Effect of covering perinatal health-care costs on neonatal outcomes in Switzerland: a quasi-experimental population-based study

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Summary

Background **Low birthweight and preterm birth are associated with an increased risk of neonatal death and chronic conditions across the life course. Reducing these adverse birth outcomes is a global public health priority and requires strategies to improve health care during pregnancy. We aimed to assess the effect of a Swiss health policy expansion fully covering illness-related costs during pregnancy on health outcomes in newborn babies.**

Methods **We implemented a quasi-experimental difference in regression discontinuity design to assess the effect of expansion of Swiss health insurance (on March 1, 2014), to fully cover health-care costs during pregnancy and 8 weeks postpartum, on neonatal outcomes. Before this reform, only costs specific to the standard monitoring of a normal pregnancy were covered. Babies born before March 1, 2014, and their mothers were assigned to the unexposed group, and babies born on or after March 1, 2014, and their mothers were assigned to the exposed group. We included nearly all children born 2011–19 in Switzerland within a period of 9 months around the date March 1, 2014, and control years 2012, 2016, and 2018. Outcomes were birthweight, low birthweight, very low birthweight, gestational age, preterm or extremely preterm birth, and neonatal death. We estimated the intention-to-treat effect of the policy using parametric regression models.**

Findings **61 910 children were born 9 months before and 63 991 were born 9 months after March 1, 2014. 382 861 children were born in the same time period around the three control dates. In the period before policy implementation, mean birthweight was 3289 g, gestational age was 275 days, and 6·5% of children had low birthweight, 1·0% very low birthweight, 7·1% were preterm, 0·4% were extremely preterm, and 0·3% died within the first 28 days of life. After initiation of the policy (*vs* before) mean birthweight increased by 23 g (95% CI 5 to 40) and the predicted proportion of low birthweight births decreased by 0·81% (0·14 to 1·48) and of very low birthweight births decreased by 0·41% (0·17 to 0·65). The effect on very low birthweight was not robust in sensitivity analyses. The policy had a negligible effect on gestational age (mean difference 1 day, 95% CI 0 to 1) and no clear effects on the other examined outcomes. The change in predicted proportion for preterm births was –0·39% (95% CI –1·2 to 0·38), for extremely preterm births was –0·09% (–0·27 to 0·08), and for neonatal death was –0·07% (–0·2 to 0·07).**

Interpretation **Free access to prenatal care in Switzerland reduced the risk of some adverse health outcomes in newborn babies. Expanding health-care coverage is a relevant health system intervention to reduce the risk of adverse health outcomes in the newborn baby and, potentially, across the life course.**

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Introduction

Birthweight and gestational age are key indicators of health and care during pregnancy, as well as predictors of early-life and long-term morbidity and mortality.[1,2] Worldwide, one in seven babies is born with a low birthweight (<2500 g).[3] In Switzerland, in 2020, the prevalence of low birthweight was 5·9% and preterm birth (<37 weeks' gestation) was 6·4%, but these estimates were as high as 6·4% and 7·2%, respectively, in 2014.[4] Low birthweight and preterm birth put children at risk of death in the short term,[5] and maternal and neonatal conditions account for about 47% of total deaths under age 5 years in Switzerland.[6] Moreover, children born preterm or with a low birthweight have a higher risk of childhood hypertension and neurodevelopmental disorders, as well as adulthood cardiometabolic diseases and mortality,[2,7–9] and lower socioeconomic status.[10] Thus, parental health, behaviours, and care during pregnancy can influence the health and socioeconomic trajectory of offspring throughout life.[3]

Poor perinatal health indicators are linked to health system factors, such as health-care coverage and access to health services.[11] Cash transfers to women from low-income families during pregnancy or in the early postpartum period or to all women before conception have improved perinatal and long-term health outcomes in children.[12–16] Residents of Switzerland must have

Research in context

Evidence before this study

We searched MEDLINE from inception to April 11, 2022. The search strategy and eligibility criteria are presented in the appendix (pp 3–4). 12 studies from the USA were included. Studies targeted policy expansions for US citizens and permanent residents, in unauthorised or recent immigrants, or both. Specifically, seven studies evaluated policy expansions in US citizens and permanent residents that related to (1) the 2014 Medicaid Expansion under the Affordable Care Act (ACA), which expanded Medicaid eligibility to low-income people younger than 65 years, regardless of pregnancy status; (2) the 2010 dependent coverage provision of ACA, which allowed young adults to stay on their parents' health insurance until they were 26 years old; and (3) the 2006 Massachusetts reform, which expanded public health insurance to low-income people regardless of family structure. In three of these seven studies, reductions in the risk of preterm birth or low birthweight were reported. Four other studies evaluated policy expansions to cover prenatal care for immigrants through state-funded or federal-funded programmes, such as the 2002 Children's Health Insurance Program (CHIP) and the 2009 CHIP Reauthorization Act. One of these four studies reported a reduction in the risk of preterm birth. Lastly, one study targeted both a presumptive eligibility policy expansion for women with pending Medicaid eligibility and the CHIP unborn child option for immigrant women, but observed no effect on preterm birth.

