# Men's Biological Clock? Rethinking Paternal Age and Birth Risk in an Era of Delayed Parenthood

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## Introduction

As childbearing is increasingly postponed, the concept of a "biological clock" has been applied almost exclusively to women (Jamieson et al. 2010, Lloyd 1996, Phillips, Taylor and Bachmann 2019). Men, by contrast, are often assumed to face minimal reproductive constraints, with the ability to delay parenthood and compensate through partnering with younger women or leveraging socioeconomic advantages. However, this asymmetry is more assumed than established. Emerging evidence suggests that advanced paternal age is associated with adverse birth outcomes (Goisis et al. 2018, Phillips, Taylor and Bachmann 2019), yet it remains unclear whether these risks are substantial at the population level or whether they can be offset by concurrent social changes such as rising education and shifting patterns of assortative mating. This study reexamines the role of paternal age in an era of delayed parenthood, asking whether men, too, face meaningful biological limits that cannot be easily circumvented.

One limitation of prior research is its tendency to consider maternal and paternal ages in isolation. In practice, reproductive outcomes are shaped by the joint characteristics of both parents, including their relative ages. Patterns of partner age matching vary systematically across populations, with many unions characterized by older fathers and younger mothers, while age-homogamous and age-hypogamous couples are also increasingly common. These differences in partner age structure may condition how parental ages translate into birth outcomes, and are often assumed to mitigate age-related risks. However, whether partner selection can meaningfully offset the biological consequences of delayed parenthood remains unclear.

In addition, the pathways linking parental age to birth outcomes may differ. Low birth weight, for example, can arise from both shortened gestation and impaired fetal growth. Distinguishing between these pathways is crucial for understanding whether paternal age effects primarily reflect increased risks of prematurity or other mechanisms. At the same time, as delayed childbearing becomes more prevalent, an increasing number of women enter motherhood at later ages, raising questions about how partner characteristics, including paternal age, shape reproductive outcomes among older mothers. Finally, rising educational attainment is closely linked to delayed parenthood. Because parental socioeconomic advantages are associated with more favorable birth outcomes, it is important to assess the extent to which improvements in maternal and paternal education can offset the risks associated with delayed childbearing.

This study addresses these gaps by integrating biological and social perspectives on delayed parenthood. Using population-based data, we examine how paternal age shapes birth outcomes alongside maternal age, and whether these risks are modified by partner age differences or offset by improvements in parental education. In doing so, we show that while educational expansion has exerted a protective effect, and partner age structures vary substantially, neither process fully offsets the risks associated with delayed parenthood. The findings thus highlight the persistence of biological constraints in an era of profound social change.

Taiwan provides a uniquely informative setting for studying delayed parenthood due to its high-quality population registers and rapid shifts toward later childbearing. These trends closely parallel those observed across East Asia, Europe, and North America, making Taiwan a useful case for understanding how biological and socioeconomic processes shape birth outcomes in low-fertility societies. The availability of complete population data further allows us to examine these processes with a level of precision that is rarely possible in survey-based studies.

**Theoretical Framework and Expectations**

This study is informed by a life course perspective, which emphasizes that the timing of parenthood has consequences that reflect the interaction of biological aging, socioeconomic resources, and relational contexts. As childbearing is increasingly delayed, these dimensions become more tightly intertwined. On the one hand, fundamental cause theory suggests that improvements in socioeconomic resources—particularly education—should mitigate adverse health outcomes. On the other hand, research on assortative mating highlights how partner characteristics, including age differences, may structure how risks are distributed across couples. However, these perspectives have rarely been considered jointly in the context of paternal aging, and little is known about whether they can fully offset biologically rooted risks associated with parental aging. By integrating these perspectives together, this study examines whether the consequences of delayed parenthood—particularly those associated with paternal age—can be attenuated by changes in educational composition and partner selection.

Building on this framework, we examine three expectations. First, we expect that advanced paternal age will be associated with elevated risks of adverse birth outcomes, although these effects are likely to be smaller than those associated with maternal age. Second, if social processes mitigate biological risks, we would expect that age-disparate unions—particularly those involving younger female partners—are associated with lower risks among older fathers. Third, if socioeconomic resources offset age-related risks, improvements in parental education should reduce predicted probabilities of adverse outcomes, potentially attenuating the impact of delayed parenthood. At the same time, if biological constraints remain salient, these social and compositional factors may only partially offset the birth risks associated with advanced parental age.

