Socioeconomic Status, Maternal Age and the Risk of Stillbirth in the Netherlands

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Abstract

Background: Stillbirths are a major public health concern in high-income countries. Most studies find that the risk is higher among socioeconomically disadvantaged women, though evidence is not always consistent. It remains unclear whether these inequalities vary across maternal age, especially as childbearing is increasingly postponed.

Methods: We use linked Dutch administrative data (2014–2020) covering over 800,000 pregnancies to examine whether socioeconomic status—measured by education and personal income—is associated with stillbirth risk, and whether this association varies across the reproductive lifespan. We estimate logistic regression models with year fixed effects and age–SES interactions, adjusting for personal and area-level characteristics.

Results: Women with low education face 1.38 to 1.47 times higher odds of stillbirth compared to those with tertiary education. This gradient persists after adjusting for confounders and in analyses limited to first pregnancies. However, SES disparities vary by maternal age: they are minimal under age 30, but widen from age 30 onward, peaking in the mid-to-late 30s. Educational gaps appear earlier, while income-related differences become more pronounced after age 35.

Conclusion: Our findings confirm persistent socioeconomic disparities in stillbirth risk in the Netherlands and show that these widen with maternal age. These results highlight that, despite a universal healthcare system, the Netherlands displays SES gradients in stillbirth risk, suggesting structural inequities in maternal health persist even in high-income settings.

Key messages

- In the Netherlands, women with low education or income face up to 1.47 times higher odds of stillbirth than their more advantaged counterparts, despite universal healthcare coverage.
- Disparities are negligible before age 30 but grow steadily through the 30s, peaking in the late thirties, a period when both biological risks and accumulated disadvantage may converge.
- Educational gaps emerge earlier, likely reflecting health literacy and early care engagement, while income differences peak later, possibly tied to resource-intensive pregnancy care and full-time employment status.
- The interaction between socioeconomic status and age suggests that cumulative disadvantage accelerates reproductive ageing, even in a high-income, low-stillbirth country.
- Interventions to reduce stillbirths must address social inequalities much earlier in life, especially for women entering their 30s with a history of disadvantage.

Introduction

Stillbirth, commonly defined as the fetal death occurring after 24 weeks of gestation or during labour[1], is a major public health concern, with profound emotional, health, and economic consequences for families [2]. Stillbirths are systematically recorded, medically investigated, and used as indicators of perinatal health, making them an outcome for population-level surveillance and prevention [1]. Across Europe, stillbirth rates range from 3 to 5 per 1,000 births. Although rates in high-income countries (HICs) are relatively low compared to low- and middle-income countries, progress has stalled in recent years, and some HICs – such as the Netherlands (2017-2021) and Germany (2010–2021) – have even reported increases [3].

Importantly, disparities in the risk of stillbirth persist both between and within countries [4]. Socioeconomic disadvantage is associated with increased stillbirth risk, with higher risks observed among women with less education, lower income, or living in more deprived areas [5, 6, 7, 8, 9, 10]. These associations have been documented across countries and time periods, and tend to persist even after adjusting for demographic and medical confounders [6, 4].

Using two national administrative sources from the Netherlands – the Dutch perinatal registry (Perined) and Statistics Netherlands (CBS) – covering over 800,000 pregnancies (2014-2020), we investigate the relationship between SES and stillbirth, and we test whether SES disparities vary by maternal age, capturing potential interactions between social disadvantage and biological ageing. We operationalise SES using two complementary, annually updated indicators: educational attainment, which captures long-term knowledge resources, health literacy, and early-life social stratification; and personal income, which reflects current material conditions and access to resources. These measures represent distinct but overlapping dimensions of women's social position across the life course. Using logistic regression models with year fixed effects, we estimate SES differences in stillbirth risk and test for interactions with maternal age, adjusting for demographic, obstetric, and area-level confounders, which help account for contextual factors (e.g., differential access to antenatal care) that may confound individual-level associations.

Although the stillbirth rate is around 3.5 per 1,000 births in the Netherlands, it rises to approximately 5 per 1,000 among women aged 35 and older [3]. Prior research has documented higher risks among women from disadvantaged households [11], deprived neighbourhoods [8], and ethnic minorities [12]. These disparities suggest that even in high-level health systems with low overall perinatal mortality, social inequalities in pregnancy outcomes persist.

Research indicates that socioeconomic deprivation is associated with higher risk of stillbirths, particularly those linked to pre-eclampsia, hypertension, haemorrhage, and congenital anomalies [9]. Beyond medical causes, broader social and structural mechanisms

[1]Definitions of stillbirth vary internationally, with most high-income countries using a gestational age threshold between 20 and 28 weeks. In Europe, 24 weeks is the most commonly adopted cutoff [1]

contribute to these disparities. Chronic stress associated with poverty, job insecurity, or marginalisation can increase cortisol levels, impair placental blood flow, and inhibit fetal growth [13, 14, 15]. Stress may also trigger harmful behaviours such as smoking, alcohol consumption, or poor nutrition during pregnancy [16, 17]. Moreover, socially disadvantaged women are more likely to live in environments with heightened exposure to heat, air pollution, or lead, while also facing barriers to access timely and high-quality antenatal care – all factors associated with increased stillbirth risk [18, 19].

Although most studies demonstrate a social gradient in stillbirth risk, a few do not (e.g., [20, 21]). This variability may stem from differences in data quality, including reliance on self-reported outcomes, limited sample sizes, or use of area-level SES proxies rather than individual-level measures [22, 20, 21].

Based on existing research, we expect to observe a socioeconomic gradient in stillbirth risk, so that women with lower education or income experience higher risks, even after accounting for contextual deprivation (Hypothesis 1).