See Online for appendix

Added value of this study

Beyond quasi-experimental studies done in the USA targeting vulnerable populations, there is no evidence of policy expansions to improve neonatal outcomes from other high-income countries. Our study evaluated a health policy expansion implemented in Switzerland that aimed to fully cover patient participation with health-care costs in the event of illness or complications related or not to the pregnancy from 13 weeks' gestation to 8 weeks postpartum. We examined the effect of this policy on birth outcomes and neonatal mortality, as well as whether variations in effect existed by demographic and socioeconomic characteristics of parents. Our results suggest that eligibility to the policy decreased the proportion of low birthweight births by 0·81% (95% CI 0·14 to 1·48) in the overall population. There was weak evidence that extremely preterm births decreased by 0·18% after initiation of the policy in children from mothers younger than 35 years, and neonatal deaths by 0·29% in children from mothers with a nationality from countries not belonging to the European Economic Area or the Organization for Economic Cooperation and Development. Finally, children with parents not at risk of poverty potentially had a lower proportion of extremely preterm births (0·19%) and neonatal deaths (0·13%) after initiation of the policy, and potentially benefited more from the policy expansion than children from parents with low income.

Implications of all the available evidence

Cross-context evidence suggests that expanding health-care coverage is a relevant health system intervention to reduce the risk of adverse health outcomes in the newborn baby and, potentially, across the life course. Our findings from Switzerland are in line with evidence from the USA, which reports modest improvements in low birthweight. However, variations exist in policy implementation across countries. Notably, whether health coverage should start before conception or once a pregnancy is documented should be assessed in future research. Also, to maximise policy expansion effects, additional strategies targeting the reorganisation of health services, health worker training, or information and education interventions in the community could be considered.

health insurance that is provided only by a private insurer and pay a financial contribution to medical treatments and consultations (deductibles and copayments).[17] Out-of-pocket spending is high, and Switzerland has the highest cost sharing in the Organization for Economic Cooperation and Development (OECD).[18,19]

In an effort to ensure equal treatment during pregnancy, on March 1, 2014, the Swiss Federal Council implemented a health policy expansion aimed at full coverage of health-care costs (including deductibles and copayments) in the event of illness or complications related or not to the pregnancy, or congenital infirmity, from 13 weeks' gestation to 8 weeks postpartum (article 64, paragraph 7, letter b of the Federal Health Insurance Law).[20] There were no policy exclusions based on immigration status, type of residency, or any other sociodemographic characteristics.

This policy expansion did not affect prenatal care specific to the monitoring of a normal pregnancy, which was already fully covered before March 1, 2014. However, the policy expansion might have improved perinatal outcomes through increased use of health-care services leading to better care. For example, implementation of this policy expansion might have led to timely intervention and thus better control of pregnancy-related complications, such as gestational diabetes or hypertension—some of the most common complications and risk factors for preterm birth and low birthweight.[1,21,22]

In a large observational study using administrative data on births between 2011 and 2017 in Switzerland, offspring of low-income (*vs* high-income) parents, of women aged 35 years and older (*vs* 20–34 years), or of mothers from countries outside the European Economic Area (EEA) and OECD (*vs* Switzerland) were at higher risk of adverse outcomes including low birthweight, preterm birth, and infant mortality.[23] Also, children of women from non-EEA-OECD countries (*vs* Switzerland) had a similar probability of dying within 1 year from birth in 2015–17 (after the policy implementation) compared with a higher probability in 2011–14 (before the policy implementation).[23] However, this study was not designed to estimate the effect of the 2014 health policy expansion on neonatal health outcomes. Therefore, we did a quasi-experimental study using a regression discontinuity design to assess whether full coverage of illness-related costs during pregnancy and for 8 weeks postpartum improves health outcomes in newborn babies in Switzerland.

Methods

Study design

Data were from administrative registries and gathered as part of the Swiss research programme on migration, National Centres of Competence in Research—on the Move.[24] We implemented a difference in regression discontinuity design (RDD) to assess the effect of eligibility to the expanded Swiss health policy on health outcomes of newborn babies.[25–27] An RDD is appropriate when assignment to a policy is based on a clear and arbitrary threshold—in our case a specific date of birth corresponding to the date of policy enactment.[28] This quasi-experimental technique mimics a randomised experiment near the chosen threshold, providing a robust alternative when policy assignment cannot be randomised and facilitating causal inference using observational data.[29] Since not all exposed mothers benefited from the expansion of insurance coverage—eg, those without illnesses or complications—our analyses provide intention-to-treat effect estimates.