## Data and Methods

### *Data Source and Sample Restrictions*

To investigate how paternal age affect birth outcomes, the birth registration data were acquired from the Ministry of the Interior in Taiwan. The year 1998 was the first year when birth register files were digitized. Thus, analyses will be done for the periods of 1998–2000 and 2018–2020, which cover a span of two decades of fertility changes. The data files contain information on the sex, birth date, birth type (singleton/multiple birth), parity, gestational age, birth location, delivery type, and birth weight of the newborn, as well as the date of birth, marriage date, education, aboriginal status of the mothers and fathers.

To ensure data quality, observations with implausible values are excluded. The analytic sample is restricted to births to mothers aged 15–54 and fathers aged 15–69, with gestational ages between 22 and 43 weeks and birth weights between 300 and 6,000 grams.

### *Variables and Measurements*

Two birth outcomes were investigated: preterm birth and low birth weight. Preterm births refer to all births that took place under 37 weeks of gestation; and low birth weight is defined as births under 2500 grams.

Paternal age at birth is measured by 5-year age groups ranging from 15–19 to 45–49 and 50–69; and a similar measure is created for maternal age at birth with response categories ranging from 15–19 to 50–54.

Parental age gap is categorized into three groups to capture both the magnitude and direction of age differences. Its definition is based on the age difference between spouses. Couples are classified as "same age" if spouses differ by no more than one year (±1 year), "husband older" if the father is more than one year older than the mother, and "husband younger" if the father is more than one year younger. This narrow window of 'same age' reflects near-identical life stage and provides a conservative benchmark for evaluating whether age asymmetry in partnerships is associated with differential birth risks. This definition captures age homogamy as a shared life stage while maintaining clear distinctions from age-asymmetric pairings. Results are robust to alternative definitions using a wider threshold (±2 years).

Paternal and maternal education is measured by four categories: less than high school, high school, junior college, and university and above. Parity status includes four categories: parities 1, 2, 3, and 4+. Dummy variables indicating whether a birth is a girl, and mother's and father's aboriginal status were also included.

### *Analytical Strategy*

The analysis proceeds in three steps. First, we document changes in parental age structure and the prevalence of delayed parenthood over time using descriptive statistics. Second, we estimate logistic regression models predicting preterm birth and low birth weight as functions of paternal and maternal age, adjusting for parental education, demographic characteristics, and birth order. Analyses focus on singleton births to minimize bias arising from the increasing concentration of multiple births at older ages. To assess whether paternal age effects operate primarily through prematurity, we compare models of low birth weight with those restricted to term births. Differences between these estimates provide insight into whether observed associations reflect increased risks of preterm delivery or other mechanisms. Third, we examine whether partner age differences moderate the association between parental age and birth outcomes. Additional analyses focus on first births to mothers aged 30 and above to assess whether partnering with a younger spouse mitigates birth risks at later maternal ages. Finally, we conduct counterfactual analyses that reweight the 1998–2000 sample to match the educational distribution of parents observed in 2018–2020. These simulations assess the extent to which improvements in paternal and maternal education offset the risks associated with delayed parenthood. All results should be interpreted as associations at the population level rather than causal effects at the individual level.

**Preliminary Findings and Discussion**

This study reexamines the role of paternal age in shaping birth outcomes in an era of delayed parenthood. Consistent with prior research, maternal age remains the primary determinant of adverse birth outcomes, with clear and persistent increases in risk at older ages. At the same time, we find that advanced paternal age is associated with modest but consistent increases in risk, particularly for low birth weight, indicating that men, too, face biological constraints that are not negligible at the population level.

Importantly, our findings provide limited support for the idea that these risks can be mitigated through partner selection. Although age-disparate unions are common, predicted risks vary little across partner age configurations, and interaction analyses do not reveal a systematic buffering effect of younger partners. This suggests that the apparent advantages of age-disparate unions are largely compositional—reflecting younger maternal ages—rather than a true moderation of biological risk. In this sense, partner choice does not provide a reliable mechanism for offsetting the consequences of delayed fatherhood.

