BMJ Open

Association between maternal age at childbirth and children's internalising problems in the USA: a cross-sectional mediation analysis of housing instability and family support using the 2022 National Survey of Children's Health (NSCH)

Ming Milano Li ,[1,2] Dianshi Moses Li ,[3] Qinru Ruby Ju,[3] Yingjie Jay Zhao ,[3,4] Zhan Thor Tuo ,[3] Xiaoran Sarah Zhang,[5] Jianhong Liu [6]

To cite: Li MM, Li DM, Ju QR, *et al*. Association between maternal age at childbirth and children's internalising problems in the USA: a cross-sectional mediation analysis of housing instability and family support using the 2022 National Survey of Children's Health (NSCH). *BMJ Open* 2026;**16**:e098280. doi:10.1136/bmjopen-2024-098280

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-098280).

Received 20 December 2024
Accepted 05 February 2026

For numbered affiliations see end of article.

Correspondence to
Professor Jianhong Liu;
liujianhong@must.edu.mo

ABSTRACT

Objectives The optimal maternal age at childbirth has been a topic of bourgeoning literature, with earlier ages offering physiological benefits for maternal recovery. In contrast, later ages to give birth may provide psychological advantages due to greater emotional maturity. This study investigates the impact of maternal age at childbirth on children's internalising problems and explores the mediating roles of housing instability and family support in this relationship.

Design Cross-sectional study; mediation analysis of the 2022 National Survey of Children's Health (NSCH) data.

Setting Response in the 2022 NSCH in the USA.

Participants This study is based on the 2022 NSCH, collecting a total of 54 103 completed surveys from randomly selected households across the USA. In this study, after excluding participants due to missing values in critical variables, 48 073 participants were included in the final analysis.

Results Our findings are consistent with the hypothesis that increasing maternal age at childbirth is associated with lower children's internalising problems. Analysis suggested this association operates directly and is indirectly linked to child outcomes through lower levels of housing instability and higher levels of family support. However, a distinct indirect effect emerged: increased maternal age was also associated with reduced family support, which was in turn linked to more internalising problems. The results illuminate potential mechanisms linking maternal age at childbirth to children's internalising problems and underscore the importance of stable housing and family support in mitigating risk factors for children's emotional well-being.

Conclusion We found an association between advanced maternal age and fewer internalising problems in children. This relationship appears to operate directly and indirectly via a sequential pathway: higher maternal age correlates with lower housing instability, which in turn is associated with increased family support, ultimately correlating with improved child mental health outcomes.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study used a nationally representative sample (n=48 073) from the 2022 National Survey of Children's Health.
⇒ The analysis employed validated scales for measuring children's internalising problems, housing instability and family support.
⇒ A serial mediation model was used to investigate the complex pathways between maternal age and children's mental outcomes.
⇒ The cross-sectional design limits the ability to establish causal inferences from the findings.
⇒ The reliance on parent-reported measures for all variables may introduce potential for common method bias.

INTRODUCTION

Maternal age has emerged as a key factor in research on childbearing.[1–6] It influences the mother's health and her child's well-being across the lifespan, affecting physical, cognitive and behavioural outcomes.[7] However, age-related health risks associated with childbearing do not affect mothers of all ages equally.

Older mothers face elevated risks of perinatal mortality and maternal near misses—the latter defined by the WHO as a woman who nearly died but survived a life-threatening complication during pregnancy, childbirth or within 42 days of pregnancy termination.

In contrast, children born to younger mothers are more likely to experience adverse birth outcomes and long-term health challenges.[2 8 9] Furthermore, studies indicate that advanced maternal age is associated with a higher incidence of congenital and chronic conditions in children, including cardiovascular, endocrine and neurological disorders.[10–13] This pattern aligns with the 'weathering hypothesis' proposed by Geronimus,[14] which posits that systemic socioeconomic and racial inequities accelerate biological ageing and health deterioration among black women. As a result, earlier childbearing may yield better health outcomes for black women, whereas delayed childbearing appears more advantageous for white women.[15] In addition to these physical health implications, research also indicates potential neurocognitive benefits for children of older mothers, such as a lower risk of dementia, delayed cognitive decline and better memory performance in later life.[16]

Maternal age at childbirth and children's internalising problems

Internalising problems represent a key dimension of child mental health, characterised by inwardly directed emotional distress. Following Suh and Luthar,[17] our analysis focuses on symptoms of anxiety and depression as core components of this broader construct.

While prior research has linked advanced maternal age with a range of adverse obstetric and perinatal outcomes,[18–20] other studies indicate that older maternal age is often associated with higher socioeconomic status—including greater educational attainment and income—which may in turn confer protective benefits for child health.[21 22]

Furthermore, evidence suggests that children's overall health tends to improve with increasing maternal age at childbirth.[23–25] In particular, offspring of older mothers exhibit fewer behavioural and academic problems compared with those of younger mothers.[16] Supporting this, Duncan *et al* found that each additional year of delayed childbearing is associated with a 0.02 to 0.04 SD improvement in school achievement and a comparable reduction in behavioural difficulties.[26]