We included data from children born between June 1, 2013, and Feb 28, 2014 (9 months), and between June 1, 2014, and Feb 28, 2015 (9 months), to be as close to the date of the policy enactment (March 1, 2014) as possible, while having a reasonable sample size and as many participants with full access to the intervention as possible. We censored births between March 1, 2014, and May 31, 2014, so that all selected pregnant women were exposed to the reform for at least 3 months (one trimester of pregnancy), and we consequently implemented a sharp RDD.[30] We matched the chosen time window after policy implementation (June 1, 2014, to Feb 28, 2015), to the time window before policy implementation (June 1, 2013, to Feb 28, 2014), to provide a comparison robust to month and seasonal variations. Finally, these analyses accounted for other underlying temporal trends and potential time-variant factors affecting the outcomes by comparing the period surrounding the policy implementation in 2014 to the same time periods in 2012, 2016, and 2018, when there was no policy enacted.

We defined exposure of interest as the eligibility for full coverage of illness-related costs during pregnancy and the early postpartum period. We used the date of childbirth relative to March 1, 2014 (henceforth the running variable), to assign participants to groups: babies born before March 1, 2014, and their mothers were assigned to the unexposed group, and babies born on or after June 1, 2014, and their mothers were assigned to the exposed group. The exposed group comprised participants who had full (ie, eligible from the first day of the 13th week of gestation) or partial (ie, eligible later in the pregnancy) access to the policy expansion.

This research is based on statistical processing of data owned by the Swiss Federal Statistical Office. Use of the dataset for research purposes has been authorised by the Swiss Federal Statistical Office upon full anonymisation of the data.

Outcomes

The primary objective of our study was to assess the effect of the policy expansion on birth outcomes and neonatal mortality. The secondary objective was to assess if the effect differed across various demographic and socioeconomic characteristics of the parents.

We assessed outcomes related to birthweight, gestational age, and survival. Birth outcomes were birthweight (continuous), low birthweight (<2500 g), very low birthweight (<1500 g), and high birthweight (>4000 g); and gestational age (continuous), preterm birth (<37 weeks or <259 days), and extremely preterm birth (<28 weeks or <196 days). The mortality outcome was neonatal mortality (death within the first 28 days of life). All outcomes but high birthweight (exploratory outcome) were specified before running the analyses.

We considered several sociodemographic characteristics of parents to examine population strata with a higher probability of adverse birth outcomes: maternal age at the time of childbirth (<35 years *vs* ≥35 years); maternal nationality at childbirth (EEA-OECD, including Switzerland *vs* non-EEA-OECD); maternal civil status at childbirth (married or registered partnership *vs* other); maternal and paternal: highest attained education (low [below a high school diploma or International Standard Classification of Education level three or lower] *vs* high [otherwise]; appendix p 11); and risk of poverty (estimated using the highest income of either parent over 3 years before childbirth; yes [<60% of the median income in our sample][31] *vs* no [otherwise]).

Statistical analysis

We evaluated whether key RDD assumptions related to potential manipulation of the intervention, exchangeability of participants on either side of the cutoff, and discontinuity in the outcomes at the cutoff were satisfied (appendix pp 8–10).[32] To assess the size of the effect, we implemented parametric regression models (linear or binary logistic depending on the outcome) with a linear specification of the running variable (appendix pp 8–10).[32] Effect measures were mean differences for continuous outcomes, and odds ratios and mean differences in predicted probabilities or marginals (mean difference, percentage) for

