

The Impact of Advanced Maternal Age on Birth Weight in sub-Saharan Africa: A Matched Observational Study

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INTRODUCTION

- Previous studies have suggested that advanced maternal age is associated with various birth outcomes.
- The effects of adverse birth outcomes are especially severe for vulnerable populations.
- Detected association does not always imply causation.

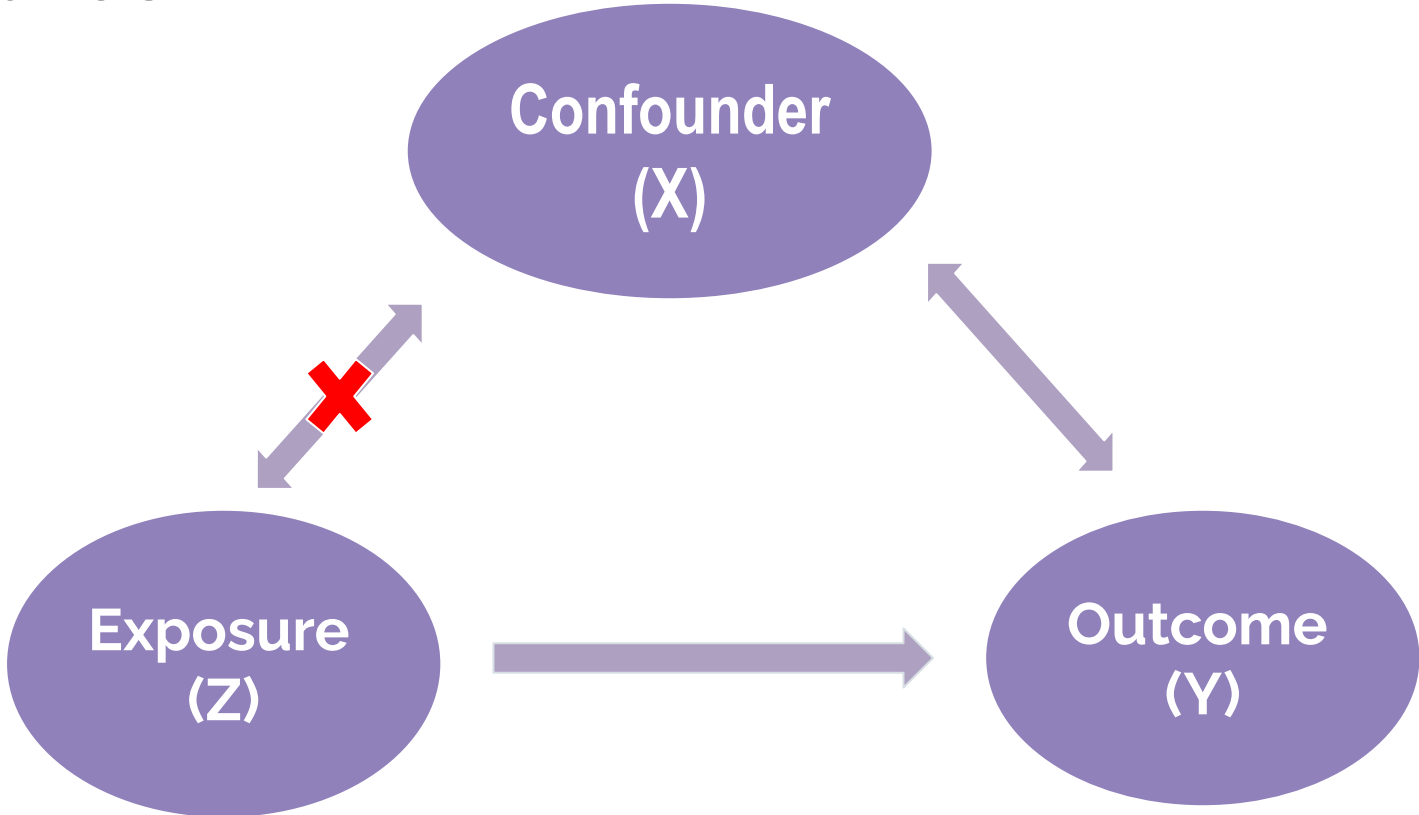
Study aim: Using a matched observational study to determine if advanced maternal age has a causal effect on birth outcomes.