Similarly, while improvements in parental education are associated with lower risks, counterfactual analyses show that educational expansion only partially offsets the increase in adverse outcomes over time. Even when both maternal and paternal education are reweighted to the more advantaged distribution observed in recent cohorts, predicted risks remain substantially below observed levels in 2018–2020, indicating that the upward trend is primarily driven by delayed parenthood. These findings highlight the limits of socioeconomic resources in compensating for biologically rooted risks.

Taken together, the results point to a more nuanced understanding of reproductive aging. While maternal age continues to play a dominant role, paternal age constitutes an independent dimension of risk that cannot be fully explained by social or demographic processes. The findings therefore challenge the implicit assumption that men can extend their reproductive window without consequence, suggesting instead that the “biological clock” is not exclusively female, but operates—albeit differently—across both sexes.

More broadly, this study underscores the importance of integrating biological, socioeconomic, and relational perspectives in understanding fertility and health in low-fertility societies. As delayed parenthood becomes increasingly prevalent, future research should continue to examine how these forces interact across institutional contexts, particularly in settings where access to reproductive technologies and patterns of family formation are rapidly evolving.

Table 1. Descriptive characteristics of births by period

| | 1998–2000 | 2018–2020 |
|---|---|---|
| **no. of births** | 516,680 | 857,116 |
| **% singleton births** | 97.6% | 96.1% |
| **% preterm birth** | 7.3% | 10.2% |
| **% low birth weight** | 6.5% | 10.0% |
| **maternal age** | | |
| 15–19 | 4.4% | 1.3% |
| 20–24 | 22.2% | 8.5% |
| 25–29 | 38.5% | 23.0% |
| 30–34 | 26.7% | 36.0% |
| 35–39 | 7.3% | 25.6% |
| 40–44 | 0.9% | 5.3% |
| 45–49 | 0.0% | 0.3% |
| 50–54 | 0.0% | 0.0% |
| **paternal age** | | |
| 15–19 | 0.9% | 0.2% |
| 20–24 | 8.1% | 4.3% |
| 25–29 | 29.4% | 16.3% |
| 30–34 | 37.2% | 32.3% |
| 35–39 | 18.4% | 31.0% |
| 40–44 | 4.7% | 12.0% |
| 45–49 | 1.0% | 2.9% |
| 50–69 | 0.3% | 1.0% |
| **mean maternal age** | 27.7 | 31.7 |
| **mean paternal age** | 31.2 | 34.1 |
| **parental age gap** | | |
| huband younger | 5.1% | 11.7% |
| same age(+/-1) | 29.3% | 37.8% |
| husband older | 65.7% | 50.5% |
| **mean parental age gap** | 3.5 | 2.5 |
| **maternal education** | | |
| < high school | 39.3% | 10.1% |
| high school | 39.8% | 23.7% |
| jr. college | 13.2% | 8.3% |
| university + | 7.8% | 57.9% |
| **paternal education** | | |
| < high school | 40.1% | 9.5% |
| high school | 35.6% | 26.2% |
| jr. college | 13.7% | 8.1% |
| university + | 10.6% | 56.3% |
| **sex of baby: girl** | 47.8% | 48.2% |
| **parity status** | | |
| parity 1 | 46.0% | 51.3% |
| parity 2 | 36.5% | 36.8% |
| parity 3 | 14.2% | 9.3% |
| parity 4+ | 3.3% | 2.7% |
| **aboriginal mother** | 0.9% | 3.9% |
| **aboriginal father** | 0.8% | 3.5% |

