40 (20.6)	125 (18.4)	189 (20.7)	1237 (18.4)	5336 (16.0)	21 241 (15.0)	1371 (16.9)	29 539 (15.4)
Maternal gestational disorder	25 (12.9)	180 (26.5)	263 (28.8)	1482 (22.1)	5724 (17.2)	11 744 (8.3)	403 (5.0)	19 821 (10.3)
Maternal age at birth of study participant, years¶	30.3 ± 5.6	29.1 ± 5.8	29.2 ± 6.1	28.8 ± 5.7	28.9 ± 5.5	28.4 ± 5.2	27.8 ± 5.0	28.5 ± 5.3
Maternal age less than 20 years	36 (4.1)†		42 (4.6)	284 (4.2)	1132 (3.4)	4393 (3.1)	321 (4.0)	6208 (3.2)
Maternal age 20-34 years	144 (74.2)	510 (75.1)	677 (74.2)	5237 (78.1)	26 625 (80.1)	119 117 (84.0)	6992 (86.2)	159 302 (83.1)
Maternal age ≥35 years	47 (24.2)	136 (20.0)	193 (21.2)	1186 (17.7)	55 009 (16.5)	18 333 (12.9)	797 (9.8)	26 192 (13.7)
Mother married at the birth of the study participant**	135 (69.6)	462 (68.0)	645 (70.7)	4927 (73.5)	25 816 (77.6)	109 860 (77.5)	5905 (72.8)	147 750 (77.1)
Fathers, n	191	661	887	6550	32 767	140 099	7977	189 132
Paternal age at birth of study participant, years††	32.9 ± 6.9	31.2 ± 6.5	31.4 ± 6.6	31.1 ± 6.3	31.2 ± 6.1	30.8 ± 5.8	30.3 ± 5.7	30.9 ± 5.8
Paternal age <20 years	14 (1.6)*		16 (1.8)	71 (1.1)	265 (0.8)	1037 (0.7)	69 (0.9)	1472 (0.8)
Paternal age 20 -years	110 (57.6)	461 (69.7)	618 (69.7)	4673 (71.3)	23 642 (72.2)	105 673 (75.4)	6176 (77.4)	141 353 (74.7)
Paternal age ≥35 years	79 (41.4)	188 (28.4)	253 (28.5)	1806 (27.6)	8860 (27.0)	33 389 (23.8)	1732 (21.7)	46 307 (24.5)
Parental SEP, highest level attained by either parent‡‡								
Upper white collar workers	77 (39.7)	257 (37.8)	341 (37.4)	2603 (38.8)	13 866 (41.7)	60 947 (43.0)	3533 (43.6)	81 624 (42.6)
Lower white collar workers	81 (41.8)	275 (40.5)	373 (40.9)	2760 (41.2)	13 383 (40.2)	57 915 (40.8)	3314 (40.9)	78 101 (40.7)
blue collar workers	24 (12.4)	111 (16.3)	155 (17.0)	991 (14.8)	4520 (13.8)	17 280 (12.2)	986 (12.2)	24 067 (12.6)
Other§§	12 (6.2)	33 (4.9)	43 (4.7)	335 (5.0)	1399 (4.2)	5333 (3.8)	261 (3.2)	7416 (3.9)
Parental offences¶¶,***	28 (14.4)	145 (21.4)	180 (19.7)	1243 (18.5)	5988 (18.0)	25 705 (18.1)	1534 (18.9)	34 823 (18.2)
Parental payment defaults***,†††	27 (13.9)	119 (17.5)	151 (16.6)	1119 (16.7)	4875 (14.7)	19 924 (14.0)	1302 (16.1)	27 517 (14.4)
Parental care for substance abuse***,‡‡‡	16 (8.2)	33 (4.9)	38 (4.2)	223 (3.3)	1037 (3.1)	3792 (2.7)	223 (2.7)	5362 (2.8)

Note that Central Population Register data on 21 (0.01%) mothers is missing. A total of 2 (<0.01%) study subjects had missing Central Population Register data for both parents. Values are mean ± SD or number (%) unless otherwise noted.

*Sankilampi et al, 2013.[66]

†Gestational age categories of 23-31 weeks are combined because privacy regulations prevent us to display cell counts of 3 or less.

‡Received disability allowance at ≥16 years of age owing to a severe medical condition. Detailed description on diagnoses and *International Classification of Diseases*, 10th edition codes included to this variable are available at online material (**Table II**).

§Missing values: n = 3735 (1.9%).

¶Missing values: n = 3 (<0.01%).

**Missing values: n = 939 (0.5%).

††Missing values: n = 2573 (1.3%).

‡‡Missing values: n = 497 (0.3%).

§§Other includes entrepreneurs, farmers, students, pensioners, unemployed, housewives, and mothers and fathers with unclassified or unknown SEP.

¶¶Either parent has a register record on criminal offending available from the Register of crimes (through February 3, 2020) and/or from the Register on fines and punishments (through December 10, 2019). Minor infractions such as fines issued for mild speeding are excluded.

***Missing values: n = 2 (<0.01%).

†††Either parent has a register record on payment default(s) available from the Register on credit defaults (through August 30, 2018).

‡‡‡Either parent has an in-hospital care episode owing to substance abuse before the birth of the study subject. Data are available since 1969; parents who died or migrated are not censored, and those who received a diagnosis only before 1969 are not accounted for.

Table V. Proxies for risk-taking behavior according to gestational age (completed weeks) category