Housing instability

Extensive research has established a strong association between housing instability—characterised by experiences such as eviction, homelessness and high housing cost burden—and adverse child health outcomes, including poorer mental health.[27] This relationship appears to be dose dependent, with greater exposure to housing instability correlating with higher risks of mental health challenges.[28] Specifically, housing instability has been linked to increased internalising problems in children. For example, moving homes twice or more before age two is associated with elevated internalising behaviour scores at age nine, suggesting that early childhood may constitute a sensitive period during which frequent residential mobility exerts detrimental effects on mental health.[29] Moreover, children exposed to housing instability face a heightened risk of developing anxiety and depression. A study found that such exposure predicts not only higher anxiety and depression scores in childhood, but also increased depressive symptoms in adulthood.[30] Additionally, poor housing quality has been linked to elevated levels of anxiety and depression in children, potentially leading to lifelong mental health challenges.[31]

Mothers play a critical role in shaping children's emotional and stress regulation; however, housing instability can disrupt these maternal influences.[32 33] Furthermore, family conflict is strongly associated with children's internalising behaviours, which underscores the importance of stable and supportive home environments.[32] In this context, housing conditions are often examined as mediating factors between parental characteristics and child outcomes.[34 35] Notably, maternal age at childbirth impacts socioeconomic status, linking it closely to housing security. As a result, families experiencing economic hardship are more vulnerable to housing instability, which increases stress and limits the availability of emotional support.

Family support

Younger maternal age at childbirth with limited socioeconomic resources often hinders a mother's access to stable housing and a robust support network.[35] In such situations, strong family support can help alleviate stress.[36] Furthermore, family support enhances parental coping and reduces stress, which in turn positively impacts children's emotional well-being and lowers the risk of internalising problems.[37]

A stable and supportive family environment provides emotional security and consistency.[34] The Strengthening Families Approach identifies support in times of need as a key protective factor. This approach emphasises the role of family support in decreasing the stress on children.[38] In well-supported families, children could alleviate isolation or insecurity. This highlights family support as a protective factor against adverse conditions.

Current study and hypotheses

This study examines the impact of maternal age at childbirth as a key predictor of children's internalising problems. While the physical effects of maternal age at childbirth during pregnancy and the prenatal period are well documented, less attention has been paid to the psychological outcomes in children related to maternal age at childbirth. To address this gap, our research explores the intergenerational influence of maternal age at childbirth on children's internalising problems, specifically focusing on the roles of housing instability and family support as mediators.

The following hypotheses are proposed:

H1: Higher maternal age at childbirth is associated with fewer internalising problems in children.

H2: The relationship between maternal age at childbirth and children's internalising problems is mediated by housing instability.

H3: The relationship between maternal age at childbirth and children's internalising problems is mediated by family support.

H4: The relationship between maternal age at childbirth and children's internalising problems is serially mediated by housing instability and family support.

METHOD

Participants

This study is based on the 2022 National Survey of Children's Health (NSCH), funded and directed by the Health Resources and Services Administration Maternal and Child Health Bureau. The survey aims to provide comprehensive national and state-level data on the physical and emotional well-being of children aged 0–17 across the USA. The primary data collection for the NSCH was conducted by the US Census Bureau.

The 2022 NSCH was administered both online and by mail, collecting a total of 54 103 completed surveys from randomly selected households across the USA. For additional technical details and information about this survey, please refer to the Child and Adolescent Health Measurement Initiative.[39] In this study, after excluding participants due to missing values in critical variables, 48 073 participants were included in the final analysis. The detailed screening process is presented in figure 1. Additionally, a Love plot (online supplemental figure S1) was used to evaluate the potential impact of attrition and missing data on sample representativeness. The results indicated that attrition and missingness did not substantially alter the demographic or health-related characteristics of the NSCH 2022 sample.

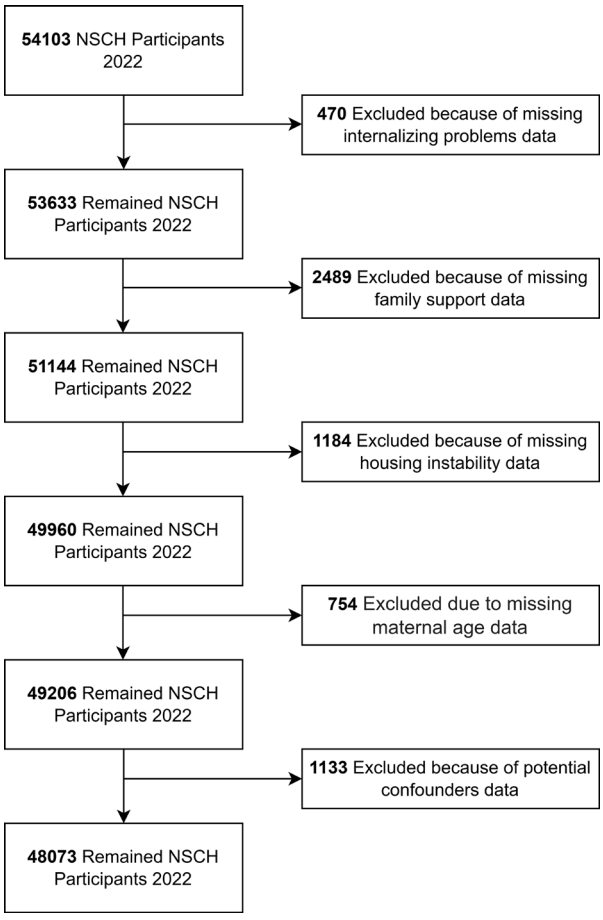

Figure 1 Flowchart of exclusion criteria for the 2022 National Survey of Children's Health (NSCH) dataset.