METHODS

Data: The study utilizes data from the Demographic and Health Surveys (DHS), specifically focusing on the Kenya 2014 DHS dataset.

OVERALL: The research employs a causal inference framework based on a matching design to establish causation rather than mere association between advanced maternal age and low birth weight outcomes.

Measures:



- Exposure: Advanced Maternal Age indicator (≥ 35 vs. $20 - 29$).
- Outcome: Birth Weight (in grams) as a continuous variable.
- Potential Confounders: Wealth Index, Mother's Education Level, Urban/Rural, Marriage Status, etc.

METHODS

Statistical analysis:

Observed outcomes and potential outcomes:

$$Y_n = \begin{cases} Y_n(1) & \text{if } Z_n = 1, \\ Y_n(0) & \text{if } Z_n = 0. \end{cases}$$

Average Treatment Effect: Refers to the average impact of a treatment on the outcome variable, compared to what the outcome would have been if the treatment had not been received.

$$ATE = \frac{1}{N} \sum_{n=1}^N Y_n(1) - \frac{1}{N} \sum_{n=1}^N Y_n(0)$$

- Reducing confounding bias via matching.

Matched Observational Study Process:

- Matching: To minimize total distance in confounders between the matched subjects, each exposed/treated subject is matched with one or multiple controls.
- Balance Assessment: Calculate standard difference in means for ideal (<0.1), acceptable ($0.1-0.2$) or unacceptable (>0.2) balance.

$$\frac{\bar{x}_{\text{exposed}} - \bar{x}_{\text{unexposed}}}{\sqrt{\frac{\sigma_{\text{exposed}}^2 + \sigma_{\text{unexposed}}^2}{2}}}$$

- Outcome Analysis:
Randomization induced by matching: Every individual had a $\frac{1}{4}$ change of being exposed,

$$P(Z_{ij} = 1 | \sum_{j=1}^4 Z_{ij} = 1, \text{confounders are matched}) = \frac{1}{4}$$

Difference-in-means estimator for ATE:

$$T = \frac{1}{I} \sum_{i=1}^I \left(Y_{i1} - \frac{Y_{i2} + Y_{i3} + Y_{i4}}{3} \right)$$

Conservative variance estimator:

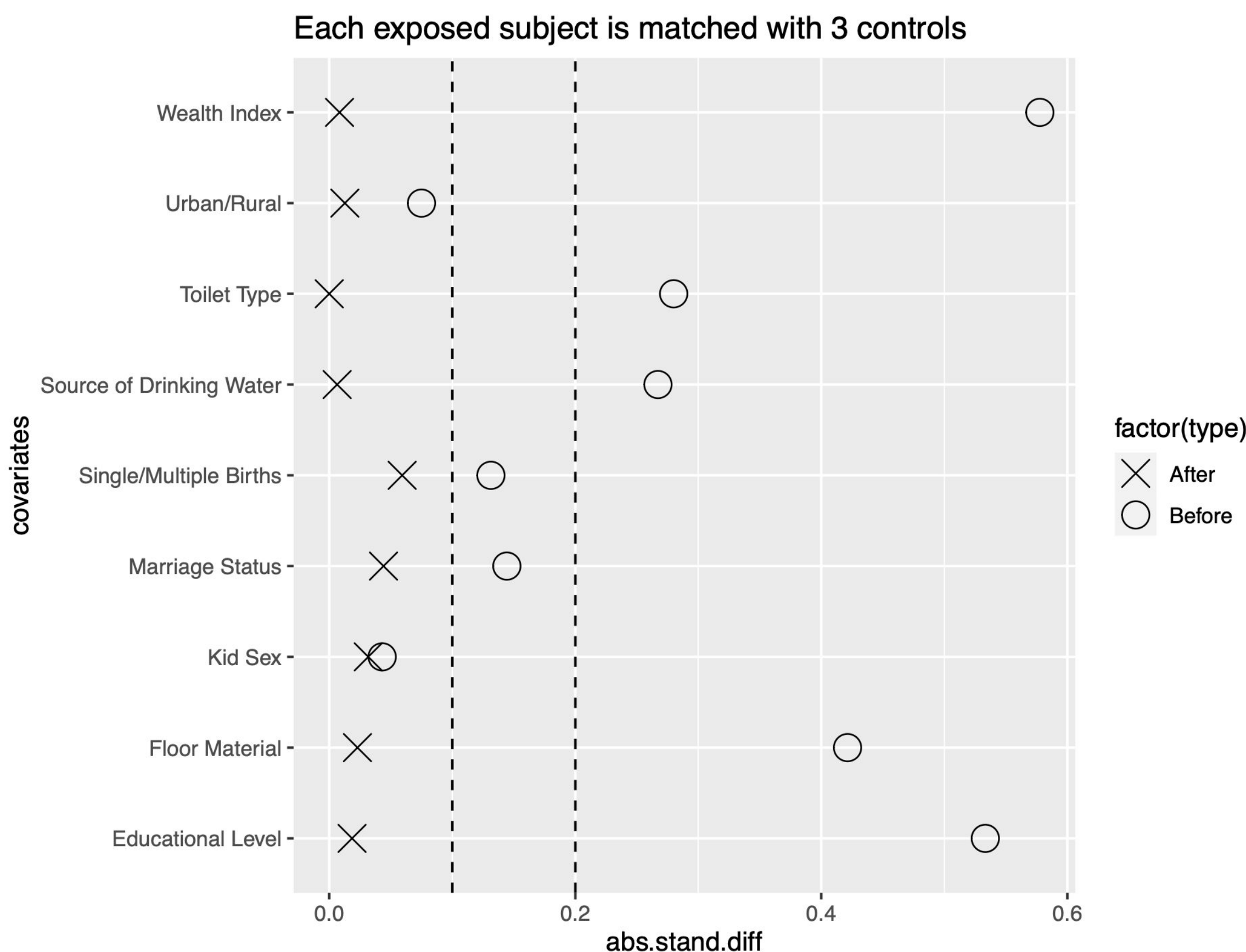
$$\widehat{\text{Var}}(T) = \frac{1}{I(I-1)} \sum_{i=1}^I \left(Y_{i1} - \frac{Y_{i2} + Y_{i3} + Y_{i4}}{3} - T \right)^2$$