Table 2. Associations between parental age and birth outcomes, by period

| | 1998–2000 | | | 2018–2020 | | |
|---|---|---|---|---|---|---|
| | **pretermB** | **low birthwgt** | **low birthwgt (term)** | **pretermB** | **low birthwgt** | **low birthwgt (term)** |
| **paternal age (ref. 30–34)** | | | | | | |
| 15–19 | 1.16 | 1.17 | 1.11 | 0.87 | 0.83 | 0.90 |
| 20–24 | 1.05 | 1.06 | 0.99 | 0.97 | 0.96 | 0.95 |
| 25–29 | 1.01 | 1.02 | 0.99 | 1.02 | 1.01 | 1.01 |
| 35–39 | 1.00 | 1.00 | 0.99 | 0.99 | 1.02 | 1.02 |
| 40–44 | 1.06 | 1.00 | 0.97 | 0.97 | 0.96 | 0.93 |
| 45–49 | 1.04 | 1.02 | 0.95 | 0.96 | 0.93 | 0.93 |
| 50–54 | 1.02 | 1.14 | 1.18 | 1.05 | 0.85 | 0.71 |
| >=55 | 1.11 | 1.23 | 0.99 | 0.98 | 0.74 | 0.56 |
| | | | | | | |
| **maternal age (ref. 30–34)** | | | | | | |
| 15–19 | 1.40 | 1.59 | 1.64 | 1.34 | 1.19 | 1.12 |
| 20–24 | 0.98 | 1.14 | 1.31 | 0.95 | 0.96 | 1.01 |
| 25–29 | 0.90 | 0.97 | 1.06 | 0.93 | 0.94 | 0.99 |
| 35–39 | 1.34 | 1.26 | 1.14 | 1.23 | 1.19 | 1.09 |
| 40–44 | 1.76 | 1.65 | 1.57 | 1.51 | 1.45 | 1.29 |
| 45–49 | 2.18 | 2.05 | 2.27 | 2.48 | 1.97 | 1.43 |
| 50–54 | 2.11 | 3.19 | 1.51 | 3.98 | 3.71 | 3.94 |
| | | | | | | |
| **maternal education (ref. junior high school)** | | | | | | |
| high school | 0.91 | 0.87 | 0.84 | 0.90 | 0.87 | 0.87 |
| junior college | 0.90 | 0.82 | 0.77 | 0.84 | 0.80 | 0.80 |
| university and above | 0.85 | 0.79 | 0.76 | 0.74 | 0.74 | 0.74 |
| | | | | | | |
| **paternal education (ref. junior high school)** | | | | | | |
| high school | 0.96 | 0.90 | 0.88 | 0.93 | 0.89 | 0.89 |
| junior college | 0.92 | 0.82 | 0.79 | 0.90 | 0.86 | 0.86 |
| university and above | 0.92 | 0.83 | 0.81 | 0.87 | 0.83 | 0.82 |
| | | | | | | |
| **mother's aboriginal status** | 1.23 | 1.29 | 1.32 | 1.10 | 1.19 | 1.17 |
| **father's aboriginal status** | 1.30 | 1.41 | 1.44 | 1.09 | 1.08 | 1.05 |
| | | | | | | |
| **sex of baby: female** | 0.82 | 1.23 | 1.59 | 0.82 | 1.31 | 1.72 |
| | | | | | | |
| **parity status (ref. parity 1)** | | | | | | |
| parity 2 | 1.12 | 0.85 | 0.72 | 1.07 | 0.74 | 0.67 |
| parity 3 | 1.15 | 0.81 | 0.70 | 1.23 | 0.75 | 0.68 |
| parity 4+ | 1.41 | 1.08 | 0.94 | 1.64 | 1.01 | 0.86 |

Figure 1. Predicted probability of low birth weight by maternal age and partner age pairing