Characteristics	Extremely preterm 23-27 weeks	Very preterm 28-31 weeks	Moderately preterm 32-33 weeks	Late preterm 34-36 weeks	Early term 37-38 weeks	Full term 39-41 weeks	Postterm 42 weeks	Total cohort 23-42 weeks
STCT*	11 (5.7)	48 (7.1)	75 (8.2)	611 (9.1)	3164 (9.5)	14 070 (9.9)	853 (10.5)	18 832 (9.8)
Age at first STCT, years†	21.5 ± 1.6	20.6 ± 2.1	20.4 ± 2.2	20.4 ± 2.2	20.2 ± 2.3	20.2 ± 2.3	20.2 ± 2.3	20.2 ± 2.3
Teenage pregnancy‡	5 (5.9)	21 (7.4)	31 (7.7)	257 (8.4)	1356 (8.7)	6514 (9.3)	390 (9.9)	8574 (9.2)
Age at first teenage pregnancy, years§	18.9 ± 1.1	18.5 ± 1.1	18.4 ± 1.2	18.1 ± 1.5	18.1 ± 1.4	18.1 ± 1.4	18.1 ± 1.5	18.1 ± 1.4
Payment default(s)¶	20 (10.3)	118 (17.4)	116 (12.8)	908 (13.6)	4131 (12.4)	17 071 (12.1)	1103 (13.6)	23 467 (12.3)
Age at first credit default, years**	25.8 ± 1.8	26.2 ± 1.7	26.0 ± 2.0	26.1 ± 1.7	26.1 ± 1.8	26.1 ± 1.8	26.0 ± 1.8	26.1 ± 1.8
Substance abuse, years††	10 (5.2)	24 (3.5)	35 (3.8)	298 (4.4)	1340 (4.0)	5763 (4.1)	352 (4.3)	7822 (4.1)
Age at first substance abuse care period, years‡‡	21.0 ± 4.3	21.7 ± 3.4	21.7 ± 4.8	20.1 ± 4.1	20.4 ± 4.2	20.3 ± 4.1	20.4 ± 4.2	20.3 ± 4.1
Criminal offending§§	16 (8.2)	107 (15.8)	136 (15.0)	1000 (14.9)	4928 (14.8)	21 012 (14.8)	1242 (15.3)	28 441 (14.8)
Age at first offence, years¶¶	27.0 ± 1.4	26.0 ± 3.3	26.5 ± 3.3	26.2 ± 3.2	26.4 ± 3.2	26.5 ± 3.1	26.4 ± 3.1	26.4 ± 3.1

Values are number (%) or mean ± SD.
*Register record(s) on STCTs in National Infectious Disease Register (through December 31, 2012). Only infections recorded at ≥10 years of age are included.
†Age at first register record on STCTs in the National Infectious Disease Register. Only infections recorded at ≥10 years of age are included.
‡Induced abortion or the birth of a live-born child at <20 years of age. Applies only to female study subjects.
§Age at first induced abortion or at the first birth of a live-born child before 20 years of age. Applies only to female study subjects.
¶Register record on payment default(s) available from the Register on credit defaults (through August 30, 2018).
**Age at first register record on payment default available from the Register on credit default (through August 30, 2018).
††Substance abuse diagnosed in a hospital inpatient or outpatient clinic. Detailed information on *International Classification of Diseases*, 10th edition codes included to this variable is available from online **Table I**. Only care periods at ≥10 years of age are included.
‡‡Age at first diagnose on substance abuse related care period in a hospital inpatient or outpatient clinic. Only care periods at ≥10 years of age are included.
§§Register record(s) on criminal offending available from the Register of crimes (through February 3, 2020) and/or from the Register on fines and punishments (through December 10, 2019). Minor infractions such as fines issued for mild speeding are excluded.
¶¶The age at the first offence available from the Register of crimes (through February 3, 2020) and/or from the Register on fines and punishments (through December 10, 2019). Minor infractions such as fines issued for mild speeding are excluded.

Teenage Pregnancies

Table V shows the proportion of women who experienced teenage pregnancy (birth or induced abortion before 20 years of age) by gestational age category. In the fully adjusted model, women born late preterm (0.83; 95% CI, 0.73-0.94) and early term (0.91; 95% CI, 0.73-0.94) had lower hazard of teenage pregnancy than women born full term (**Figure 2**, B, **Tables VII** and **VIII**; available at www.jpeds.com). A linear dose-response relationship was statistically significant, corresponding with a 3.3% decrease (95% CI, 1.9%-4.8%) in teenage pregnancies per each week decrease in gestational age.

Payment Defaults

Table V shows the proportion of individuals with payment default by gestational age category. In the fully adjusted model, those born very preterm had 28% higher HR (95% CI, 7%-53%) for payment default than those born full term. This association remained also when parental payment defaults were included as an additional covariate (**Figure 2**, C, **Table IX**; available at www.jpeds.com). Gestational age as a continuous variable was associated with payment defaults in a nonlinear way (for the linear model, $P = .54$; for the spline model $P = .05$) (**Table VII**).

Substance Abuse

Table V shows the proportion of individuals with substance abuse by gestational age category. In fully adjusted models, gestational age as a categorical variable was not statistically significantly associated with substance abuse (**Figure 2**, D, **Table X**; available at www.jpeds.com). The P value for the linear trend between gestational age and substance abuse was .08 (**Table VII**).

Criminal Offending

Table V shows the proportion of individuals with criminal offending by gestational age. In the fully adjusted models, those born extremely preterm had a 51% lower hazard (95% CI, 31%-83%) for criminal offending than those born full term (**Figure 2**, E, **Table XI**; available at www.jpeds.com). The P value for the linear trend between gestational age and criminal offending was less than .01 (**Table VII**).

Sensitivity Analyses

The inclusion of all of each mother's children born during the recruiting period (not only the first born during that period) and who were alive at 10 years of age (n = 227 323) had no effect on the interpretations (data not shown).

Discussion

In this population-based register-linkage cohort study of 191 705 individuals, we found that the lower the gestational age is at birth, the lower is the risk for teenage pregnancies and STCTs in adolescence and young adulthood, respectively. Preterm birth was, however, unrelated to the rates of