Furthermore, no prior study has systematically explored the intersection between SES and age in the stillbirth risk, to our knowledge. This is a significant gap, especially as more women postpone childbearing [23] and the risk of stillbirth increases with age in a well-documented J-shaped pattern [24, 25]. Across Europe, the likelihood of stillbirth roughly doubles between ages 30–34 and 35–39, and more than triples for women aged 40 or older [25] (e.g. adjusted risk ratio ≈ 3 for 40+ vs. 25–29). This elevated risk partly reflects the greater prevalence of complications such as placental dysfunction, pre-eclampsia, and fetal growth restriction, conditions that also contribute to the SES gradient in stillbirth [9].

The "weathering hypothesis" suggests that cumulative exposure to social and environmental stressors accelerates health deterioration among socially disadvantaged groups [26, 27]. Initially developed to explain racial disparities in U.S. perinatal health, this framework has been increasingly applied in European contexts to understand social inequalities in health and perinatal outcomes [28, 29]. These insights underscore the importance of examining how SES and maternal age may interact in shaping pregnancy experiences, particularly given the global trend towards childbearing at later maternal ages.

Therefore, we hypothesize that this gradient may vary across maternal age, consistent with cumulative disadvantage and unequal ageing processes (Hypothesis 2).

We contribute to the literature in two ways. First, we provide robust, individual-level estimates of stillbirth risk by two complementary dimensions of women's socioeconomic status—education and personal income—using large-scale, population-wide data. By including a granular area-level SES measure, we account for contextual factors that may confound individual-level associations. Second, we assess whether the association between SES and stillbirth risk varies across maternal age. While previous studies adjust for age, none have systematically tested whether the SES disparities in stillbirth widen or narrow across maternal age. Identifying which social groups are most at risk of stillbirth is also important for prevention. Understanding how risk varies across SES, maternal age, and their interaction can reveal achievable benchmarks as groups with the lowest rates demonstrate what is possible under optimal conditions. In doing so, this study provides novel evidence on whether and how socioeconomic disadvantage accumulates across women's reproductive lives in shaping stillbirth risk.

Methods

Sample

We use linked data from two nationwide Dutch administrative sources: the Perined perinatal registry and CBS. Perined includes all pregnancies reaching at least 24 weeks' gestation between 2014 and 2020, with information on maternal age, gestational length, pregnancy order, and a standardised neighbourhood SES score. CBS offers annually updated sociodemographic data including education, personal income, and partner co-residence.

The initial Perined sample includes 1,163,459 pregnancies. We exclude the cases lacking maternal ID (mostly losses before week 24, 179.000 cases), those with invalid years (9 cases), individuals identified as male (42 cases), those missing year of birth (292 cases) and those with missing pregnancy order (803 cases). To ensure education reflects completed attainment, we drop 59,226 pregnancies conceived before maternal age 23[2]. Finally, we exclude 113,710 pregnancies with missing or invalid education data. The final analytical sample includes 810,377 pregnancies to 606,603 women. For robustness checks, we analyse a subsample of 202,000 first pregnancies (see Flowchart in Supplementary Material).

Variables

Our outcome of interest is stillbirth, defined as fetal deaths occurring at or after 24 completed weeks of gestation. Earlier losses are not individually identifiable in the data. One of the primary exposure variables is education, recorded annually in CBS and based on the SOI 2021 classification, and grouped into three categories: low (primary and lower secondary), medium (upper secondary and intermediate vocational), and high (tertiary education, including professional and academic degrees). This grouping reflects the stratified nature of the Dutch educational system, where vocational and general education tracks diverge early and may determine long-term socioeconomic trajectories differently.

The other exposure variable, gross personal income quintile, is measured in the calendar year before conception to mitigate reverse causality issues. We focus on personal (rather than household) income to capture women's individual economic resources and position within the labour market. This may underestimate overall household resources, particularly in the Dutch context, where part-time employment among women is common [30]. Gross personal income, while an imperfect measure, more directly captures women's position in the labour market and is thus more suitable for measuring social stratification than net income.

[2] In the Dutch system, most students complete their tertiary education by age 22 or 23; hence, restricting the sample ensures that registered education reflects women's final educational level.

Table 1: Descriptive statistics by outcome (live birth vs stillbirth)

	Live birth		Stillbirth	
	%	N	%	N
Education				
Primary/Lower Secondary	10.56	85,160	14.29	538
Upper Secondary	39.53	318,867	39.58	1,490
Degree or higher	49.91	402,585	46.14	1,737
Age				
24–29	36.56	294,902	34.16	1,286
30–34	42.34	341,551	38.96	1,467
35–39	17.97	144,946	20.35	766
40+	3.13	25,213	6.53	246
Partnership status				
No co-residential partner	11.99	96,749	13.97	526
Co-residential partner	88.01	709,863	86.03	3,239
Parity				
No children	42.61	343,677	42.68	1,607
1 child	37.40	301,666	32.56	1,226
2+ children	19.99	161,269	24.75	932
Pregnancy order				
1st pregnancy	33.68	271,689	32.35	1,218
2nd pregnancy	66.32	534,923	67.65	2,547
Household income quintile				
Bottom quintile	19.99	160,625	22.08	829
2nd quintile	20.04	160,989	20.51	770
3rd quintile	19.97	160,481	19.50	732
4th quintile	20.00	160,678	20.35	764
Top quintile	20.00	160,743	17.55	659
Total				
N		803,516		3,754
Total (Live Births & Stillbirths)			807,270	

Moreover, maternal age is measured in completed years at conception. Conception year is based on Perined records of gestational length (day) and expected delivery date (day, month, year). Partnership status is based on co-residence and indicates whether the woman lived with a partner during pregnancy. SES is a well-established predictor of partnership status, which is linked to better financial and emotional support during pregnancy [31] and healthier prenatal behaviours [32]. We also include a standardised 4-digit postcode-level SES score from Perined. This measure corresponds to the average gross personal income of all residents within each postcode area, and is standardised across the national distribution. This area-level indicator likely reflects both material disadvantage and access to services such as antenatal care. Pregnancy order (parity) is defined as the number of previous pregnancies. Descriptive statistics for all pregnancies reaching 24 weeks, by outcome (live birth vs stillbirth), are shown in Table 1. Full definitions and coding details are in Table S1 in Supplementary Material.