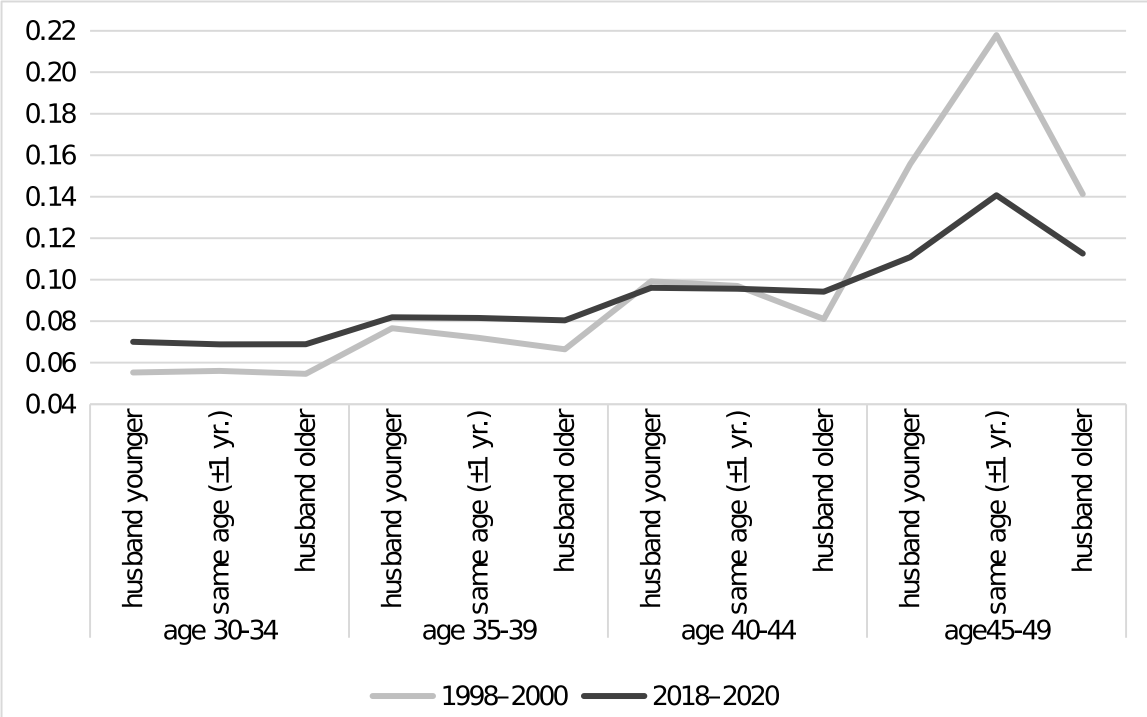
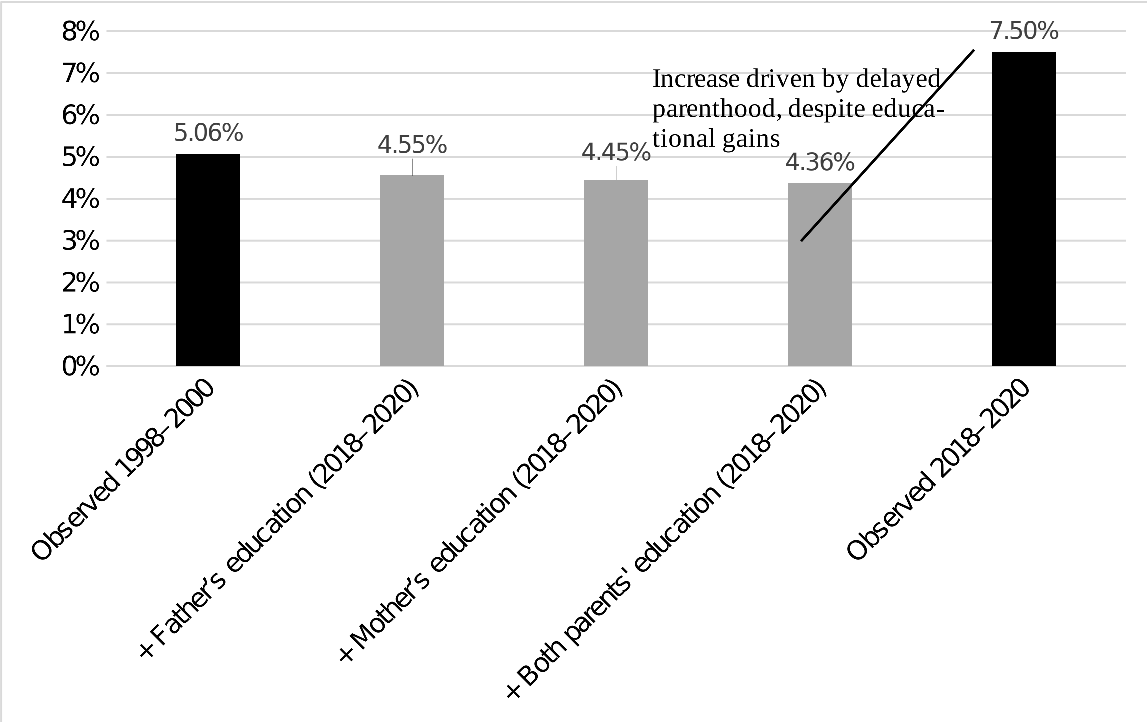



Figure 2. Changes in low birthweight risk under observed and counterfactual educational distributions


8%
7%
6%
5%
4%
3%
2%
1%
0%
5.06%
4.55%
4.45%
4.36%
7.50%
Increase driven by delayed parenthood, despite educa-tional gains
Observed 1998–2000
+ Father’s education (2018–2020)
+ Mother’s education (2018–2020)
+ Both parents' education (2018–2020)
Observed 2018–2020