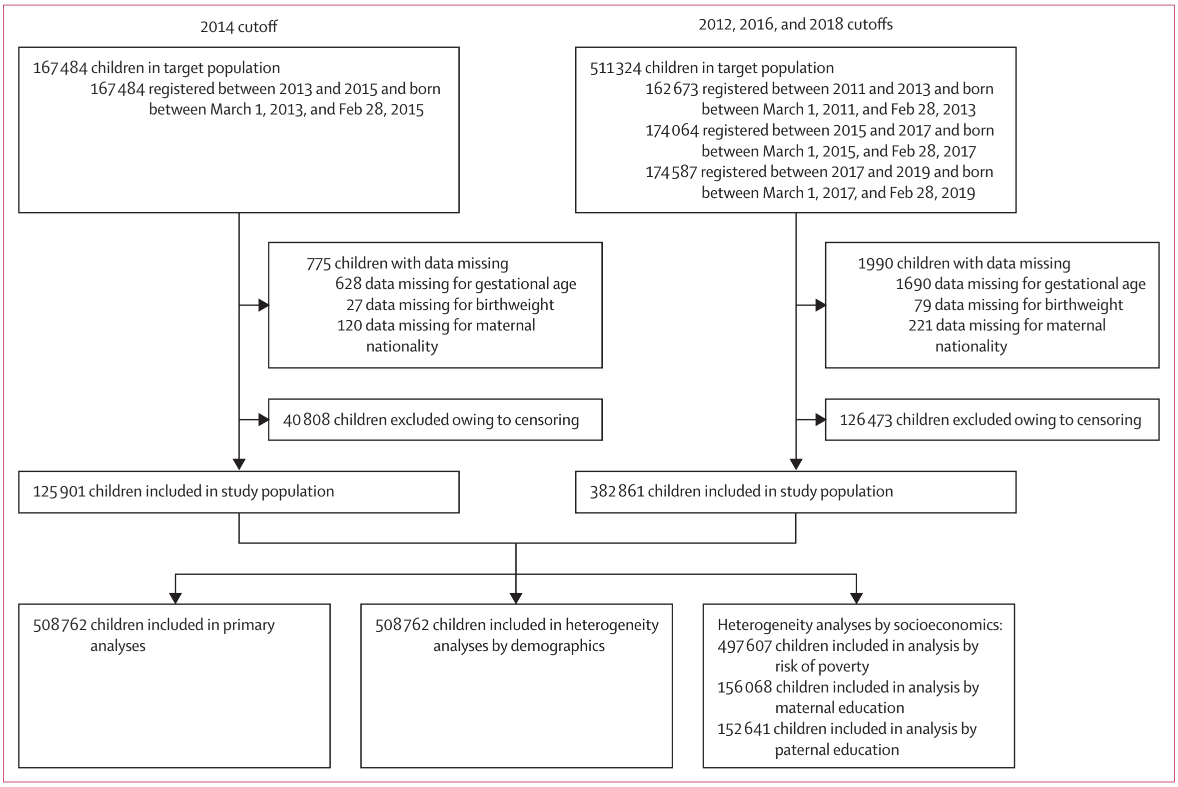

Figure 1: **Study profile**

categorical outcomes. The mean difference sizes provide a sense of the absolute magnitude of the potential effect of the policy and allow assessment of potential effect modifications across population strata on the additive scale.[33] 95% CIs with heteroscedasticity-consistent SEs were estimated. To assess the potential effect modification of the chosen parental socio-demographic characteristics, we ran the regression model in each covariate's stratum. The SE of the difference in those estimates was computed with the direct method.

We did several sensitivity analyses to evaluate the robustness of our results (1) to a different model specification; (2) to potential measurement error in birthweight; (3) to the choice of bandwidth and number of censored months; (4) to the choice of estimating a discontinuity nearby the chosen cutoff date by implementing a local randomisation approach that compares mean outcomes between the chosen periods before and after policy implementation; and (5) to potential misclassification of parents at risk of poverty (appendix pp 8–10). Data were analysed in Stata (version 17) and R (version 4.0.2).

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

61 910 children were born 9 months before (June 1, 2013, to Feb 28, 2014) and 63 991 were born 9 months after (June 1, 2014, to Feb 28, 2015) the implementation date of the reform (March 1, 2014), totalling 125 901 children (figure 1). 382 861 children were born in the same time period around the three control dates (March 1, 2012; March 1, 2016; and March 1, 2018). We ran primary analyses and heterogeneity analyses by mother's demographic characteristics on 508 762 children with complete data on health outcomes and mother's related covariates (99·5% of 511 527 births in the same periods; figure 1). We ran analyses by parental risk of poverty in 497 607 (97·3%) children owing to incomplete data on this characteristic, and by attained maternal education in 156 068 (30·5%) and paternal education in 152 641 (29·8%) children because these characteristics were available from a random subsample (appendix pp 8–10).

Over half of mothers were exposed to the policy, with almost 20% having partial access to it because they were at more than 13 weeks' gestation at the time of the policy implementation (table 1). Mothers were mostly from EEA-OECD countries, younger than 35 years, and married or in a registered partnership. Just over half of the children were male and about half came from families with high education. About one in ten children had parents at risk of poverty. Characteristics of participants and outcomes in control years were similar to those in the reform year (appendix pp 14–16).

RDD assumptions were satisfied. There was no sign of manipulation around the cutoff as the histogram of the frequency of the running variable was uniform (appendix p 25) and the manipulation test rejected the null hypothesis of discontinuity around the cutoff for the running variable (appendix p 17). Key characteristics were either similar or had a mirrored pattern across the exposed and unexposed groups (appendix p 26). Finally, a clear discontinuity around March 1, 2014, was observed for most outcomes (figure 2).

According to our difference in RDD models (table 2), the policy increased mean birthweight by 23 g (95% CI 5–40) and decreased the predicted proportion of low birthweight births by 0·81% (0·14–1·48) and of very low birthweight births by 0·41% (0·17–0·65). These data correspond to 518 fewer low birthweight babies and 260 fewer very low birthweight babies in the exposed period. The policy had a negligible effect on gestational age. Effects on the other examined outcomes were inconclusive as there were both decreased and increased marginal differences of similar magnitude.