Patient and public involvement

The current study is a secondary analysis of deidentified, publicly available data from the NSCH. Patients and/or the public were not involved in formulating the research question or selecting outcome measures for this secondary analysis, nor in the design, conduct, analysis or interpretation of the present study. As individual respondents cannot be identified or contacted, results will not be disseminated directly to survey participants. Findings will be communicated through peer-reviewed publications and conference presentations.

Measures

This study includes four core variables—maternal age at childbirth, housing instability, family support and internal problems—along with other explanatory covariates, all of which were extracted from the 2022 NSCH dataset.[40]

Maternal age at childbirth corresponds to the item in the 2022 NSCH: 'What was the age of the mother when this child was born? Your best estimate is fine'. The response is recorded as the mother's numeric age in years.

Housing instability includes three items related to housing cost burden, eviction and homelessness: 'during the past 12 months, (1) was there a time when you were not able to pay the mortgage or rent on this? (2) how often were you worried or stressed about being evicted, foreclosed on or having your housing condemned? (3) since the child was born, have they ever been homeless or lived in a shelter?' These items have been used in previous research to measure the degree of housing instability.[27] Among them, items 1 and 3 were dichotomous variables, which were coded as '1' for 'yes' and '0' for 'no'; item 2 was measured by a 5-point question, from 1 to 5, with '1' coded as 'never' and '5' coded as 'always'. To unify the dimensions and facilitate interpretation, item 2 was recoded into a 0–1 scale using min–max normalisation. The transformation was performed using the following equation (1):

$$s_p = (s_{os} - s_{cn}) / (s_{cx} - s_{cn}) \qquad (0 \le s_p \le 1) \qquad (1)$$

where s_p represents the normalised percentage score, s_{os} is the original score, s_{cx} is the conceptual maximum of the original scale and s_{cn} is the conceptual minimum of the original scale. In this study, all items were recoded and summed, ensuring that higher scores for housing instability reflect a greater degree of instability.

Family support was assessed using four items: 'When your family faces problems, how often are you likely to do each of the following? (1) Talk together about what to do; (2) work together to solve our problems; (3) know we have strengths to draw on; (4) stay hopeful even in difficult times'. All items were measured by a 4-point scale, from 1 to 4, '1' as 'none of the time' and '4' as 'all of the time'. Following the processing method described in Gjelsvik *et al*,[41] the scores of the four items were summed to create a composite measure, with higher scores indicating stronger family support. In this study, the Cronbach's alpha for this measure is 0.903.

In this study, the variable internalising problems is measured using the following two items: 'Has a doctor or other healthcare provider EVER told you that this child has: (1) Anxiety problems? (2) Depression?' If a participant is reported to have either anxiety or depression, this variable is coded as 1; otherwise, it is coded as 0. It is important to note that this operational definition captures only two common manifestations of internalising psychopathology.

The selection of explanatory covariates in this study followed the recommendations and principles for identifying appropriate control variables.[42–44] This approach ensures that these covariates minimise confounding and reduce the potential for misleading results. Specifically, this study used demographic variables from the 2022 NSCH, including the selected child's sex and race, the caregiver's sex, whether the participant was born in the USA, the participant's physical and mental health conditions, household income as a percentage of the federal poverty level (FPL) and the number of family members. Sensitivity analyses and robustness checks confirmed that the results remained stable across these covariates (see online supplemental material 1).

Analysis

This study conducted multiple mediation analyses to evaluate the relationship between maternal age at childbirth and internalising problems, mediated by housing instability and family support. To ensure the reliability and validity of the estimators, we followed the recommendations of Zhao *et al*[45] and used the percentile bootstrap method to estimate all direct and indirect effects. Both unstandardised coefficients and percentile bootstrap coefficients (b_p) were reported.[46] The b_p coefficient is an emerging regression metric regarded as a replacement for standardised coefficients due to their limitations in comparability and interpretability.[47–50] It has been widely adopted in public health and other social science fields.[51–53] The indirect effects were calculated as the mean product of the corresponding b_p coefficients from 5000 bootstrap regressions, allowing for statistical comparability of different indirect effects within the same mediation model. For further technical details and computer programmes, please refer to references.[46 54] All analyses were conducted using Python V.3.12 and R V.4.5, along with Andrew Hayes' PROCESS macro for R (V.4.3).[55]

To improve comparability and interpretability across measures, we rescaled all continuous variables to a common 0–1 percentage score before modelling. We report effect sizes using the b_p, which facilitates interpretation on a percentage-point scale.[46 50] For transparency, we also report the corresponding unstandardised coefficients estimated on the original scales as a reference alongside b_p. Although when the outcome is binary, ordinary least squares (OLS) corresponds to a linear probability model, and coefficients are interpreted as absolute changes in outcome probability, a percentage score can be viewed as a continuous variable, and its b_p can be interpreted as a percentage change in the outcome variable.[46 50] Therefore, to better compare unstandardised and percentage coefficients, we kept both analyses using OLS estimation.