Statistical Analyses

We estimate logistic regression models at the pregnancy level, treating stillbirth as a binary outcome (stillbirth vs. live birth). The main exposure variables are educational attainment (low, medium, high) and lagged personal income quintiles. All models include maternal age in completed years, modeled both linearly and quadratically. We first estimate separate models for education and income (Table 2). We also restrict the sample to first pregnancies (Table S2 in the Supplementary Material) to test whether findings are driven by parity-related selection.

In a second step, we examine whether SES–stillbirth associations vary by maternal age. We interact age with (a) education and (b) income quintiles (Figure 2; Table S3 in Supplementary Material), testing whether social disparities widen or narrow across the reproductive lifespan. As a robustness check, we repeat the interaction models using four age bands (24–29, 30–34, 35–39, 40+; Table S4 in Supplementary Material). Standard errors are clustered at the woman level to account for repeated pregnancies. Baseline models include year fixed effects. Fully adjusted models additionally control for partner status, pregnancy order, and area-level SES.

Results

Overall, 0.47% of pregnancies in our sample ended in stillbirth. This rate was higher among socioeconomically disadvantaged women: 0.50% for those with lower education vs. 0.40% for those with a tertiary education (20% relative difference), and 0.49% in the lowest income quintile vs. 0.39% in the highest (24% gap). Logistic regressions controlling for age and year of conception (Table 2, cols. 1 & 3) confirm these disparities. Women with primary & lower education face approximately 1.47 ($\approx 1/(\exp(-0.382)$; col. 1, Table 2) times higher odds of stillbirth compared to women with tertiary education, after adjusting for baseline covariates. In fully adjusted models (cols. 2 & 4), the SES gradient remains statistically significant – women with lower education face 1.68 times higher odds (≈ 1/exp(-0.321); col. 2, Table 2) – albeit slightly attenuated after including partner status, parity, and neighbourhood SES. Income gradient results less apparent from the educational one. Only women in the 5th quintile (the highest) markedly differ from those in the 1st, in the fully adjusted model.

Figure 1 shows predicted probabilities of stillbirth by education (left) and income (right), comparing baseline (circles) and adjusted (squares) models. Restricting the sample to the first pregnancies (Table S2) confirms that the differences in SES persist beyond parity or union status.

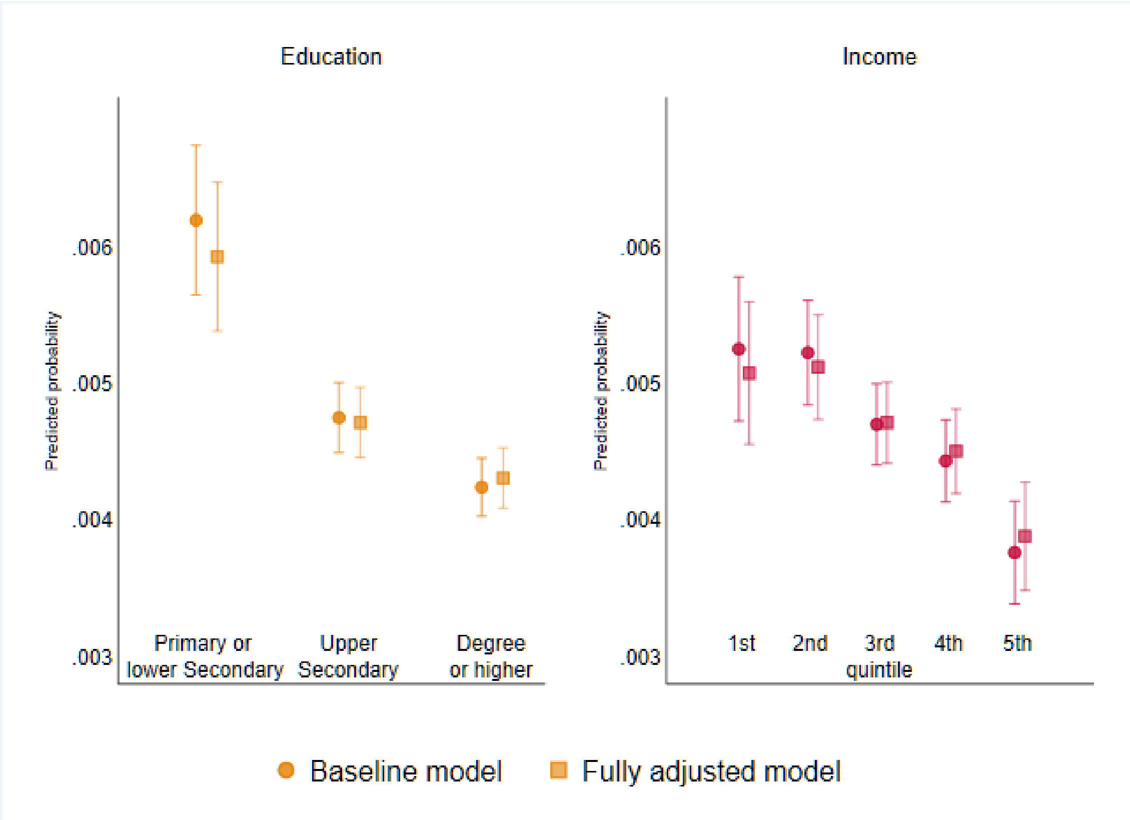

Figure 1: Stillbirth risk by maternal socioeconomic status. Left: Education (primary & lower secondary, upper secondary, tertiary & higher education). Right: Income (income quintiles).