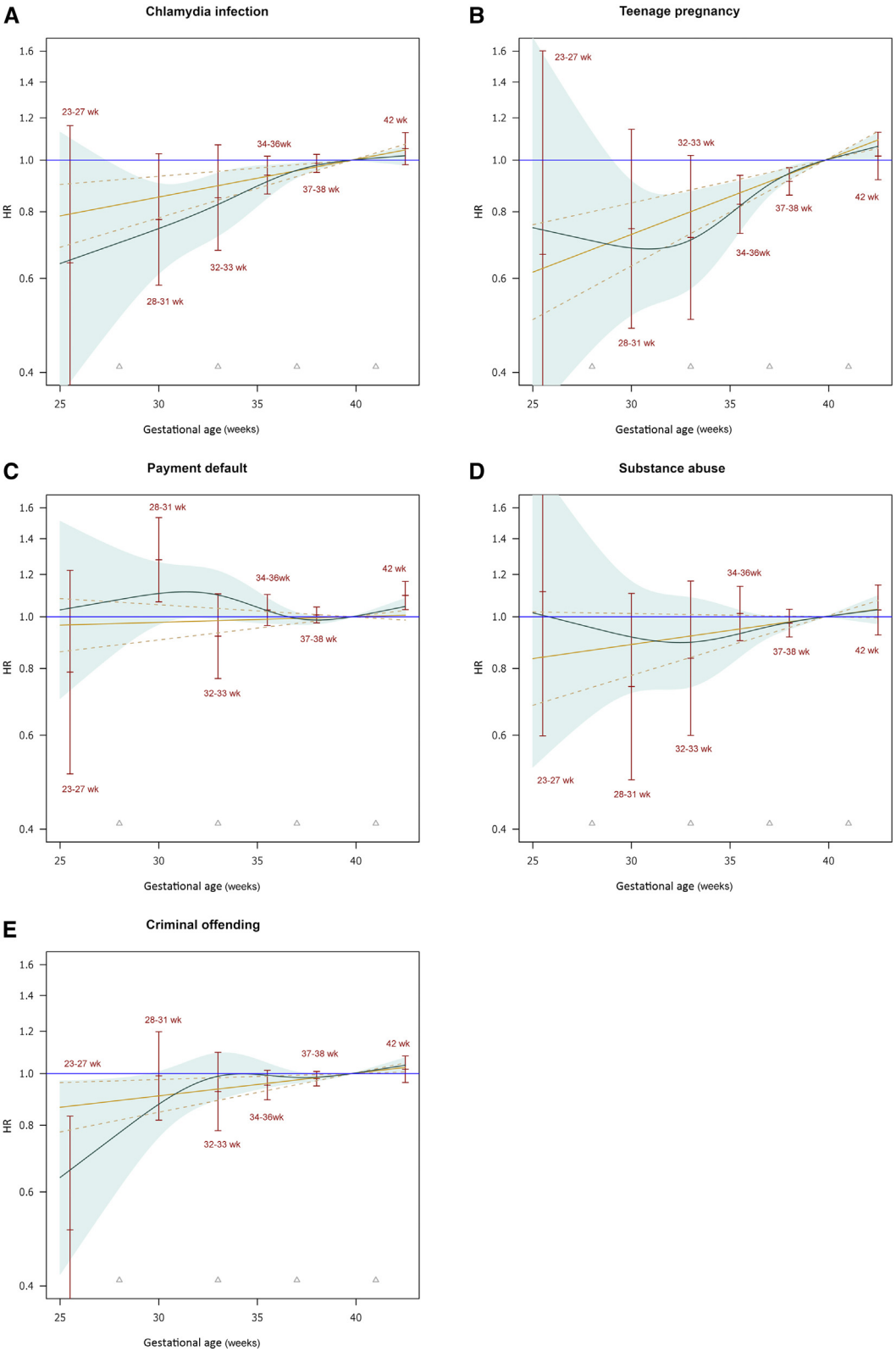

Figure 2. Estimated HR for the 5 proxies for risk-taking behavior by gestational age (gestational age), corresponding to the categorical model and continuous linear and spline models. **A,** STCTs. **B,** Teenage pregnancies. **C,** Payment defaults. **D,** Substance abuse. **E,** Criminal offending. The vertical bars (*in red*) correspond with the HR and its 95% CI by gestational age category with gestational age of 39-41 completed weeks being the reference (HR, 1.0) (bars drawn at category midpoints). The *continuous orange curve* corresponds with the linear regression fit between gestational age and log HR for the outcome (95% CIs as *orange broken lines*). The *green curve* shows the corresponding restricted cubic spline regression fit based on 4 knots (95%

substance abuse. Furthermore, those born preterm had similar relative frequencies of criminal offending as their full-term born peers, except those born extremely preterm (23-27 full gestational weeks) who had a lower risk for criminal offending. Payment defaults were more common among those born very preterm (28-31 weeks of gestation). These associations were not confounded by family SEP, pregnancy-related factors such as maternal pregnancy disorders and smoking in pregnancy, or by severe medical conditions, including neurosensory impairments and other medical disabilities.

The main strength of our study is that it uses a whole population cohort, being large enough to analyze a range of gestational age categories. The study combines, by means of unique personal identity codes, information from 11 population-wide, individual-level administrative registers with only marginal loss to follow-up. The study improves the knowledge on the range of long-term impacts of prematurity; several of our study outcomes are novel and have not been assessed before in this context.

There are also limitations. We had no data on whether the estimation of the gestational age of the child was based on fetal ultrasonography or on last maternal menstrual period. The last maternal menstrual period method tend to overestimate the gestational age, and because fetal ultrasound examination was only being introduced in clinical practice in Finland in 1987 through 1990, the distribution of the gestational ages may have moved toward a slight overestimation of gestational age and decreased rates of preterm birth, with a negligible effect on our estimation.[37] Further, information on deaths and emigrations were only accessible until April 2012. The aggregate data provided by Statistics Finland, however, indicate a mortality rate of only 65 per 100 000 and emigration rate of 806 per 100 000 among Finns aged 25-34 years in 2019.[38-40] The availability of the information on the payment defaults and criminal offending were affected by the abolition terms of the registers, as described in the **Appendix**. Register data on hospital-treated miscarriages were not included. The bias caused by these issues is moderate, leading to slight underestimations of the rates of outcome events, slight inaccuracy or inexactness in defining the study cohort, and to delay of capturing a study subject's first record (payment defaults, criminal offending, and pregnancies). Finally, prenatal corticosteroid treatment, although beneficial, can also potentially harm the brain development of the fetus and may be associated with mental and behavioral disorders of the child.[41-44] This common strategy treatment was not established as a routine in Finland in the late 1980s.[45]

Our results indicating fewer STCTs and teenage pregnancies among preterm adolescents and young adults are in line with those of Swamy et al and with a recent meta-analysis summarizing the contemporary knowledge on the effect of preterm birth on social relationships in adulthood, including sexual partnership and parenthood.[46,47] The results of these 2 studies indicate that, in particular, those born extremely or very preterm have been less likely experienced romantic relationships, sexual intercourse, or parenthood. Although these results do not reflect exactly the same phenomenon as ours, the lower rates of teenage pregnancies and STCTs in our study could be explained by less engagement in sexual behavior. However, these results could also be explained by other factors, such as more frequent contraceptive use.[48] To our best knowledge, no prior studies on preterm birth and STCTs, or personal payment default records exists. Basten et al showed that, at 42 years of age, adults born preterm more often reported personal financial difficulties compared with their term-born peers.[49] They, however, interpret the study findings more as a result of a weaker cognitive capacity, resulting in poorer education and wealth in adulthood, and less as an expression of a certain behavioral trait.