The current study used 'model 6' as the mediation model in the PROCESS macro to test the mediating effect. The mediation model in this study contains three paths, and the corresponding regression equations are as follows:

$$M_{Housing\ instability}=\beta_0+\beta_1 x_{Maternal\ age\ at\ childbirth}+\sum\gamma_{1k}C_k+\varepsilon_1 \quad (1)$$

$$M_{Family\ support}=\beta_3+\beta_4 x_{Maternal\ age\ at\ childbirth}+\beta_5 M_{Housing\ instability}+\sum\gamma_{2k}C_k+\varepsilon_2 \quad (2)$$

$$Y_{Internalizing\ problems}=\beta_7+\beta_8 x_{Maternal\ age\ at\ childbirth}+\beta_9 M_{Housing\ instability}+\beta_{10} M_{Family\ support}+\sum\gamma_{3k}C_k+\varepsilon_3 \quad (3)$$

In these equations, 'C_k' refers to the set of various covariates, and all equations use the same set of covariates. A list of covariates is provided (see online supplemental table S1). No default settings have been modified in the PROCESS macro.

RESULTS

Participant characteristics

The characteristics of demographic variables are reported in table 1. Among 48 073 respondents, the average maternal age at childbirth was above 30 (mean=30.49, SD=5.73), and more than half of the children were male (51.66%). The caregivers' physical and mental health were also illustrated (mean=2.12, SD=0.92; mean=2.15, SD=0.88). The mean of the housing instability was 0.17 (SD=0.44). On average, family support was 5.93 (SD=2.29). The mean score of children internalising problems was 0.05 (SD=0.21). The non-Hispanic white was the largest racial group (65.89%), and the second-largest racial group was Hispanic, comprising 14.8% in the model. The remaining racial categories included non-Hispanic multiracial (8.2%), non-Hispanic Asian (5.7%) and non-Hispanic black (5.5%). The female caregiver occupied 68.62% (n=32 989) and the male was 31.38% (n=15 084). The distribution of household income was categorised according to the FPL. Families with incomes between 0% and 99% of the FPL represented 10.99% (n=5366), while those between 100% and 199% of the

Table 1 Demographic characteristics (n=48 073)

Characteristic	M±SD/F (%)
Maternal age	30.49±5.73
Caregiver's physical health	2.12±0.92
Caregiver's mental health	2.15±0.88
Housing instability	0.17±0.44
Family support	5.93±2.29
Internalising problems	0.05±0.21
Selected child's sex	
Female	23 240 (48.34%)
Male	24 833 (51.66%)
Selected child's race	
Hispanic	7082 (14.73%)
Non-Hispanic Asian	2768 (5.76%)
Non-Hispanic black	2632 (5.48%)
Non-Hispanic multirace	3918 (8.15%)
Non-Hispanic white	31 673 (65.89%)
Caregiver sex	
Female	32 989 (68.62%)
Male	15 084 (31.38%)
Household income as a percentage of the federal poverty level	
0–99% FPL	5282 (10.99%)
100–199% FPL	7455 (15.51%)
200–399% FPL	14 208 (29.56%)
400% FPL or greater	21 128 (43.95%)
Number of family members in 2022	
1 member	2972 (6.18%)
2 members	14 433 (30.02%)
3 members	18 771 (39.05%)
4 members	8157 (16.97%)
5 members	3740 (7.78%)

F, frequency; FPL, federal poverty level; M, mean.

FPL constituted 15.51% (n=7455). Families with incomes between 200% and 399% of the FPL comprised 29.56% (n=14 208), and households with incomes at 400% FPL or higher comprised the largest proportion, at 43.95% (n=21 128). The largest group of family members was made up of three, constituting 39.05% (n=18 771), and the smallest group was five, comprising 7.78% (n=3740).

Main effects of maternal age at childbirth on outcomes

Online supplemental tables S2 and S3 present the preliminary linear regression analysis results with multicollinearity diagnostics. The results showed that maternal age at childbirth was negatively related to children's internalising problems (B=−0.005, p<0.001). Family support was also negatively related to children's internalising problems (B=−0.020, p<0.001). Housing instability was positively related to children's internalising problems (B=0.085, p<0.001). The multicollinearity test also showed an acceptable level, and the variance inflation factor (VIF) values of all variables involved in the analysis were below 5. This provides great confidence for the subsequent mediation analysis.

As described in table 2 and figure 2, there was a significant negative association between maternal age at childbirth and children's internalising problems (b_p=−0.045, p<0.001, CI −0.055 to −0.034), which indicates that the higher maternal age at birth, the less internalising problems of the children. The association between maternal age at childbirth and housing instability was negative (b_p=−0.043, p<0.001, CI −0.050 to −0.035), illustrating that as maternal age at childbirth increased, housing instability decreased. The housing instability also positively affected children's internalising problems (b_p=0.094, p<0.001, CI 0.076 to 0.112). Moreover, the larger the maternal age at childbirth, the less family support (b_p=−0.030, p<0.001, CI −0.038 to −0.022), and there was a negative impact between family support and child internalising problems (b_p=−0.085, p<0.001, CI −0.10 to −0.07).