In sensitivity analyses checking the robustness of our primary results to choices in data bandwidth, model specification, and measurement error, our primary results for birthweight, low birthweight, and very low birthweight were confirmed (appendix pp 18–19). Additionally, effects with different number of censored months were similar to those from primary analyses (appendix p 20). Finally, effects from the local randomisation approach (appendix p 21) were in line with those from the primary analyses for all outcomes apart from very low birthweight, for which the estimate corresponded to a predicted difference after versus before policy implementation of –0·01% (95% CI –0·18 to 0·16).

Finally, trends of low birthweight and preterm percentages between 2000 and 2019 (appendix p 27) were assessed with yearly summary statistics available from the Swiss Federal Statistical Office. The proportion of low birthweight children increased up to 2013 and started to decrease afterwards, whereas the proportion of preterm births has been decreasing since 2007, with no marked change after 2013. These trends support the estimated reduction of low birthweight in the period after policy implementation. Additionally, since our difference in RDD provides only effect estimates nearby the cutoff date, these trends indicate that the effect of the policy might have continued in later years.

The discontinuity test showed no evidence of manipulation around the cutoff in all examined subgroups apart from children with mothers and fathers with low education (appendix p 17). Thus, we did not estimate effects in children with low maternal and paternal education.

The effects of the policy on children with mothers who were younger than 35 years, from EEA-OECD countries,

	All children (n=125 901)	Unexposed children (n=61 910)	Exposed children (n=63 991)
Birthweight, g	3291 (546)	3289 (545)	3292 (547)
Low	8119 (6·4%)	4025 (6·5%)	4094 (6·4%)
Very low	1203 (1·0%)	603 (1·0%)	600 (0·9%)
High	8954 (7·1%)	4363 (7·0%)	4591 (7·2%)
Gestational age, days	275 (13)	275 (13)	275 (14)
Preterm	9057 (7·2%)	4421 (7·1%)	4636 (7·2%)
Extremely preterm	502 (0·4%)	251 (0·4%)	251 (0·4%)
Neonatal death	365 (0·3%)	182 (0·3%)	183 (0·3%)
Exposure to expanded policy			
No	61 910 (49·2%)	61 910 (100·0%)	..
Yes, full access	40 152 (31·9%)	..	40 152 (62·7%)
Yes, partial access	23 839 (18·9%)	..	23 839 (37·3%)
Birth quarter			
January–March	26 901 (21·4%)	13 404 (21·7%)	13 497 (21·1%)
April–June	13 900 (11·0%)	6781 (11·0%)	7119 (11·1%)
July–September	44 379 (35·2%)	21 922 (35·4%)	22 457 (35·1%)
October–December	40 721 (32·3%)	19 803 (32·0%)	20 918 (32·7%)
Multiple pregnancy			
No	121 525 (96·5%)	59 796 (96·6%)	61 729 (96·5%)
Yes	4376 (3·5%)	2114 (3·4%)	2262 (3·5%)
Sex			
Female	61 316 (48·7%)	30 238 (48·8%)	31 078 (48·6%)
Male	64 585 (51·3%)	31 672 (51·2%)	32 913 (51·4%)
Maternal age at childbirth, years			
<35	90 327 (71·7%)	44 228 (71·4%)	46 099 (72·0%)
≥35	35 574 (28·3%)	17 682 (28·6%)	17 892 (28·0%)
Maternal nationality			
EEA-OECD*	105 858 (84·1%)	52 049 (84·1%)	53 809 (84·1%)
Non-EEA-OECD	20 043 (15·9%)	9861 (15·9%)	10 182 (15·9%)
Maternal civil status			
Married (including registered partnership)	98 705 (78·4%)	48 745 (78·7%)	49 960 (78·1%)
Other†	27 196 (21·6%)	13 165 (21·3%)	14 031 (21·9%)
Maternal residence permit			
Swiss or C permit	96 159 (76·4%)	47 373 (76·5%)	48 786 (76·2%)
Other‡	25 665 (20·4%)	12 490 (20·2%)	13 175 (20·6%)
Data missing	4077 (3·2%)	2047 (3·3%)	2030 (3·2%)
Risk of poverty			
No	109 524 (87·0%)	53 715 (86·8%)	55 809 (87·2%)
Yes	13 886 (11·0%)	6929 (11·2%)	6957 (10·9%)
Data missing	2491 (2·0%)	1266 (2·0%)	1225 (1·9%)
Maternal education			
High	20 363 (16·2%)	9937 (16·1%)	10 426 (16·3%)
Low	19 534 (15·5%)	9733 (15·7%)	9801 (15·3%)
Data missing	86 004 (68·3%)	42 240 (68·2%)	43 764 (68·4%)
Paternal education			
High	21 205 (16·8%)	10 484 (16·9%)	10 721 (16·8%)
Low	17 782 (14·1%)	8777 (14·2%)	9005 (14·1%)
Data missing	86 914 (69·0%)	42 649 (68·9%)	44 265 (69·2%)

Data are number (%) or mean (SD). EEA=European Economic Area. OECD=Organization for Economic Cooperation and Development. *Switzerland is part of this category. †Single, widowed, divorced, not married, or dissolved partnership. ‡Permit L or B or G or N or F or Ci; diplomats; and international civil servants with or without diplomatic immunity.