SES differences in stillbirth risk vary across the reproductive lifespan. Figure 2 plots predicted probabilities of stillbirth by maternal age for selected SES groups: lower vs. higher education (left) and bottom vs. top income quintile (right). Intermediate categories are omitted for clarity, but shown in Supplementary Material Figure S1. These estimates are based on the interaction models reported in Table S3 in Supplementary Material.

Among women younger than 30, the risk of stillbirth is broadly similar across socioeconomic groups. From age 30 onward, however, a clear divergence emerges: lower-SES women face a progressively higher risk of stillbirth, with the gap widening through the thirties before tapering off after age 40.

Table 2: Logistic regression models predicting stillbirth

	(1)	(2)	(3)	(4)
Age (linear)	-0.263***	-0.255***	-0.268***	-0.259***
	(0.044)	(0.044)	(0.044)	(0.044)
Age (quadratic)	0.005***	0.004***	0.005***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Highest education				
(Ref: Primary/Lower Secondary)				
Upper Secondary	-0.268***	-0.231***		
	(0.053)	(0.054)		
Tertiary	-0.382***	-0.321***		
	(0.053)	(0.056)		
Personal income (Ref: 1st quintile)				
2nd quintile			-0.005	0.009
			(0.063)	(0.063)
3rd quintile			-0.112*	-0.075
			(0.061)	(0.062)
4th quintile			-0.171***	-0.120*
			(0.063)	(0.065)
5th quintile			-0.336***	-0.270***
			(0.074)	(0.077)
Co-resident partner		-0.041		-0.065
		(0.050)		(0.050)
Pregnancy order (Ref: 1st pregnancy)				
2nd pregnancy		-0.107**		-0.111**
		(0.044)		(0.044)
3rd pregnancy		-0.033		-0.036
		(0.051)		(0.052)
4th+ pregnancy		0.109**		0.123**
		(0.053)		(0.054)
Neighbourhood SES		-0.035**		-0.038***
		(0.014)		(0.014)
Year FE	Yes	Yes	Yes	Yes
Observations	807,270	807,270	807,270	807,270

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

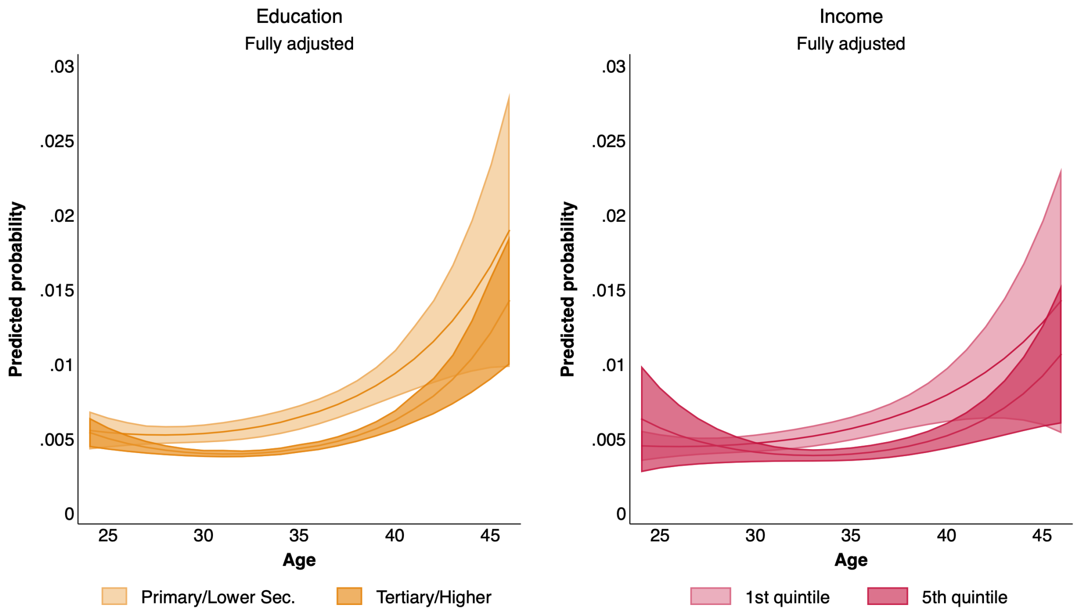

Figure 2: Interaction between maternal age and socioeconomic status. Left: educational attainment (primary & lower secondary vs. tertiary & higher education). Right: personal income (1st quintile vs. 5th quintile)

Robustness Check

We re-estimated the interaction models using categorical age groups (24–29, 30–34, 35–39, 40+; see Table S4). The results confirm that SES disparities are small below age 30, but widen notably thereafter, especially among women with primary/lower secondary education or in the bottom income quintile. For example, among women aged 35–39, stillbirth risk is significantly lower for those with tertiary education or high income compared to their disadvantaged peers. These findings indicate that SES gradients in stillbirth risk may evolve non-linearly, with the sharpest disparities observed in the mid-to-late thirties. Although confidence intervals widen in the 40+ group due to smaller sample sizes, the coefficents of interaction terms for high-income women remain large and statistically significant.