Our results indicate that very preterm born individuals have a higher risk for payment defaults. This finding may be due to more periods of unemployment, more receipt of social benefits, lower academic qualifications, poorer self-control, and weaknesses in certain cognitive tasks, such as judgements of risks.[50] In comparison with those born very preterm, those born extremely preterm may more unlikely be in situation to take up credit or commit an offence, and consequently be at a lower risk of payment default(s) and record(s) of criminal offending.

Risk-taking behavior has been assessed primarily by questionnaires measuring proxies of risk taking or sensation seeking, including smoking, alcohol and illicit drug use, and violation of the law. The study results indicate lesser or similar level of risk-taking behavior among those born preterm.[14,16,17,20-23] Few studies based on register data only on preterm birth and risk-taking behaviors exist; a Norwegian study assessing drug felony, violence, criminal damage, and overall criminality across separate levels of gestational age found no differences between gestational age categories.[15] Two nationwide Swedish register studies indicate that individuals born preterm appear to be at slightly higher risk for addictive disorder(s).[51,52] This association was, however, attenuated when comorbidity with other psychiatric disorders was taken into account.[51] Two other Swedish register studies reported no association between preterm birth (without being small for gestational age) and substance-related disorders or drug dependence, and one of these studies showed increased rates for drug dependence for those born preterm and small for gestational age.[19,53] A further Swedish study indicated decreased risk for problematic

CIs in *green shading*, knot locations indicated as *triangles*). For continuous models HR is calculated with respect to hazard at the mean value of gestational age (39.8 weeks). The figures show the final models adjusted for all confounding factors (models 4 or 5 are available in the **Appendix**, in **Table VI**, and **Tables VIII-XI**). Logarithmic scale.

substance use and criminality among individuals born extremely preterm.[18] A Danish study of 8000 individuals, supplemented with register data, suggested an increase in the risk of developing alcoholism in preterm born males, but not among females.[54] We found no interaction between the effects of sex and preterm birth on substance abuse. Generally, studies on the association between gestational age and substance abuse based on questionnaires or interviews indicate lower rates of such behavior among those born preterm than among those born at term. Register-based studies employing inpatient and outpatient diagnosis data from health care registers do not capture substance abuse that does not need medical attention and therefore is likely to comprise more severe cases. This may in part explain the differences in the direction of estimates between the studies of different design.

The relationship between preterm birth and in general lower or similar likelihood of engaging in risk-taking behavior is not straightforward and is not wholly explained by this study. Reasons for differences between gestational age categories in the rates of such behavior that may be considered as risky remain unclear. It has been hypothesized that variation in behavior could be related to personality traits typical to preterm born individuals, qualitative differences in social interaction, a slower transition to young adulthood, parental behavior or even, especially among those born most preterm, to social isolation and lack of social and intellectual resilience, and fewer friends, as well as to increased bullying victimization, which have been found to be related to less financial planning previously.[6,8,55-64] In addition, other factors/mechanisms, such as not living independently, could contribute to this association.[65,66] These factors could not be assessed within this register-based study.

Our findings on lower rates of chlamydia infections and teenage pregnancies with decreasing gestational age and lower rates of criminal behavior among those born extremely preterm suggest that the lower risk taking extends to sexual and to some extent criminal behaviors in adolescents and young adults born preterm (or early term). Higher rates of payment defaults were contrary to this hypothesis, but limited to those born very preterm. These novel findings provide knowledge on the range of the long-term impacts of prematurity, highlighting once again that preterm birth is not a pediatric condition only. They also expand the understanding of the preterm-born individual in the context of a life course approach and may also contribute to self-awareness among those born preterm. ■

Acknowledgment information is available at www.jpeds.com.

Submitted for publication May 3, 2022; last revision received Aug 24, 2022; accepted Sep 22, 2022.

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Acknowledgments

The authors thank perinatologist Anneli Pouta, PhD (Finnish Institute for Health and Welfare, Helsinki, Finland), for her valuable contribution, including participation in the administrative process, at the initial stage of the project. The authors also thank psychologist Marius Lahti-Pulkkinen, PhD (Department of Psychology and Logopedics, University of Helsinki, Helsinki, Finland; University BHF Center for Cardiovascular Sciences, Queen's Medical Research Institute, University of Edinburgh, Edinburgh, UK; and Finnish Institute for Health and Welfare, Helsinki, Finland), and psychologist Sara Sammallahti, MD, PhD (Department of Psychology and Logopedics, University of Helsinki, Helsinki, Finland; Children's Hospital, Helsinki University Hospital and University of Helsinki, Helsinki, Finland; Finnish Institute for Health and Welfare, Helsinki, Finland), for their significant assistance while preparing the covariates that reflect substance abuse.

Table I. Diagnosis codes included to the variable referred to as substance abuse

Diagnoses	ICD-10 codes*	ICD-9 codes†	ICD-8 codes‡
Mental and behavioral disorders owing to use of:			
Alcohol–acute intoxication	F10.0§	3050A	980.00-01
Alcohol–other	F10.1-9	2910A, 2911A, 2913A, 2918A, 3039X	291.00-99, 303.00-99
Opioids	F11	2920A, 2921B, 2928B, 2928D, 2928X, 3040A, 3055A	304.00-10, 965.00
Cannabinoids	F12	2920A, 2921B, 2928B, 2928D, 2928X, 3043A, 3052A	304.50
Sedatives or hypnotics	F13	2920A, 2921B, 2928B, 2928D, 2928X, 3041A, 3054A	304.20-30
Cocaine	F14	2920A, 2921B, 2928B, 2928D, 2928X, 3056A	304.40
Other stimulants	F15	2920A, 2921B, 2928B, 2928D, 2928X, 3049X, 3059X	304.60, 970.00
Hallucinogens	F16	2920A, 2921B, 2928D, 2928X, 3045A, 3053A	304.70
Tobacco	F17	2920A, 3051A	..
Volatile solvents	F18	2920A, 2921B, 2928B, 2928X, 3046A, 3059X	..
Multiple drugs and other psychoactive substances	F19	2920A, 2921B, 2928B, 2928X, 3049X, 3059X	304.88-99
Alcoholic polyneuropathy	G62.1	3575A	..
Alcoholic cardiomyopathy	I42.6	4255A	..
Alcoholic gastritis	K29.2	5353A	..
Alcoholic liver disease	K70	5710A, 5711A, 5712A, 5713X	571.00-01
Poisoning by narcotics and hallucinogens	T40	9650B, 9650E, 9650X, 9696A, 9697X, 9698X	965.00, 967.00-99, 971.00-09
Poisoning by other and unspecified drugs, medicaments, and biological substances	T50.9	9779X	970.10, 970.90, 970.98-99
Toxic effect of alcohol, including alcohols other than ethyl-alcohol	T51	9800A, 9801A, 9802A, 9808X, 9809X	979.00-979.40, 980.00-99
Toxic effect of tobacco and nicotine	T65.2	..	..