Indirect effects of maternal age at childbirth on outcomes

As shown in table 3, housing instability negatively mediated the relationship between maternal age at childbirth and child internalising problems (b_p=−0.004, p<0.001, CI −0.005 to −0.003) and family support positively mediated this relationship (b_p=0.003, p<0.001, CI 0.002 to 0.003). These results supported H2 and H3. Moreover, the serial mediation from maternal age at childbirth to child internalising problems was also statistically acknowledged. These results indicated that H4 was supported. For details regarding the proportion mediated metric, please refer to online supplemental table S4.

DISCUSSION

This study examined the association between maternal age at childbirth and children's internalising problems, specifically exploring the mediating roles of housing instability and family support. Our findings provide insights into the mechanisms of the relationship between maternal age at childbirth and child psychological outcomes.

Summary of key findings

The results support our primary hypothesis that higher maternal age at childbirth is associated with fewer internalising problems in children. This finding aligns with previous research indicating that older mothers possess greater emotional maturity and financial stability, which may contribute to a more secure and nurturing environment for their children.[16] The protective effect of higher maternal age at childbirth highlights the potential benefits of increased life experience, better access to resources and more established

Table 2 Direct effect of maternal age on housing instability, family support and internalising problems

	Housing instability		Family support		Internalising problems	
	b_p	β	b_p	β	b_p	β
Maternal age at childbirth	−0.043***	−0.004***	−0.030***	−0.013***	−0.045***	−0.002***
Selected child's sex (1=female)	−0.002	−0.006	−0.002	−0.023	0.027***	0.027***
Selected child's race (reference 'black')						
Hispanic	−0.048***	−0.135***	−0.014**	−0.162**	0.025***	0.025***
White	−0.071***	−0.198***	−0.006	−0.074	0.034***	0.034***
Asian	−0.071***	−0.198***	.016**	0.189**	0.015***	0.015***
Multiracial	−0.055***	−0.155***	−0.006	−0.065	0.028***	0.028***
Caregiver sex (1=male)	0.008***	0.024***	−0.012***	−0.149***	0.016***	0.016***
Caregiver born in the USA (1=outside the USA)	0.004	0.012	0.009***	0.105**	−0.013***	−0.013***
Caregiver's physical health	0.061***	0.043***	0.043***	0.128***	0.048***	0.012***
Caregiver's mental health	0.087***	0.061***	0.284***	0.852***	0.040***	0.010***
Household income as a percentage of the federal poverty level	−0.105***	−0.001***	0.007*	0.000*	−0.002	−0.000
Number of family members in 2022	−0.026***	−0.018***	0.010**	0.029**	−0.033***	−0.008***
Housing instability			−0.064***	−0.275***	0.094***	0.034***
Family support					−0.085***	−0.007***
N	48073		48073		48073	
R^2	0.150		0.145		0.041	
Adj R^2	0.150		0.144		0.040	

β: unstandardised coefficient. The coefficients and significance level reported in this table are obtained by percentile bootstrap.
*p<0.05, **p<0.01, ***p<0.001.

support networks, which can positively influence children's emotional development.[26]

Our analysis also confirmed the mediating roles of housing instability and family support in the relationship between maternal age at childbirth and children internalising problems. Younger mothers, often facing greater economic challenges, are more susceptible to housing instability, which increases stress and negatively impacts children's mental health. This finding supports the Family Stress Model,[56 57] which posits that financial hardship undermines family functioning, leading to poorer child outcomes.

Furthermore, the evidence for serial mediation involving housing instability and family support provides new insights into the mechanism. The pathway suggests that higher maternal age at childbirth reduces housing instability, which enhances family support, ultimately leading to fewer internalising problems in children. This effect underscores the critical role of socioeconomic stability in fostering a supportive family environment, which serves as a buffer against psychological distress in children.

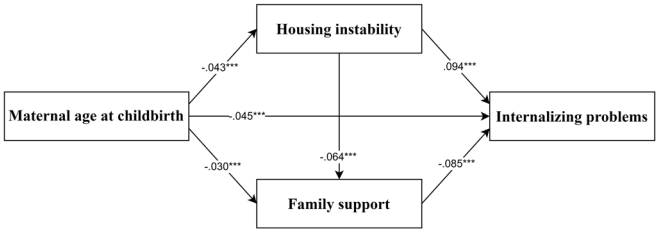

Figure 2 The effect of maternal age at childbirth on internalising problems mediated by housing instability and family support. *p<0.05, **p<0.01, ***p<0.001.

An unexpected finding was that the indirect effect of increased maternal age at childbirth leading to reduced family support. While older mothers generally benefit from greater social and economic resources, they may also experience reduced access to family support due to smaller or less active support networks. This trade-off suggests that delayed childbearing, despite its advantages, may present challenges in maintaining strong familial ties, which are vital for emotional support.

Comparison with previous research

Our findings are consistent with and extend previous literature in several important ways. Prior studies have shown that older maternal age at childbirth is linked to better behavioural outcomes in children, primarily due to socioeconomic advantages. However, this study expands on these results by identifying housing instability and family support as critical mediating factors, providing a more comprehensive framework for understanding the impacts of maternal age at childbirth on children's psychological well-being.