Discussion

Stillbirth is a major public health concern with profound emotional, health, and economic consequences for families [2]. As the risk of stillbirth increases substantially with advanced maternal age [33], it becomes increasingly critical to examine and address its preventable causes, particularly in contexts characterized by fertility postponement where childbearing is increasingly postponed into the 30s and beyond [23].

Previous studies in HICs report higher stillbirth risks among socioeconomically disadvantaged women, measured through income [5], education [6, 7], neighbourhood deprivation [8], or migration status [34]. However, most of this literature treats maternal age solely as a control variable, overlooking whether the social gradient varies across the reproductive lifespan.

Using comprehensive register data from the Netherlands covering over 800,000 pregnancies (2014-2020), we investigated the relationship between SES and stillbirth. Also, we tested whether SES disparities in stillbirth risk varied by maternal age, capturing potential interactions between social disadvantage and biological ageing. Our findings make two major contributions. First, we confirmed a persistent SES gradient in stillbirth risk, in line with Hypothesis 1. Second, we showed that this gradient emerges primarily after age 30, indicating cumulative and unequal ageing trajectories, consistent with Hypothesis 2, which anticipated that SES disparities would increase across the reproductive lifespan.

The Netherlands has one of the lowest stillbirth rates in Europe, although recent research (2017–2021) shows signs of a slight increase [3]. If social inequalities in perinatal outcomes emerge in a relatively egalitarian setting such as the Netherlands [11], it is plausible that similar, or more pronounced, disparities exist in other countries with greater structural inequalities. Also, the widening gradient across age may reflect the cumulative effects of long-term behavioural, structural, and environmental disadvantages faced by lower-SES women.

We first examined the association between SES and stillbirth using two indicators: education and personal income. In line with most previous research, we found that women with higher education or income had lower odds of stillbirth. However, these two SES dimensions operated differently. Educational gradients were evident across all levels, while income-based differences were concentrated in the top quintile. Women with upper secondary or tertiary education had significantly lower odds of stillbirth than those with only primary or lower secondary education. This association persisted after adjusting for partnership status, pregnancy order, and neighbourhood SES. Using income as the SES measure, lower stillbirth risks were observed in the fourth and fifth quintiles, though only the top quintile remained significant in fully adjusted models. Overall, both indicators suggest that socioeconomic disadvantage is associated with higher stillbirth risk. This finding aligns with prior studies using alternative SES measures such as occupational status [35], neighbourhood deprivation [8], and household income [11].

Several mechanisms may underlie the observed social gradient in stillbirth risk. First, high-SES women tend to have better overall health and are more likely to follow healthier lifestyles before and throughout the pregnancy, which may be protective against stillbirth risk. However, lifestyle factors alone do not fully account for the SES gradient. For instance, smoking is more prevalent among disadvantaged women in the Netherlands [36], but its association with stillbirth remains inconsistent across studies [16, 37]. Conversely, alcohol use is more consistently linked to higher stillbirth risk [38], but is more prevalent among highly educated women in the Netherlands [39]. Second, SES gradient is evident in the quantity, quality, and scope of healthcare received during pregnancy. This includes closer monitoring of high-risk pregnancies [1, 40] and a more effective management of complicated deliveries in better-resourced hospital settings [41], which are more readily available and accessible to higher-SES individuals. Although we adjusted for neighbourhood-level SES, which partially captures area-level variation in healthcare infrastructure, this did not eliminate the SES gradient, suggesting healthcare provision is relevant but insufficient to fully explain it. Third, disadvantaged women are more often exposed to cumulative stressors such as financial insecurity, poor housing, environmental hazards, and job loss, all of which are linked to stillbirth risk [42, 43, 19]. These may exacerbate biological vulnerabilities. Moreover, research on maternal occupation highlights that specific job types, such as those involving manual labor, agriculture, or exposure to chemical hazards, are associated with higher stillbirth risk, through both physiological (e.g., toxic exposure, physical strain) and social mechanisms (e.g., irregular schedules, lack of autonomy, precarious work conditions) [44, 45]. Lastly, the SES gradient appears steeper for education than for income, hinting at the role of health literacy, long-term behaviours, and navigation of healthcare systems —factors more closely tied to education rather than income. Nevertheless, the interplay of behavioral, clinical, and structural pathways remains complex. Further research is needed to fully elucidate these mechanisms.

Our second main finding is that the SES-stillbirth risk association varies significantly by maternal age. Before age 30, SES differences are small and not statistically significant. From age 30 onward, however, a clear social gradient emerges, with women of lower education or income facing steadily increasing risk. This disparity peaks in the late 30s and decreases after age 40. However, due to wide confidence intervals and smaller sample sizes for pregnancies after age 40, SES differences at older ages are not precisely estimated. This relatively flat gradient before age 30 is notable, as it suggests that social gradient in stillbirth risk only emerges with advancing maternal age.

These findings align with the well-documented J-shaped relationship between maternal age and stillbirth risk as well as other adverse outcomes such as preterm birth and fetal growth restriction — both key predictors of stillbirth [46]. Importantly, we show that this age-related risk is not uniform across SES groups. SES disparities widen between ages 30 and 40, consistent with the "weathering hypothesis" [26], which posits that cumulative exposure to social disadvantage accelerates biological aging and health deterioration. Biological mechanisms such as vascular and chromosomal ageing, impaired placental perfusion, and systemic inflammation become more common with advancing maternal age [13, 46, 47] and may be exacerbated by chronic social stressors. By showing these widening SES gaps by age, our study adds to the literature examining stillbirth risk across the reproductive lifespan by race [48], which shows racial disparities peak between ages 30-34.