Table 1: **Descriptive statistics for study participants**

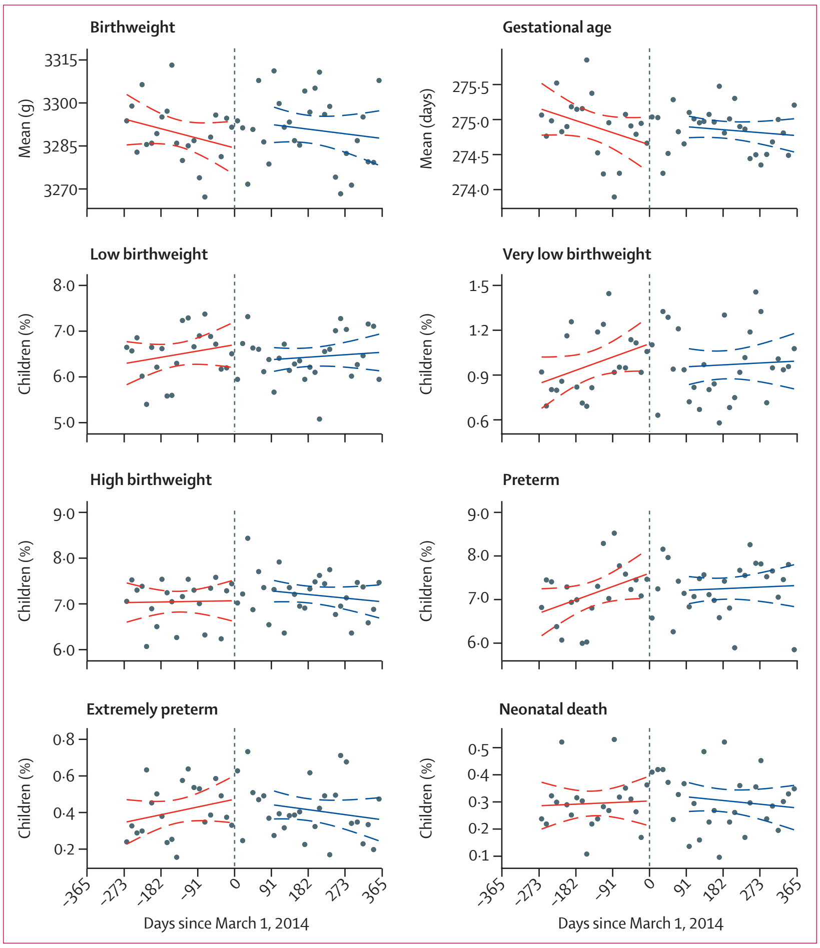

Figure 2: **Exposure effect on neonatal health outcomes and mortality**
Data were grouped into bins of 13 days and the outcome mean or proportion, as well as the mean of the running variable, in each bin were computed. Linear prediction lines (solid) with 95% CIs (dashed) for each group (red if unexposed and blue if exposed) were plotted using the aggregated data. The vertical dashed lines show the implementation date of the policy, March 1, 2014.

	Odds ratio (95% CI)	Mean difference (95% CI)
Birth outcomes		
Birthweight, g	..	23 (5 to 40)
Low	0·85 (0·74 to 0·97)	–0·81 (–1·48 to –0·14)
Very low	0·72 (0·52 to 1·01)	–0·41 (–0·65 to –0·17)
High	1·09 (0·96 to 1·24)	0·31 (–0·43 to 1·05)
Gestational age, days	..	1 (0 to 1)
Preterm	0·95 (0·84 to 1·07)	–0·39 (–1·2 to 0·38)
Extremely preterm	0·91 (0·55 to 1·51)	–0·09 (–0·27 to 0·08)
Mortality outcome		
Neonatal death	0·98 (0·53 to 1·82)	–0·07 (–0·2 to 0·07)

The effect size is odds ratio for binary outcomes, mean difference between exposed and unexposed for birthweight and gestational age, and mean difference between exposed and unexposed in predicted probability of binary outcomes (percentage).