RESULTS

Table 1: Data Summary of Kenya 2014

	Data Description		
	Unexposed (N=3321)	Exposed (N=698)	Overall (N=4019)
Maternal Age			
Mean (SD)	24.3 (2.72)	37.9 (2.69)	26.7 (5.82)
Median [Min, Max]	24.0 [20.0, 29.0]	37.0 [35.0, 47.0]	25.0 [20.0, 47.0]
Kid Current Age			
Mean (SD)	1.92 (1.39)	1.86 (1.41)	1.91 (1.39)
Median [Min, Max]	2.00 [0, 4.00]	2.00 [0, 4.00]	2.00 [0, 4.00]
Birth Weight			
Mean (SD)	3270 (627)	3250 (689)	3260 (638)
Median [Min, Max]	3200 [600, 6300]	3200 [1000, 6900]	3200 [600, 6900]
Low Birth Weight Indicator			
No	3089 (93.0%)	635 (91.0%)	3724 (92.7%)
Yes	232 (7.0%)	63 (9.0%)	295 (7.3%)

Figure A: Love Plot shows the balance of each confounder before and after matching. After matching, all the confounders are in the ideal range of balance.



After matching, the total remaining sample size is 840 (210 exposed subjects and 630 unexposed).

Table 3: The point estimate (ATE) was calculated and it indicates a negative effect of advanced maternal age on the birth weight. A confidence interval was calculated. The p-value under the null effect is significant.

Table 3: Results of Analysis		
Point Estimate	Confidence Interval (95%)	p-value
-173.39	(-246.95, -99.82)	< 0.001

On average, the effect of advanced maternal age is to reduce the birthweight by -173 grams. The confidence interval of this weight reduction is between -246 and -99 grams.

SUMMARY AND DISCUSSION

- Advanced maternal age has a causal relationship with low birth weight outcomes for Kenya, 2014.
- Point estimate was negative, indicating a negative effect.
- Birth weight was lower for mothers of advanced age versus mothers of young age.
- P-value is significant which assures us that advanced maternal age has an impact on birth weight.
- Prioritization of prenatal resources for mothers with advanced maternal age.

LIMITATIONS

Acknowledging limitations such as unmeasured coufounders, not including other countries in DHS, and missing data, this study's robust methodology and statistical analysis offer valuable insights into the relationship between maternal age and birth weight outcomes in sub-Saharan Africa.

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