Notably, educational disparities emerge earlier (around age 30), while income differences peak closer to age 35. This may be explained by distinct mechanisms: education-linked advantages (e.g., health literacy, early antenatal engagement) matter earlier, whereas income becomes more relevant later in pregnancy when complications are more frequent and reaching and benefiting from specialised care may require greater informational and material resources. These differences between SES indicators should be understood in the context of the Dutch universal healthcare system, which seeks to minimise income barriers for routine care [11]. Although suggestive, this interpretation aligns with the idea that different dimensions of SES operate through distinct pathways across life course.

This study has some limitations. First, we could not adjust for potential confounders such as ethnicity, immigration status, and pre-existing health conditions, which are associated with both SES and stillbirth risk [12, 49], and may partially explain the observed social gradient. Second, Perined anonymizes pregnancies ending before 24 weeks, preventing linkage to maternal records and limiting our analysis to later losses. Nonetheless, focusing on stillbirth ensures consistency in definitions and robust estimation in a large national cohort. Third, Perined does not distinguish between antepartum and intrapartum stillbirths. Pathways leading to antepartum stillbirth are documented to differ from those of intrapartum stillbirth [50], and these pathways may operate differentially across social groups [51, 9]. Finally, due to data limitations, we could not examine several mediators such as smoking, BMI, or prenatal care use. These factors are likely mediators rather than confounders, and adjusting for them could obscure the total SES effect. Our models thus capture the overall association between social position and stillbirth. Future work linking registry and survey data could help disentangle underlying mechanisms and better guide prevention.

These limitations are offset by several strengths. First, we used Perined, a nationwide registry covering all births in the Netherlands, with nearly complete follow-up for pregnancies reaching 24 weeks. The large sample size (800,000 pregnancies) offers strong statistical power to detect even modest socioeconomic differences. Second, SES indicators (education and income) come from administrative records, minimising under-reporting and recall bias. Third, using both indicators allowed us to capture distinct aspects of disadvantage: education relates to health literacy and healthcare system navigation, while income reflects material resources shaping care quality and access. Finally, we included a granular area-level SES measure, which helps to account for contextual disadvantage and better isolate the effects of individual SES.

In conclusion, this study offers evidence of socioeconomic disparities in stillbirth risk in the Netherlands, especially as maternal age increases. The interaction between SES and age suggests that social disadvantage may accumulate over the reproductive life course. These findings highlight the potential for targeted prevention strategies and the need to address structural and informational barriers to health inequality. Future research should also explore earlier gestational losses and distinguish between antepartum and intrapartum stillbirths to better capture the full extent of inequality.

As maternal age at childbearing continues to rise in high-income countries, failure to address the underlying social disparities may result in larger gaps in stillbirth risk and other reproductive health outcomes. Persistent or increasing inequalities could disproportionately burden disadvantaged women and their families, both emotionally and economically. In the long term, addressing these disparities is important for improving perinatal outcomes, promoting reproductive justice and reducing intergenerational disadvantage.

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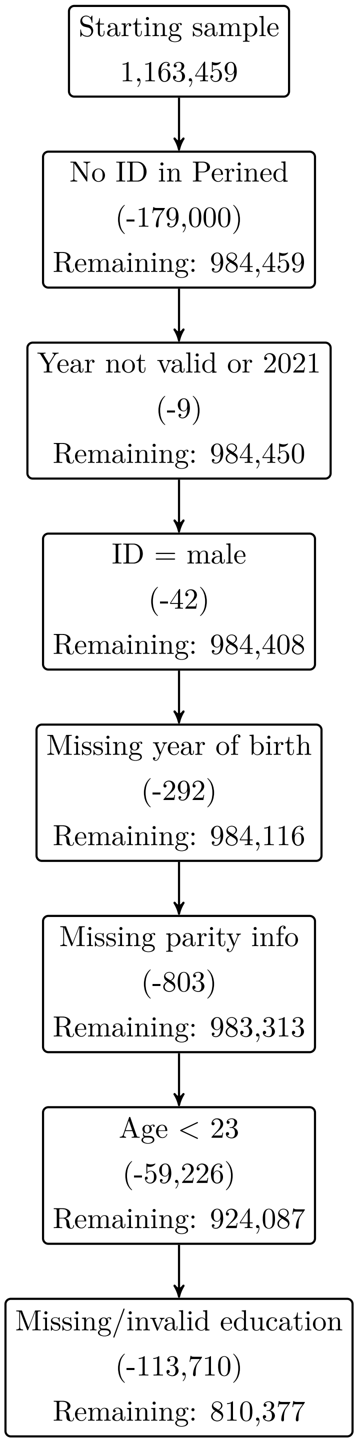
Supplementary Material



Sample Construction

Table S1: Variables Overview

Variable name	Description
Perined	
stillbirth	Binary indicator: 1 if the baby was born without signs of life after 24 weeks of gestation, 0 otherwise.
maternal age	Age of the woman at the time of delivery, in completed years.
pregnancy order	Number of total pregnancies a woman has had up to the current one (including the index pregnancy).
postcode income	Area-level SES indicator based on average income in the woman's 4-digit postcode of residence.
year of conception	Calendar year in which the pregnancy started. It is calculated as the difference between the expected delivery date (recorded in day, month, year) and the gestational age at the end of pregnancy (expressed in days), both provided by Perined. This derived variable is used for year fixed effects.
CBS	
education	Categorical variable indicating the highest completed level of women's education, derived from the SOI 2021 classification (`OPLNIVSOI2021AGG4HB`). It is recoded into three groups: low (no education, primary, lower secondary), medium (upper secondary, intermediate vocational), and high (tertiary education including professional and academic degrees).
personal income	Categorical variable (5 quintiles) capturing the woman's gross personal income in the calendar year prior to delivery. This measure is based on the variable `INPAHHHBRUT5HB` and requires no further transformation.
partner status	Indicates whether the woman was living with a partner at the time of pregnancy end. A woman is considered partnered if she and her partner were registered at the same residential address and shared the same household ID.