In contrast to studies focusing on the physical health risks of delayed childbearing (eg, increased risk of congenital anomalies), our research focuses on psychological and environmental influences. By revealing the correlation between maternal age at childbirth, economic stability and family functioning, this study contributes to a broader understanding of

Table 3 Indirect effect of maternal age at childbirth on internalising problems through housing instability and family support

Indirect path	b_p	β	95% CI	P value
MAC→HI→IP	−0.00399***	−0.00015***	−0.00505 to −0.00302	0.000
MAC→FS→IP	0.00257***	0.00010***	0.00181 to 0.00337	0.000
MAC→HI→FS→IP	−0.00023***	−0.00000***	−0.00031 to −0.00017	0.000

β: unstandardised coefficient.
*p<0.05, **p<0.01, ***p<0.001.
FS, family support; HI, housing instability; IP, internalising problems; MAC, maternal age at childbirth.

the factors influencing child internalising problems beyond purely biological considerations.

Theoretical implications

This study has important implications for theories of child development. The findings support the Family Stress Model, illustrating the mechanisms of maternal age at childbirth on child outcomes. By identifying serial mediation pathways, this research offers insights into how maternal age at childbirth influences children's internalising problems through direct and indirect effects.

The evidence for reduced family support as a potential downside of increased maternal age at childbirth suggests the need to reconsider the assumptions of delayed childbearing. While the Social Support Theory emphasises the benefits of strong social networks, this study indicates that older mothers may face challenges maintaining active support systems, highlighting a potential area for future investigation.

Practical implications

The findings have significant implications for policy and practice. Given the strong relationship between housing instability and child internalising problems, interventions that provide economic assistance and housing support for younger mothers are essential. Policies aimed at increasing access to affordable housing could reduce stressors that undermine family stability and negatively impact children's mental health. Additionally, enhancing family support, particularly for older mothers, could mitigate the effect of maternal age at childbirth on children's internalising problems. Programmes that facilitate social connection and provide parenting resources should be encouraged.

Limitations and future research

Despite the contributions, several limitations should be acknowledged. First, the cross-sectional data limit our ability to draw causal inferences. To better understand the long-term effects of maternal age at childbirth on child outcomes, future studies should employ longitudinal data for a clearer examination. Second, anxiety and depression are core internalising disorders; our measure was necessarily narrow due to data constraints. We were unable to account for other serious mental health presentations, such as self-harming behaviours, suicide attempts, eating disorders or substance use, which are valid and often severe indicators of internalising distress. Third, despite the large and nationally representative sample, all measures were derived from parent-reported survey data, which introduces the potential for common method bias and may be influenced by reporting subjectivity or social desirability.

CONCLUSION

This study suggests that maternal age at childbirth is associated with children's internalising problems, both directly and through a serial mediation involving housing instability and family support indirectly. It also offers valuable insights for policymakers and practitioners that stable housing and strengthening family support are effective interventions for mitigating risk factors and promoting the psychological well-being of children.

Author affiliations
[1]Zhuhai College of Science and Technology, Zhuhai, Guangdong, China
[2]Department of Government and Public Administration, University of Macau, Faculty of Social Sciences, Taipa, Macao
[3]Centre for Empirical Legal Studies, University of Macau Faculty of Law, Taipa, Macao
[4]Centre for Data Science, University of Macau, Institute of Collaborative Innovation, Taipa, Macao
[5]School of Public Administration & Law, Fujian Agriculture and Forestry University, Fuzhou, China
[6]Faculty of Law, Macau University of Science and Technology, Taipa, Macao

Contributors MML (Guarantor): Conceptualisation, formal analysis, methodology and writing – original draft. DML: Methodology and writing – original draft. QRJ: Data curation and writing – review and editing. ZTT: Validation and writing – review and editing. YJZ: Data curation, methodology and software. XSZ: Writing – review and editing. JL: Supervision.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Ethical approval for the original NSCH survey, from which the current study uses data, was obtained from the National Center for Health Statistics Research Ethics Review Board. The link of NSCH Methodology Report was attached for reference: https://www2.census.gov/programs-surveys/nsch/technical-documentation/methodology/2022-NSCH-Methodology-Report.pdf. Our current study has been reviewed by the medical ethics committee of Macau University of Science and Technology, which approved our study and determined that the study

falls within the scope of humanities and social sciences and recommended that the relevant faculty issue an approval certificate. For inquiries regarding ethical approval, the contact email is fl_inquiry@must.edu.mo.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. The 2022 National Survey of Children's Health dataset used in this study is publicly available on the Data Resource Center for Child & Adolescent Health website, details see: https://www.childhealthdata.org/learn-about-the-nsch/topics_questions/2022-nsch-guide-to-topics-and-questions/.