Table 2: **Effect of eligibility to the policy on health outcomes (primary analyses)**

or married or in a registered partnership were in line with those estimated in the whole sample for all outcomes apart from extremely preterm birth (appendix p 22). The predicted proportion of extremely preterm births was 0·18% (95% CI –0·01% to 0·38%) lower in children born after (*vs* before) the policy implementation whose mothers were younger than age 35 years. Additionally, there was an estimated differential effect across strata (≥35 years *vs* <35 years) for very low birthweight and extremely preterm outcomes, whereby the predicted (after *vs* before policy implementation) reduction in these outcomes was larger (0·63%, 95% CI 0·02 to 1·23 for very low birthweight, and 0·36%, 95% CI –0·06 to 0·77 for extremely preterm) in children whose mother was younger than 35 years than in those whose mother was aged at least 35 years. For the subgroups of children with mothers older than 35 years, from non-EEA-OECD countries, and who were not married or in a registered partnership, the estimates were not precise and thus inconclusive for all outcomes apart from neonatal death. The predicted proportion of neonatal deaths was 0·29% (95% CI 0·01 to 0·56) lower in children born after (*vs* before) the policy implementation whose mothers had non-EEA-OECD nationality. Additionally, there was an estimated differential effect across strata (non-EEA-OECD *vs* EEA-OECD) for neonatal deaths, whereby the predicted (after *vs* before policy implementation) reduction in this outcome was larger (0·27%, 95% CI –0·04 to 0·59) in children whose mothers were from non-EEA-OECD countries than in children whose mothers were from EEA-OECD countries.

The effect of the policy in children with parents not at risk of poverty was in line with that estimated in the whole sample for all outcomes apart from extremely preterm and neonatal death (appendix p 23). Children with parents not at risk of poverty had a decreased predicted proportion of extremely preterm births (–0·19%, 95% CI –0·36 to –0·02) and of neonatal deaths (–0·13%, –0·26 to 0·01). The effect of exposure to the policy in children with parents at risk of poverty was not precise or consistent across primary and sensitivity analyses (appendix p 23), and was thus inconclusive. There was an estimated differential effect across strata (parents at risk of poverty *vs* not) for extremely preterm births and neonatal deaths, whereby the predicted (after *vs* before policy implementation) reduction in these outcomes was larger (0·9%, 95% CI –0·09 to 1·89 for extremely preterm, and 0·57%, 95% CI –0·06 to 1·2 for neonatal deaths) in children whose parents did not have low income than in children whose parents had low income.

The effect of the policy in children with mothers or fathers with high education status was in line with that estimated in the whole sample for all outcomes (appendix p 24).

Discussion

In this study, we assessed the effect of a Swiss policy expansion providing full coverage of illness-related costs during pregnancy on neonatal health outcomes, both overall and by sociodemographic characteristics of the parents. Our results suggest that eligibility to the policy decreased the proportion of low birthweight births by 0·81% (95% CI 0·14–1·48) in the overall population. Effects on the other examined outcomes were either imprecise or not robust to sensitivity analyses. There was weak evidence that extremely preterm births decreased by 0·18% after initiation of the policy in children from mothers younger than 35 years, and neonatal deaths by 0·29% in children from mothers with a non-EEA-OECD nationality. Parents not at risk of poverty potentially had fewer extremely preterm births (0·19%) and neonatal deaths (0·13%) than before policy implementation, and this reduction was potentially larger than that in children with parents at risk of poverty.

The effects of removing financial barriers to receiving care for illness during pregnancy on adverse neonatal outcomes are mixed. The effects seem to be modest at best at the population level and vary by timing, content, target groups, health system contexts, and research methodologies.[34] Previous evidence of differences in health outcomes as a result of variations in health policies comes from the USA and shows the effect of extending eligibility for health insurance to low-income or immigrant women (our systematic searches on MEDLINE retrieved 12 original studies and a systematic review; appendix p 5). The comparability of findings between the Swiss and the US policy expansions is limited by differences in the target groups (all pregnant women *vs* vulnerable groups), policy type (removing out-of-pocket costs *vs* extending eligibility for health insurance), and timing (pregnancy beyond 13 weeks' gestation *vs* no limitation by pregnancy status). Many studies have evaluated the 2014 Medicaid expansion under the Affordable Care Act (ACA), a similar reform from Massachusetts, USA, implemented as early as 2006, or the 2010 dependent coverage provision of ACA, which allowed young adults to stay on their parents' health insurance up to age 26 years. The 2014 ACA Medicaid expansion seemed to increase perinatal care use by 3·3%,[35] but evidence of a beneficial effect on birth outcomes is scarce.[36] One single-state difference-in-difference analysis reported improvements in the prevalence of low birthweight or preterm birth, but no effect on neonatal mortality.[37] Another study on the 2014 ACA Medicaid expansion found a decrease in the rate of low birthweight in women at high risk with de-novo hypertension,[38] whereas a study on the 2010 ACA dependent coverage provision found a modest reduction in preterm births.[39] The rest of the available evidence evaluated policies to cover prenatal care for immigrants through state-funded or federal-funded programmes, but one study found that the adoption of the 2009 Children's Health Insurance Program Reauthorization Act was associated with a 0·5% decrease in the incidence of preterm births.[40]