Table S2: Logistic regression models. Outcome: stillbirth. Sample: first pregnancies only

	(1)	(2)	(3)	(4)
Age (linear)	-0.228***	-0.226***	-0.231***	-0.230***
	(0.074)	(0.074)	(0.075)	(0.075)
Age (quadratic)	0.004***	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Highest education				
(Ref: Primary/Lower Secondary)				
Upper Secondary	-0.324***	-0.321***		
	(0.115)	(0.115)		
Tertiary	-0.462***	-0.456***		
	(0.115)	(0.115)		
Personal income (Ref: 1st quintile - Lowest)				
2nd quintile			0.041	0.041
			(0.136)	(0.136)
3rd quintile			-0.201	-0.198
			(0.129)	(0.129)
4th quintile			-0.183	-0.178
			(0.130)	(0.131)
5th quintile			-0.338**	-0.331**
			(0.146)	(0.147)
Co-resident partner	-0.076	-0.073	-0.092	-0.089
	(0.088)	(0.088)	(0.089)	(0.089)
Neighbourhood SES		-0.012		-0.012
		(0.026)		(0.026)
Year FE	Yes	Yes	Yes	Yes
Observations	271,894	271,894	271,894	271,894

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table S3: Regression results: SES, Age and SES × Age. Outcome: Stillbirth

	(1)	(2)	(3)	(4)
Age (linear)	-0.215**	-0.220**	-0.125	-0.151
	(0.103)	(0.105)	(0.112)	(0.113)
Age (quadratic)	0.004**	0.004**	0.003	0.003*
	(0.002)	(0.002)	(0.002)	(0.002)
Highest education attained				
(Ref: Primary / Lower Secondary)				
Upper Secondary	-0.532	-0.369		
	(2.015)	(2.035)		
Tertiary	2.843	2.500		
	(2.006)	(2.032)		
Upper Secondary × Age (linear)	0.019	0.008		
	(0.124)	(0.126)		
Tertiary × Age (linear)	-0.173	-0.154		
	(0.122)	(0.124)		
Upper Secondary × Age (quadratic)	-0.000	-0.000		
	(0.002)	(0.002)		
Tertiary × Age (quadratic)	0.002	0.002		
	(0.002)	(0.002)		
Personal income (Ref: 1st quintile - Lowest)				
2nd quintile			2.538	2.384
			(2.295)	(2.318)
3rd quintile			1.731	1.271
			(2.248)	(2.260)
4th quintile			5.430**	4.707*
			(2.435)	(2.454)
5th quintile - Highest			5.970*	4.570
			(3.148)	(3.145)
2nd quintile × Age (linear)			-0.162	-0.151
			(0.144)	(0.145)
3rd quintile × Age (linear)			-0.110	-0.082
			(0.140)	(0.141)
4th quintile × Age (linear)			-0.329**	-0.285*
			(0.150)	(0.151)
5th quintile × Age (linear)			-0.334*	-0.253
			(0.183)	(0.183)

Continued on next page

Table S3 – continued from previous page

	(1)	(2)	(3)	(4)
2nd quintile × Age (quadratic)			0.003	0.002
			(0.002)	(0.002)
3rd quintile × Age (quadratic)			0.002	0.001
			(0.002)	(0.002)
4th quintile × Age (quadratic)			0.005**	0.004*
			(0.002)	(0.002)
5th quintile × Age (quadratic)			0.004	0.003
			(0.003)	(0.003)
Co-resident partner		-0.044		-0.068
		(0.050)		(0.051)
Pregnancy order (Ref: 1st pregnancy)				
2nd pregnancy		-0.097**		-0.100**
		(0.044)		(0.045)
3rd pregnancy		-0.021		-0.024
		(0.052)		(0.052)
4th or more pregnancy		0.113**		0.126**
		(0.054)		(0.055)
Neighbourhood SES		-0.033**		-0.038***
		(0.014)		(0.014)
Year FE	Yes	Yes	Yes	Yes
Observations	807,270	807,270	807,270	807,270

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table S4: Regression results: SES, Age Groups, and Stillbirth Risk

	(1)	(2)	(3)	(4)	(5)	(6)
Age groups (Ref: 24–29)						
30–34	0.082	0.037	0.133	0.084	0.030	0.137
	(0.053)	(0.054)	(0.218)	(0.120)	(0.121)	(0.247)
35–39	0.395***	0.303***	0.516**	0.293**	0.199	0.471
	(0.065)	(0.067)	(0.255)	(0.143)	(0.144)	(0.289)
40+	0.922***	0.794***	1.396***	0.909***	0.795***	1.515***
	(0.098)	(0.101)	(0.374)	(0.196)	(0.198)	(0.427)
Highest education						

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Table S4 – continued from previous page