Note that the variable on the substance abuse of the study subjects include ICD-10, codes only, and the variable on parental substance abuse before the birth of the study subject includes ICD-9 and ICD-8 codes only.
ICD-10, *International Classification of Diseases*, 10th edition.
*ICD-10; 1996 onward.
†ICD-9; 1987-1995.
‡ICD-8; 1969-1986.
§Included to the variables only when it appears in Care Register for Health Care as a main diagnosis.

Table II. Diagnosis codes included in the variable on severe medical condition following Moster et al[17]

Medical disabilities*	ICD-10
Cerebral palsy	G80-83
Mental retardation	F70-F79
Schizophrenia	F20-21
Autism spectrum	F84
Disorders of psychological development, behavior, and emotion	F80-83, F88-F98
Other major disabilities*	ICD-10
Epilepsy	G40-41
Blindness, low vision	H54
Hearing loss	H90-91

*The nationwide data on medical disabilities and the other major disabilities are derived from the register on disability allowance maintained by the Social Insurance Institution. A study subject was considered to have medical condition and/or other major disability if any of the diagnosis codes presented appeared in the register on disability allowance at age of 16 or older on December 31, 2015.

Table IV. Univariate association (HR and 95% CI) between individual covariates for each of the 5 outcomes

	STCT	Teenage pregnancy	Payment default	Substance abuse	Criminal offending
Independent effect of covariates	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**
Sex (female vs male)	2.08 (2.02-2.14)	na	0.71 (0.70-0.73)	0.74 (0.71-0.76)	0.34 (0.33-0.35)
BWSD-score	0.97 (0.96-0.98)	0.93 (0.91-0.95)	0.92 (0.90-0.93)	0.92 (0.90-0.94)	0.99 (0.98-1.00)$^{P = .02}$
Severe medical condition*	0.25 (0.25-0.36)	0.52 (0.34-0.80)$^{P = .03}$	1.33 (1.15-1.54)	1.72 (1.38-2.14)	0.71 (0.59-0.84)
Maternal smoking in pregnancy (nonsmoker vs smoker or unknown smoking status)†					
Smoker	1.61 (1.55-1.67)	2.35 (2.24-2.46)	2.67 (2.60-2.75)	2.26 (2.15-2.37)	1.62 (1.57-1.66)
Unknown smoking status	0.96 (0.86-1.07)$^{P = .46}$	1.30 (1.12-1.51)	1.22 (1.11-1.33)	1.13 (0.96-1.34)$^{P = .14}$	1.05 (0.97-1.15)$^{P = .19}$
Gestational disorder‡	0.82 (0.78-0.86)	0.90 (0.84-0.97)$^{P = .01}$	0.93 (0.89-0.97)	0.93 (0.86-1.00)$^{P = .05}$	0.92 (0.88-0.95)
Maternal age, per year§	0.966 (0.963-0.978)	0.933 (0.929-0.937)	0.929 (0.926-0.931)	0.954 (0.950-0.958)	0.964 (0.961-0.966)
Maternal age (20-34 yr vs less than 20 yr or more than 34 yr)					
<20	1.63 (1.57-1.79)	2.89 (2.68-3.12)	3.10 (2.96-3.25)	2.23 (2.03-2.42)	1.96 (1.87-2.06)
>34	0.76 (0.73-0.80)	0.73 (0.68-0.73)	0.73 (0.70-0.76)	0.81 (0.75-0.87)	0.86 (0.83-0.89)
Maternal marital status¶ (married vs unmarried or unknown marital status)					
Unmarried	1.46 (1.42-1.51)	1.85 (1.77-1.94)	2.17 (2.11-2.23)	1.91 (1.83-2.01)	1.49 (1.45-1.53)
Unknown	1.06 (0.87-1.30)$^{P = .58}$	1.46 (1.11-1.93)$^{P = .01}$	1.54 (1.31-1.81)	1.29 (0.96-1.75)$^{P = .09}$	1.10 (0.94-1.30)$^{P = .23}$
Paternal age, per year‡	0.972 (0.970-0.975)	0.953 (0.949-0.957)	0.955 (0.953-0.958)	0.970 (0.967-0.974)	0.978 (0.976-0.980)
Paternal age (20-34 yr vs less than 20 yr or more than 34 yr or unknown)					
<20	1.82 (1.61-2.06)	3.19 (2.77-3.67)	3.09 (2.83-3.38)	2.22 (1.87-2.64)	1.98 (1.79-2.19)
>34	0.79 (0.76 - 0.82)	0.75 (0.71-0.79)	0.79 (0.76-0.81)	0.85 (0.80-0.89)	0.89 (0.87-0.92)
Unknown paternal age	1.30 (1.16 - 1.45)	1.81 (1.57-2.09)	2.34 (2.16-2.53)	1.92 (1.66-2.22)	1.44 (1.32-1.57)
Parental SEP** (lower white collar vs higher white collar or blue collar or other or unknown)					
Higher white collar	0.77 (0.74-0.79)	0.56 (0.53-0.59)	0.50 (0.48-0.51)	0.68 (0.64-0.71)	0.71 (0.69-0.73)
Blue collar	1.05 (1.01-1.10)$^{P = .02}$	1.42 (1.35-1.51)	1.48 (1.43-1.53)	1.28 (1.20-1.36)	1.21 (1.17-1.25)
Other	0.78 (0.72-0.85)	0.99 (0.89-1.10)$^{P = .83}$	1.05 (0.99-1.12)$^{P = .14}$	1.02 (0.91-1.14)$^{P = .75}$	1.23 (1.16-1.30)
Unknown	0.57 (0.27-1.19)$^{P = .13}$	0.87 (0.36-2.08)$^{P = .75}$	1.20 (0.76-1.91)$^{P = .72}$	2.27 (1.26-4.10)$^{P = .01}$	1.09 (0.69-1.73)$^{P = .72}$
Parental register records on the outcome	na	na	1.66 (1.61-1.71)††	2.52 (2.31-2.76)‡‡	2.00 (1.94-2.05)§§

All P values are ≤.001 if not otherwise noted.