The small-to-moderate effect sizes and the differential risk reduction by some parental sociodemographics in our study could (1) indicate that the removal of financial barriers provided by the policy had little effect as costs related to routine prenatal care were already covered, or (2) reflect a restrictive access to illness-related care periconceptionally and the poor ability of health system interventions to modify multifactorial outcomes. The Swiss policy expansion did not target the preconception period or the first trimester of pregnancy. Therefore, women might have entered pregnancy with a poorer health status or might have been more reluctant to seek care for previously uncontrolled chronic conditions owing to high perceptions of teratogenic drug effects.[41] The larger reductions in adverse outcomes in children from parents not at risk of poverty (*vs* those at risk of poverty) suggest non-financial factors also cause health disparities. Poor neonatal health and mortality are multifactorial, meaning they are influenced by biological, social, environmental, and health system factors. As such, some clinical trials have shown that a combination of health system interventions (eg, home visits) and community interventions based on information–education–communication improved perinatal mortality compared with standard care.[42] Cultural health capital and health literacy might thus play an important role in perinatal health care.

The present study used a large representative population-based sample and a quasi-experimental design, thereby enabling robust causal inference from observational data with high external validity. Data were available from almost all (99·5%) livebirths registered in Switzerland and we undertook a rigorous difference in RDD analysis. RDD is able to yield causal effects from real-world settings and in contexts, such as prenatal care, in which random assignment to no intervention is not feasible or not acceptable.[28] To make sure that the design is valid and the findings are robust, we did tests that fulfilled the same function as the balance tests in randomised controlled trials, as well as several other falsification and sensitivity analyses. We showed that all observed covariates were balanced between the exposed and unexposed groups.

This study has several limitations. First, a few insurers had different interpretations as to which health-care services were covered by this policy expansion and a clarification on this subject was issued by the Federal office 4 years after policy implementation.[20] These barriers in implementation might have led to an underestimation of our effect sizes and might have contributed a greater benefit of the policy change for those with high socioeconomic status. Second, the results of this study are unlikely to be generalisable to countries other than Switzerland because of particularities in the definition and implementation of the policy expansion, potential differences in terms of standard of care and population demographics, and the financial model and fragmented organisation of the Swiss health system (ie, health insurance is mandatory and provided through a regulated competition between insurers; the financing and delivery of care are under the responsibility of the 26 Swiss cantons). Third, ethnicity data are not available in the Swiss registry, and so we were unable to analyse our data by ethnic origin. Fourth, the estimated effect could be biased. Specifically, confounding bias due to unmeasured factors, such as prepregnancy maternal lifestyle behaviours, cannot be excluded, but we believe that this risk is minimised by the valid RDD design and the fact that there were no imbalances in the measured baseline covariates. Information bias cannot be excluded for birthweight and gestational age outcomes owing to the different data collection methods across health-care settings and regions. To address these concerns, we did sensitivity analyses to test for measurement error in low birthweight, with convincing results. We cannot exclude a bias from anticipatory behaviours leading to exposure manipulation. Nevertheless, the policy was an expansion of already available routine care and might have represented a minor reason to change the pregnancy plan; the manipulation test did not show evidence of sorting across the policy cutoff in most examined cases; and we censored the first 3 months after the policy implementation, potentially excluding some births related to manipulation. Finally, we did not assess potential mechanisms through which the policy might have had a beneficial effect on neonatal health outcomes because of the scarcity of public data on health-care costs or maternal health and behaviours.

This study shows that the Swiss policy expansion had a positive effect on the health of children born after March 1, 2014, which might predict an improvement in their life course health. The policy did not benefit low-income families more than high-income families, indicating that barriers other than financial ones remain for families at low income.

Future studies should focus on investigating other important perinatal and later-life outcomes related to this policy expansion, but also on developing further effective strategies to maximise maternal and child health. Important outcomes that merit further consideration include perinatal maternal health and mortality, as well as the developmental and cardiometabolic risk trajectories of offspring. Potential interventions that might hold promise in overcoming both financial and non-financial barriers, and thus improve implementation and reduce health disparities for vulnerable subgroups, are package interventions that include components targeting the health system (eg, further policy changes aimed at risk prevention in women of reproductive age, health-care worker education and continuous quality improvement, and reorganisation of health services) and the community (eg, information–education–communication, financial incentives, and behavioural interventions).[42]

Contributors

CC and SC designed the study with input from AC, AME, and PW. PW collected, managed, and curated data. AME, PW, and CC had direct access to the dataset. AME did the systematic literature search. AME and CC did the statistical analyses, wrote and reviewed the statistical codes underpinning the results of the study, and verified the reported data. All authors had full access to all the data in the study. EC provided methodological input on the RDD analyses. AME wrote the first draft of the manuscript with substantial involvement from CC. All authors made critical revisions to the manuscript for important intellectual content, and read and approved the final content. CC had final responsibility for the decision to submit for publication.

Declaration of interests

We declare no competing interests.

Data sharing

The data used in this study were prepared by the NCCR—on the Move and pertain to the Swiss Federal Statistical Office. Access is subject to data sharing policies and restrictions of the data holder, and requests should be made to Prof Philippe Wanner.

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