	(1)	(2)	(3)	(4)	(5)	(6)
(Ref: Primary/Lower Sec.)						
Upper Secondary	-0.040	-0.015	0.008			
	(0.048)	(0.049)	(0.050)			
Degree or Higher	-0.080	-0.051	-0.032			
	(0.062)	(0.063)	(0.066)			
Age × Highest education						
(Ref: 24–29 × Primary/L. Sec.)						
30–34 × Upper Secondary	-0.136	-0.120	-0.132			
	(0.092)	(0.093)	(0.092)			
35–39 × Upper Secondary	-0.198**	-0.166	-0.211*			
	(0.107)	(0.108)	(0.113)			
40+ × Upper Secondary	-0.205	-0.154	-0.252*			
	(0.144)	(0.145)	(0.152)			
30–34 × Degree+	-0.172**	-0.142	-0.154			
	(0.082)	(0.083)	(0.087)			
35–39 × Degree+	-0.342***	-0.292***	-0.341***			
	(0.097)	(0.098)	(0.102)			
40+ × Degree+	-0.265**	-0.244	-0.302***			
	(0.132)	(0.135)	(0.142)			
Personal income						
(Ref: 1st quintile)						
2nd quintile				0.010	-0.005	-0.002
				(0.095)	(0.096)	(0.096)
3rd quintile				-0.127	-0.118	-0.092
				(0.093)	(0.094)	(0.096)
4th quintile				-0.067	-0.052	-0.010
				(0.102)	(0.104)	(0.107)
5th quintile				0.194	0.190	0.229
				(0.174)	(0.176)	(0.180)
Age × Personal income						
(Ref: 24–29 × 1st quintile)						
30–34 × Income Q2				-0.018	-0.020	-0.005
				(0.147)	(0.147)	(0.148)
30–34 × Income Q3				0.024	0.052	0.053
				(0.140)	(0.141)	(0.144)
30–34 × Income Q4				-0.159	-0.112	-0.119
				(0.146)	(0.146)	(0.153)

Continued on next page

	(1)	(2)	(3)	(4)	(5)	(6)
30–34 × Income Q5				-0.533**	-0.461**	-0.461**
				(0.211)	(0.211)	(0.219)
35–39 × Income Q2				0.087	0.083	0.068
				(0.176)	(0.177)	(0.178)
35–39 × Income Q3				0.060	0.097	0.052
				(0.170)	(0.171)	(0.174)
35–39 × Income Q4				-0.157	-0.097	-0.180
				(0.174)	(0.175)	(0.180)
35–39 × Income Q5				-0.587***	-0.488**	-0.582**
				(0.227)	(0.227)	(0.235)
40+ × Income Q2				0.090	0.049	0.057
				(0.250)	(0.251)	(0.253)
40+ × Income Q3				0.003	0.031	-0.073
				(0.251)	(0.252)	(0.254)
40+ × Income Q4				-0.098	-0.062	-0.221
				(0.253)	(0.253)	(0.258)
40+ × Income Q5				-0.772***	-0.690**	-0.875***
				(0.294)	(0.294)	(0.306)
Co-resident partner		-0.070	-0.113		-0.074	-0.107
		(0.050)	(0.083)		(0.050)	(0.083)
2nd pregnancy		-0.091**	-0.062		-0.101**	-0.058
		(0.044)	(0.069)		(0.044)	(0.069)
3rd pregnancy		-0.006	0.203**		-0.022	0.205**
		(0.051)	(0.085)		(0.052)	(0.085)
4+ pregnancies		0.152***	0.232**		0.136**	0.233**
		(0.052)	(0.104)		(0.054)	(0.107)
Neighbourhood SES		-0.038***	-0.025		-0.037***	-0.026
		(0.014)	(0.023)		(0.014)	(0.024)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Interaction controls	No	No	Yes	No	No	Yes
Observations	807,270	807,270	807,270	807,270	807,270	807,270

Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

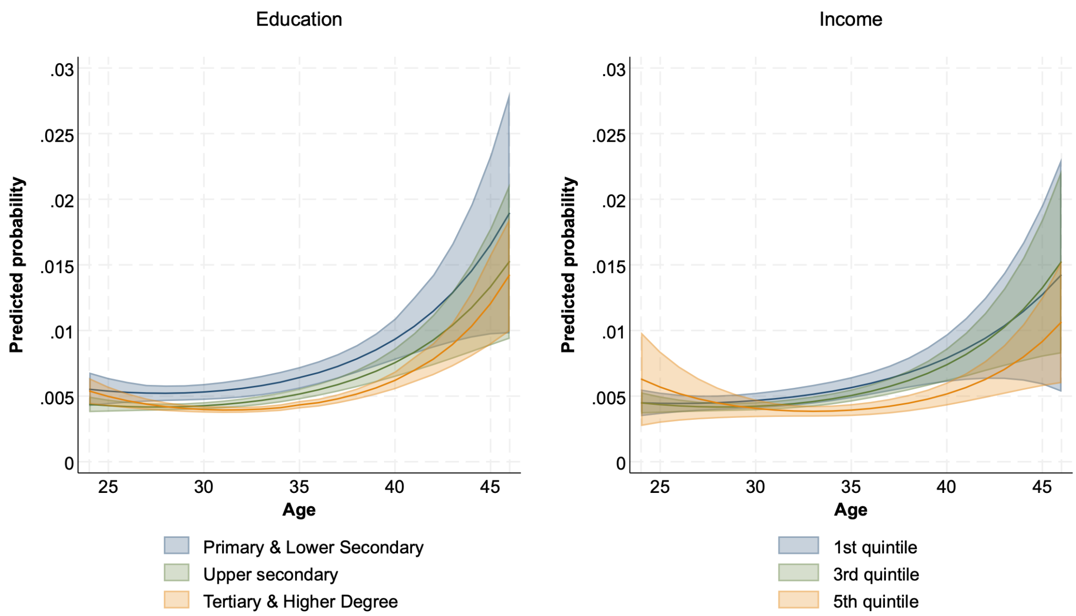

Figure S1: Interaction between maternal age and socioeconomic status. Left: educational attainment (primary & lower secondary, upper secondary, tertiary & higher education). Right: personal income (1st, 3rd and 5th quintile)

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