BWSD, birth weight SD; *na*, not applicable.

*Received disability allowance at ≥16 years of age owing to a severe medical condition.

†Maternal smoking in index pregnancy.

‡Gestational disorder includes gestational diabetes, gestational hypertensive disorder, and intrahepatic cholestasis of pregnancy.

§Age at the birth of the study subject.

¶Marital status at the birth of the study subject.

**Other includes entrepreneurs, farmers, students, pensioners, unemployed, housewives and mothers and fathers with unclassifiable or unknown SEP.

††Either parent has a register record on payment default(s) available from the Register on credit defaults (through August 30, 2018).

‡‡Either parent has an in-hospital care episode owing to substance abuse before the birth of the study subject. Data are available since 1969; parents who died or migrated are not censored, and those who received a diagnosis only before 1969 are not accounted for.

§§Either parent has a register record on criminal offending available from the Register of crimes (through February 3, 2020) and/or from the Register on fines and punishments (through December 10, 2019). Minor infractions such as fines issued for mild speeding are excluded.

Table VI. The number of study subjects alive at 10 years of age with STCT and HR with 95% CI for STCT by gestational age (completed weeks) category

	Extremely preterm	Very preterm	Moderately preterm	Late preterm	Early term	Full term	Postterm	Total cohort
	23-27 weeks	28-31 weeks	32-33 weeks	34-36 weeks	37-38 weeks	39-41 weeks	42-42 weeks	23-42 weeks
Gestational age categories, n	194	679	912	6707	33 257	141 846	8110	191 705
STCT, n (%)	11 (5.7)	48 (7.1)	75 (8.2)	611 (9.1)	3164 (9.5)	14 070 (9.9)	853 (10.5)	18 832 (9.8)
Model	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	..	HR (95% CI)*	..
0	0.55 (0.30-0.99) $P = .05$	0.71 (0.53-0.94)	0.83 (0.66-1.04) $P = .10$	0.92 (0.84-0.99)	0.96 (0.92-1.00)	ref	1.08 (1.01-1.16)	..
1	0.57 (0.32-1.03) $P = .06$	0.75 (0.56-0.99) $P = .05$	0.86 (0.68-1.08) $P = .18$	0.94 (0.87-1.02) $P = .14$	0.97 (0.94-1.01) $P = .17$	ref	1.09 (1.01-1.16)	..
2	0.57 (0.32-1.03) $P = .06$	0.74 (0.56-0.98)	0.84 (0.67-1.06) $P = .14$	0.93 (0.86-1.01) $P = .09$	0.97 (0.93-1.01) $P = .13$	ref	1.09 (1.01-1.16)	..
3	0.58 (0.32-1.04) $P = .07$	0.73 (0.55-0.97)	0.84 (0.67-1.06) $P = .13$	0.93 (0.86-1.01) $P = .10$	0.99 (0.95-1.03) $P = .46$	ref	1.05 (0.98-1.12) $P = .18$	..
4	0.64 (0.36-1.16) $P = .14$	0.77 (0.58-1.03) $P = .08$	0.85 (0.68-1.07) $P = .16$	0.94 (0.86-1.02) $P = .12$	0.99 (0.95-1.03) $P = .47$	ref	1.05 (0.98-1.13) $P = .17$	..

Model 0: Unadjusted model.
Model 1: Stratified by the sex of the study subject.
Model 2: Model 1 + parental highest attained SEP.
Model 3: Model 2 + parental ages, maternal smoking in pregnancy, maternal marital status at the birth of the study subject, maternal gestational disorder, birth weight SD score of the study subject.
Model 4: Model 3 + severe medical condition.
*All *P* values are < .05 if not otherwise noted.

Table VII. Summary of the different (the employed and additional) models to test the trend between the gestational age and each of the 5 outcomes*

			Outcome					
			STCT	Teenage pregnancy	Payment default	Substance abuse	Criminal offending	(Criminal offending)†
Observations, n			191 705	93 539	191 427	191 705	191 589	(183 290)
Events, n			18 832	8574	23 467	7822	28 441	(27 183)
Model comparison								
P value(s)‡ for linear and nonlinear effects								
	Df1§	Df2¶	*P* value	*P* value	*P* value	*P* value	*P* value	*P* value
Linear** vs without_gestational age††	17	18	0.0004	0.0000	0.5358	0.0773	0.0072	(0.0568)
Spline‡‡ vs without_gestational age	17	20	0.0015	0.0000	0.0540	0.3218	0.0168	(0.2082)
Spline vs linear	18	20	0.2107	0.4164	0.0265	0.8307	0.2242	(0.6321)
Slope(s) in model linear§§	..	..	Exp (95% CI)	Exp (95% CI)	Exp (95% CI)	Exp (95% CI)	Exp (95% CI)	Exp (95% CI)
			1.016 (1.007-1.026)	1.033 (1.019-1.048)	1.003 (0.995-1.010)	1.012 (0.999-1.026)	1.010 (1.003-1.017)	1.008 (1.000-1.016)

*Gestational age in considered as a continuous variable and measured in days. Each model is stratified by sex and adjusted for all confounding factors (Model 4 in online **Tables VI**, **VIII**, **IX**, **X**, and **XI**).
†Last column corresponds with variable criminal offending with gestational age restricted to the interval 28 to 41 completed weeks only.
‡*P* values correspond with likelihood ratio tests with Df2-Df1 degrees of freedom for the significance of the additional Df2-Df1 terms in the larger model compared to the smaller model. In each model comparison, smaller model is always nested within the larger model.
§Df1 is the number of parameters in smaller of the compared models.
¶Df2 is the number of parameters in larger of the compared models.
**Linear-linear model with gestational age as a continuous variable.
††Without_gestational age; HR independent of gestational age.
‡‡Spline-restricted cubic spline model (illustrated in **Figure 2**, A-E). Knots set at gestational age values of 28, 33, 37, and 41 weeks.
§§Estimated slope for the linear model corresponds to the linear model for the logarithm of the HR (model linear). Exp (slope) therefore corresponds to the relative increase in the hazard rate as gestational age increases by one week. In addition to Exp (slope) the 95% CI are shown.