ORCID iDs
Ming Milano Li https://orcid.org/0009-0005-3401-7104
Dianshi Moses Li https://orcid.org/0009-0002-3469-2917
Yingjie Jay Zhao https://orcid.org/0009-0003-7022-2936
Zhan Thor Tuo https://orcid.org/0009-0008-8869-4436
Jianhong Liu https://orcid.org/0000-0001-5278-9283

REFERENCES

1 Geronimus AT, Bound J, Hughes L. Trend toward older maternal age contributed to growing racial inequity in very-low-birthweight infants in the US: Study examines older maternal age and racial inequity in very-low-birthweight babies in the US. *Health Aff* 2023;42:674–82.
2 Laopaiboon M, Lumbiganon P, Intarut N, *et al*. Advanced maternal age and pregnancy outcomes: a multicountry assessment. *BJOG* 2014;121:49–56.
3 Lean SC, Derricott H, Jones RL, *et al*. Advanced maternal age and adverse pregnancy outcomes: A systematic review and meta-analysis. *PLoS One* 2017;12:e0186287.
4 Frick AP. Advanced maternal age and adverse pregnancy outcomes. *Best Pract Res Clin Obstet Gynaecol* 2021;70:92–100.
5 Sauer MV. Reproduction at an advanced maternal age and maternal health. *Fertil Steril* 2015;103:1136–43.
6 Jacobsson B, Ladfors L, Milsom I. Advanced Maternal Age and Adverse Perinatal Outcome. *Obstet Gynecol* 2004;104:727–33.
7 Saloojee H, Coovadia H. Maternal age matters: for a lifetime, or longer. *Lancet Glob Health* 2015;3:e342–3.
8 Klemetti R, Gissler M, Sainio S, *et al*. At what age does the risk for adverse maternal and infant outcomes increase? Nationwide register-based study on first births in Finland in 2005-2014. *Acta Obstet Gynecol Scand* 2016;95:1368–75.
9 Royer H. *What all women (and some men) want to know: does maternal age affect infant health*. Center for Labor Economics, University of California Berkeley, 2004.
10 Pariente G, Wainstock T, Walfisch A, *et al*. Advanced Maternal Age and the Future Health of the Offspring. *Fetal Diagn Ther* 2019;46:139–46.
11 Schulkey CE, Regmi SD, Magnan RA, *et al*. The maternal-age-associated risk of congenital heart disease is modifiable. *Nature New Biol* 2015;520:230–3.
12 Nørregaard MMO, Basit S, Sillesen A-S, *et al*. Impact of maternal age and body mass index on the structure and function of the heart in newborns: a Copenhagen Baby Heart Study. *BMC Med* 2023;21:499.
13 Mamasoula C, Bigirumurame T, Chadwick T, *et al*. Maternal age and the prevalence of congenital heart defects in Europe, 1995-2015: A register-based study. *Birth Defects Res* 2023;115:583–94.
14 Geronimus AT. The weathering hypothesis and the health of African-American women and infants: evidence and speculations. *Ethn Dis* 1992;2:207–21.
15 Cohen PN. Maternal Age and Infant Mortality for White, Black, and Mexican Mothers in the United States. *SocScience* 2016;3:32–8.
16 Tearne JE. Older maternal age and child behavioral and cognitive outcomes: a review of the literature. *Fertil Steril* 2015;103:1381–91.
17 Suh B, Luthar SS. Parental aggravation may tell more about a child's mental/behavioral health than Adverse Childhood Experiences: Using the 2016 National Survey of Children's Health. *Child Abuse Negl* 2020;101:104330.
18 Heffner LJ. Advanced maternal age--how old is too old? *N Engl J Med* 2004;351:1927–9.
19 Schmidt L, Sobotka T, Bentzen JG, *et al*. Demographic and medical consequences of the postponement of parenthood. *Hum Reprod Update* 2012;18:29–43.
20 Mills TA, Lavender T. Advanced maternal age. *Obstet Gynaecol Reprod Med* 2014;24:85–90.
21 Power C, Kuh D, Morton S. From developmental origins of adult disease to life course research on adult disease and aging: insights from birth cohort studies. *Annu Rev Public Health* 2013;34:7–28.
22 Pillas D, Marmot M, Naicker K, *et al*. Social inequalities in early childhood health and development: a European-wide systematic review. *Pediatr Res* 2014;76:418–24.
23 Sutcliffe AG, Barnes J, Belsky J, *et al*. The health and development of children born to older mothers in the United Kingdom: observational study using longitudinal cohort data. *BMJ* 2012;345:e5116.
24 Bushnik T, Garner R. The children of older first-time mothers in Canada: their health and development. Statistics Canada Ottawa, Canada; 2008.
25 Kato T, Yorifuji T, Yamakawa M, *et al*. Association of maternal age with child health: A Japanese longitudinal study. *PLoS ONE* 2017;12:e0172544.
26 Duncan GJ, Lee KTH, Rosales-Rueda M, *et al*. Maternal Age and Child Development. *Demography* 2018;55:2229–55.
27 Lal A, Slopen N. Housing Instability and Children's Health and Education. *JAMA Pediatr* 2024;178:967–8.
28 Kang S. The Cumulative Relationship between Housing Instability and Mental Health: Findings from the Panel Study of Income Dynamics. *J Soc Distress Homelessness* 2022;31:191–203.
29 Rumbold AR, Giles LC, Whitrow MJ, *et al*. The effects of house moves during early childhood on child mental health at age 9 years. *BMC Public Health* 2012;12:583.
30 Keen R, Chen JT, Slopen N, *et al*. Prospective Associations of Childhood Housing Insecurity With Anxiety and Depression Symptoms During Childhood and Adulthood. *JAMA Pediatr* 2023;177:818–26.
31 Schupmann W. How housing quality affects child mental health. Housing Matters; 2017.
32 Creasey N, Beijers R, O'Donnell KJ, *et al*. Maternal sensitivity and child internalizing and externalizing behavior: a mediating role for glucocorticoid receptor gene (*NR3C1*) methylation? *Dev Psychopathol* 2024;36:967–78.
33 Brock RL, Kochanska G. Interparental conflict, children's security with parents, and long-term risk of internalizing problems: A longitudinal study from ages 2 to 10. *Dev Psychopathol* 2016;28:45–54.
34 Conger RD, Ge X, Elder GH Jr, *et al*. Economic stress, coercive family process, and developmental problems of adolescents. *Child Dev* 1994;65:541–61.
35 Cooper CE, McLanahan SS, Meadows SO, *et al*. FAMILY STRUCTURE TRANSITIONS AND MATERNAL PARENTING STRESS. *J Marriage Fam* 2009;71:558–74.
36 Armstrong MI, Birnie-Lefcovitch S, Ungar MT. Pathways Between Social Support, Family Well Being, Quality of Parenting, and Child Resilience: What We Know. *J Child Fam Stud* 2005;14:269–81.
37 An J, Zhu X, Shi Z, *et al*. A serial mediating effect of perceived family support on psychological well-being. *BMC Public Health* 2024;24:940.
38 Harper Browne C. *The strengthening families approach and protective factors framework: a pathway to healthy development and well-being. Innovative approaches to supporting families of young children*. Springer, 2016:1–24.
39 Child, Initiative AHM. National survey of children's health: methodology report. 2022. Available: https://www2.census.gov/programs-surveys/nsch/technical
40 Child and Adolescent Health Measurement Initiative (CAHMI). 2022 National Survey of Children's Health, (SPSS) indicator dataset. Data Resource Center for Child and Adolescent Health supported by Cooperative Agreement from the U.S. Department of Health and Human Services, Health Resources and Services Administration (HRSA), Maternal and Child Health Bureau (MCHB). 2024. Available: https://childhealthdata.org