Table VIII. The number of female study subjects alive at 10 years age who experienced teenage pregnancy and HR with 95% CI for teenage pregnancy by gestational age (gestational age, completed weeks) category

	Extremely preterm	Very preterm	Moderately preterm	Late preterm	Early term	Full term	Postterm	Total cohort
	23-27 weeks	28-31 weeks	32-33 weeks	34-36 weeks	37-38 weeks	39-41 weeks	42-42 weeks	23-42 weeks
Gestational age categories, n	**85**	**282**	**405**	**3064**	**15 669**	**70 107**	**3927**	**93 539**
Teenage pregnancy, n (%)	5 (5.9)	21 (7.4)	31 (7.7)	257 (8.4)	1356 (8.7)	6514 (9.3)	390 (9.9)	8574 (9.2)
Model	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	..	HR (95% CI)*	..
0	0.61 (0.25-1.47) $^{P = .27}$	0.80 (0.52-1.22) $^{P = .30}$	0.82 (0.57-1.16) $^{P = .26}$	0.90 (0.79-1.02) $^{P = .09}$	0.93 (0.88-0.99) $^{P = .01}$	ref	1.07 (0.97-1.19) $^{P = .18}$	..
1	na	na	na	na	na	ref	na	..
2	0.62 (0.26-1.49) $^{P = .29}$	0.75 (0.49-1.15) $^{P = .19}$	0.78 (0.55-1.11) $^{P = .16}$	0.87 (0.77-0.98)	0.91 (0.86-0.97)	ref	1.07 (0.96-1.18) $^{P = .21}$	..
3	0.62 (0.26-1.49) $^{P = .28}$	0.72 (0.47-1.11) $^{P = .13}$	0.71 (0.50-1.01) $^{P = .06}$	0.82 (0.73-0.93)	0.91 (0.86-0.97)	ref	1.02 (0.92-1.13) $^{P = .74}$	..
4	0.67 (0.28-1.60) $^{P = .37}$	0.74 (0.48-1.14) $^{P = .18}$	0.72 (0.50-1.02) $^{P = .07}$	0.83 (0.73-0.94)	0.91 (0.86-0.97)	ref	1.02 (0.92-1.13) $^{P = .74}$	..

na, not applicable.
Model 0: Unadjusted model.
Model 1: Stratified by the sex of the study subject.
Model 2: Model 1 + parental highest attained SEP.
Model 3: Model 2 + parental ages, maternal smoking in pregnancy, maternal marital status at the birth of the study subject, maternal gestational disorder, birth weight SD score of the study subject.
Model 4: Model 3 + severe medical condition.
*All *P* values are < .05 if not otherwise noted.

Table IX. The number of study subject alive at 18 years of age with register record on payment default(s) and HR with 95% CI for payment default by gestational age (completed weeks) category

	Extremely preterm	Very preterm	Moderately preterm	Late preterm	Early term	Full term	Postterm	Total cohort
	23-27 weeks	28-31 weeks	32-33 weeks	34-36 weeks	37-38 weeks	39-41 weeks	42-42 weeks	23-42 weeks
Gestational age categories, n	**194**	**677**	**908**	**6697**	**33 198**	**141 657**	**8096**	**191 427**
Payment default, n (%)	20 (10.3)	118 (17.4)	116 (12.8)	908 (13.6)	4131 (12.4)	17 071 (12.1)	1103 (13.6)	23 467 (12.3)
Model	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	..	HR (95% CI)*	..
0	0.85 (0.55-1.32) $^{P = .47}$	1.50 (1.25-1.79)	1.07 (0.89-1.28) $^{P = .49}$	1.14 (1.06-1.22)	1.04 (1.00-1.07) $^{P = .05}$	ref	1.16 (1.09-1.23)	..
1	0.84 (0.54-1.30) $^{P = .42}$	1.46 (1.22-1.75)	1.05 (0.87-1.26) $^{P = .62}$	1.12 (1.05-1.20)	1.03 (0.99-1.06) $^{P = .12}$	ref	1.15 (1.09-1.23)	..
2	0.82 (0.53-1.27) $^{P = .38}$	1.40 (1.17-1.67)	0.99 (0.82-1.19) $^{P = .91}$	1.08 (1.01-1.16)	1.01 (0.98-1.05) $^{P = .49}$	ref	1.16 (1.09-1.24)	..
3	0.80 (0.51-1.23) $^{P = .31}$	1.29 (1.07-1.54)	0.92 (0.77-1.11) $^{P = .37}$	1.03 (0.96-1.10) $^{P = .38}$	1.01 (0.97-1.04) $^{P = .65}$	ref	1.10 (1.03-1.17)	..
4	0.79 (0.51-1.22) $^{P = .29}$	1.28 (1.07-1.53)	0.92 (0.77-1.10) $^{P = .37}$	1.03 (0.96-1.10) $^{P = .39}$	1.01 (0.97-1.04) $^{P = .65}$	ref	1.10 (1.03-1.17)	..
5	0.79 (0.51-1.22) $^{P = .29}$	1.28 (1.07-1.54)	0.90 (0.75-1.08) $^{P = .25}$	1.00 (0.93-1.07) $^{P = .93}$	1.00 (0.96-1.03) $^{P = .81}$	ref	1.09 (1.02-1.16)	..

Model 0: Unadjusted model.
Model 1: Stratified by the sex of the study subject.
Model 2: Model 1 + parental highest attained SEP.
Model 3: Model 2 + parental ages, maternal smoking in pregnancy, maternal marital status at the birth of the study subject, maternal gestational disorder, birth weight SD score of the study subject.
Model 4: Model 3 + severe medical condition.
Model 5: Model 4 + parental payment defaults.
*All *P* values are < .05 if not otherwise noted.

Table X. The number of study subject alive at 10 years of age with register record on substance abuse, and HR with 95% CI for substance abuse by gestational age (completed weeks) category

	Extremely preterm	Very preterm	Moderately preterm	Late preterm	Early term	Full term	Postterm	Total cohort
	23-27 weeks	28-31 weeks	32-33 weeks	34-36 weeks	37-38 weeks	39-41 weeks	42-42 weeks	23-42 weeks
Gestational age categories, n	194	679	912	6707	33 257	141 846	8110	191 705
Substance abuse, n (%)	10 (5.2)	24 (3.5)	35 (3.8)	298 (4.4)	1344 (4.0)	5768 (4.1)	352 (4.3)	7831 (4.1)
Model	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	..	HR (95% CI)*	..
0	1.27 (0.68-2.36) $P = .45$	0.87 (0.58-1.30) $P = .50$	0.94 (0.68-1.32) $P = .73$	1.10 (0.98-1.23) $P = .11$	0.99 (0.94-1.05) $P = .79$	ref	1.08 (0.97-1.20) $P = .16$	..
1	1.25 (0.67-2.32) $P = .49$	0.85 (0.57-1.27) $P = .43$	0.93 (0.67-1.30) $P = .67$	1.09 (0.97-1.22) $P = .16$	0.99 (0.93-1.05) $P = .63$	ref	1.08 (0.97-1.20) $P = .18$	..
2	1.22 (0.66-2.28) $P = .53$	0.83 (0.56-1.24) $P = .36$	0.90 (0.65-1.26) $P = .54$	1.06 (0.94-1.19) $P = .32$	0.98 (0.92-1.04) $P = .43$	ref	1.08 (0.97-1.20) $P = .16$	..
3	1.19 (0.64-2.22) $P = .58$	0.77 (0.51-1.15) $P = .20$	0.84 (0.60-1.18) $P = .31$	1.02 (0.91-1.14) $P = .77$	0.97 (0.92-1.03) $P = .38$	ref	1.03 (0.93-1.15) $P = .58$	..
4	1.12 (0.60-2.08) $P = .73$	0.74 (0.50-1.11) $P = .14$	0.84 (0.60-1.17) $P = .29$	1.01 (0.90-1.14) $P = .81$	0.97 (0.92-1.03) $P = .37$	ref	1.03 (0.92-1.15) $P = .60$	..
5	1.05 (0.57-1.96) $P = .87$	0.73 (0.49-1.08) $P = .12$	0.83 (0.59-1.16) $P = .27$	1.01 (0.90-1.14) $P = .83$	0.97 (0.91-1.03) $P = .31$	ref	1.03 (0.93-1.15) $P = .58$	..

Model 0: Unadjusted model.
Model 1: Stratified by the sex of the study subject.
Model 2: Model 1 + parental highest attained SEP.
Model 3: Model 2 + parental ages, maternal smoking in pregnancy, maternal marital status at the birth of the study subject, maternal gestational disorder, birth weight SD score of the study subject.
Model 4: Model 3 + severe medical condition.
Model 5: Model 4 + parental substance abuse.
*All *P* values are < .05 if not otherwise noted.

Table XI. The number of study subject alive at 15 years of age with register record on criminal offending and HR with 95% CI for criminal offending by gestational age (completed weeks) category

	Extremely preterm	Very preterm	Moderately preterm	Late preterm	Early term	Full term	Postterm	Total cohort
	23-27 weeks	28-31 weeks	32-33 weeks	34-36 weeks	37-38 weeks	39-41 weeks	42-42 weeks	23-42 weeks
Gestational age categories, n	194	677	909	6703	33 232	141 769	8105	191 589
Criminal offending, n (%)	16 (8.2)	107 (15.8)	136 (15.0)	1000 (14.9)	4928 (14.8)	21 012 (14.8)	1242 (15.3)	28 441 (14.8)
Model	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	HR (95% CI)*	..	HR (95% CI)*	..
0	0.54 (0.33-0.87)	1.08 (0.90-1.31) $P = .40$	1.01 (0.85-1.19) $P = .92$	1.01 (0.95-1.08) $P = .68$	1.00 (0.97-1.03) $P = .92$	ref	1.05 (0.99-1.11) $P = .08$	..
1	0.50 (0.31-0.82)	1.00 (0.83-1.21) $P = .97$	0.96 (0.81-1.13) $P = .62$	0.98 (0.92-1.04) $P = .47$	0.98 (0.95-1.01) $P = .18$	ref	1.04 (0.99-1.11) $P = .15$	..
2	0.49 (0.30-0.80)	0.98 (0.81-1.18) $P = .82$	0.93 (0.79-1.10) $P = .40$	0.96 (0.90-1.02) $P = .16$	0.97 (0.94-1.00) $P = .07$	ref	1.05 (0.99-1.11) $P = .09$	..
3	0.48 (0.29-0.78)	0.95 (0.79-1.15) $P = .62$	0.92 (0.78-1.09) $P = .34$	0.95 (0.89-1.01) $P = .11$	0.98 (0.95-1.01) $P = .16$	ref	1.02 (0.96-1.08) $P = .56$	..
4	0.51 (0.31-0.83)	0.99 (0.82-1.20) $P = .92$	0.93 (0.78-1.10) $P = .37$	0.95 (0.89-1.01) $P = .13$	0.98 (0.95-1.01) $P = .17$	ref	1.02 (0.96-1.08) $P = .53$	..
5	0.51 (0.31-0.84)	0.97 (0.80-1.17) $P = .75$	0.92 (0.78-1.09) $P = .34$	0.95 (0.89-1.01) $P = .08$	0.98 (0.95-1.01) $P = .14$	ref	1.02 (0.96-1.08) $P = .56$	..

Model 0: Unadjusted model.
Model 1: Stratified by the sex of the study subject.
Model 2: Model 1 + parental highest attained SEP.
Model 3: Model 2 + parental ages, maternal smoking in pregnancy, maternal marital status at the birth of the study subject, maternal gestational disorder, birth weight SD score of the study subject.
Model 4: Model 3 + severe medical condition.
Model 5: Model 4 + parental criminal offending.
*All *P* values are < .05 if not otherwise noted.