41 Gjelsvik A, Rogers ML, Song L, *et al*. Residential Mobility and Flourishing Among United States School-Age Children, 2011/2012 National Survey of Children's Health. *Matern Child Health J* 2019;23:522–9.
42 Cinelli C, Forney A, Pearl J. A Crash Course in Good and Bad Controls. *Sociol Methods Res* 2024;53:1071–104.
43 Gelman A, Hill J, Vehtari A. *Regression and other stories*. Cambridge University Press, 2021.
44 Rubin DB. Should observational studies be designed to allow lack of balance in covariate distributions across treatment groups? *Stat Med* 2009;28:1420–3.
45 Zhao X, Lynch JG, Chen Q. Reconsidering Baron and Kenny: Myths and Truths about Mediation Analysis. *J Consum Res* 2010;37:197–206.
46 Zhao X, Li DM, Lai ZZ, *et al*. Percentage coefficient (bp)--effect size analysis (theory paper 1) (pre print). *arXiv* 2024;240419495.
47 King G. How Not to Lie with Statistics: Avoiding Common Mistakes in Quantitative Political Science. *Am J Pol Sci* 1986;30:666.
48 Blalock HM. Evaluating the Relative Importance of Variables. *Am Sociol Rev* 1961;26:866.
49 Liu J, Li DM. Is Machine Learning Really Unsafe and Irresponsible in Social Sciences? Paradoxes and Reconsideration from Recidivism Prediction Tasks. *Asian J Criminol* 2024;19:143–59.
50 Zhao X, Ju QR, Liu PL, *et al*. Intellectual up-streams of percentage scale ($ ps $) and percentage coefficient ($ b_p $)--effect size analysis (theory paper 2) (pre print). *arXiv* 2025;250713695.
51 Ao SH, Zhang L, Liu PL, *et al*. Social media and partnership jointly alleviate caregivers' psychological distress: exploring the effects of online and offline connectedness. *BMC Psychol* 2023;11:394.
52 Zhang L, Ye JF, Zhao X. "I Saw it Incidentally but Frequently": Exploring the Effects of Online Health Information Scanning on Lung Cancer Screening Behaviors Among Chinese Smokers. *Health Commun* 2025;40:345–56.
53 Li MM, Zhao X, Tuo ZT. Influence of Social Media on Public Support for Cancer Prevention Policies. *Interdisciplinary Soc Res Rep* 2024;1:1–18.
54 Han T, Zhang L, Zhao X, *et al*. Total-effect Test May Erroneously Reject So-called" Full" or" Complete" Mediation. *arXiv* 2023;230908910.
55 Hayes AF. *Introduction to mediation, moderation, and conditional process analysis: a regression-based approach*. Guilford publications, 2017.
56 Conger RD, Wallace LE, Sun Y, *et al*. Economic pressure in African American families: a replication and extension of the family stress model. *Dev Psychol* 2002;38:179–93.
57 Masarik AS, Conger RD. Stress and child development: a review of the Family Stress Model. *Curr Opin Psychol* 2017;13:85–90.