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Regular Article

The association between parenting quality and offspring's biological aging evaluated by telomere length: A systematic review and meta-analysis

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Abstract

There is widespread agreement that offspring are shaped by the parenting they receive in early childhood. This development is intertwined with offspring's biological functioning, evidenced by their telomeres length (TL)—a key biomarker of aging. Until recently, most studies have focused on the detrimental implications of negative parenting for offspring's TL. Contemporary research is oriented toward exploring the possible resilience-promoting effect of positive parenting on the biological aging of the offspring. We conducted a meta-analysis synthesizing the findings regarding the association between parenting quality and offspring's TL. It examines whether positive parenting delays aging processes and whether such processes are exacerbated by exposure to negative parenting. An analysis of 15 studies ($k = 23$; $N = 3{,}599$, $M_{mean\ cohort's\ age} = 15.5$, SD = 17.5) revealed a significant association between positive parenting and offspring's longer TL ($r = .16$, 95% CI [.11, .20]). Negative parenting was associated with an increased risk of TL erosion ($r = -.17$, 95% CI [−.28, −.06]). Moreover, this negative association became more robust as offspring grew older ($\beta = -.01$, $p < .001$). Future investigations would benefit from probing associations between parental quality and offspring's development. Interventions fostering positive parenting might also scaffold these biological processes.

Keywords: parenting quality; positive parenting; negative parenting; biological aging; telomere length; stress; children

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Introduction

Psychological, medical, and biological research has demonstrated beyond doubt that the parent-child relationship is a central aspect of human development, with parents having a significant impact on their offspring's developmental trajectories—for better or worse (Belsky et al., 2007; Collins & Feeney, 2000; Landry et al., 2006). The quality of early parenting has major effects on the child's psychological, cognitive, physiological, and biological functions in the short and long terms (Dowd, 2017; Gershoff, 2016; Shonkoff et al., 2009).

Most of the research thus far has concentrated on the unfavorable effects of negative and adverse parenting on offspring's development. However, expanding the focus to the beneficial factors related to parenting might further illuminate the conduits for promoting resilience parenting. Positive, resilience parenting encompasses (1) sensitivity and responsiveness, which refer to parents' attunement to their offspring's cues, emotions, interests, and capabilities; (2) cognitive stimulation such as parents' didactic efforts to enrich the child's cognitive and language development); (3) warmth, meaning expressions of affection and respect toward the child; (4) emotional availability and accessibility that promote secure attachment; (5) positive relationships and communication; (6) consistency; and (7) the setting of realistic limits and boundaries (Gavidia-Payne et al., 2015; Lugo-Gil & Tamis-LeMonda, 2008). Research has shown that positive parenting significantly impacts offspring's resilience and well-being, affecting their cognitive, socio-emotional, and physical development (Hill & O'Neill, 1994; Propper & Moore, 2006).

Negative parenting lies on a continuum and can be classified as sub-optimal, maladaptive, poor, dysfunctional, and abusive or neglectful (Wolfe & McIsaac, 2011). The last category includes maltreatment, abuse, or neglect and is associated with severe behavioral, cognitive, emotional, physical, biological, and mental disturbances. Poor parenting is common. It generally involves intrusiveness, overly controlling behaviors, coercion, hostility, anger, rejection, cold parenting, emotionally maladaptive strategies, insensitive parenting, and lack of availability and accessibility for the child's attachment needs (Bailey et al., 2009; Crockenberg, 1987; May-Chahal & Cawson, 2005; Neppl et al., 2009). Research has shown that poor parenting can have a negative impact on offspring's development and well-being (Newland, 2015), including low self-esteem (Pinquart & Gerke, 2019), poor academic performance (Garcia & Serra, 2019), social difficulties, and physical and mental health problems (Mahdavi et al., 2013; Sansbury & Wahler, 1992).

Psychobiological studies suggest that the harmful effects of adverse parenting on offspring's cognitive, emotional, and

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behavioral development are also evident on the bio-physiological level (Beijers et al., 2014; Bethell et al., 2017; Dowd, 2017; Esteves et al., 2020; Thijssen et al., 2017). Examples include neuro-anatomical and neuro-functional abnormalities in offspring (Colich et al., 2017; Gershoff, 2016; Thijssen et al., 2017), and elevated cortisol levels that play an essential role in stress-related health outcomes (Essex et al., 2002; Shonkoff et al., 2009). There are even alterations in the child's DNA by epigenetic processes (e.g., Trump et al., 2016; Unternaehrer et al., 2021). It seems that there are a variety of biomarkers that highlight the link between adverse parenting and malchildhood development. These indicators are also considered biological aging markers that can accelerate certain aspects of offspring's development (Belsky, 2019). The length of the offspring's telomeres (TL) – is a well-known key biomarker of biological aging (Vaiserman & Krasnienkov, 2021).

Telomeres are repetitive DNA sequences (TTAGGG) located at the ends of chromosomes. They play a crucial role in preventing chromosome fusion and in maintaining genome stability (Bojesen, 2013; López-Otín et al., 2013). When telomeres shorten and reach a critical point, cellular senescence is triggered, cell division ceases, and the cell dies (Bojesen, 2013; López-Otín et al., 2013). TL is considered a heritable trait, with genetics contributing to approximately 70% of the variability, while 30% of the variability is due to external factors such as environmental factors (Broer et al., 2013). Telomere shortening is a well-known hallmark of both cellular senescence and organismal aging. An accelerated rate of telomere attrition is also a common feature of age-related diseases. Therefore, TL has been recognized as one of the best biomarkers of aging (Müezzinler et al., 2013; Vaiserman & Krasnienkov, 2021). Emerging data from the last two decades has revealed that TL can also grow and be modified by genetic, epigenetic, and environmental factors (Melicher et al., 2015). Longer telomeres are more likely to emerge in a nurturing and secure environment (Asok et al., 2013; Beijers et al., 2020; Robles et al., 2016). However, the predictors and environmental modifications that can prevent or delay telomere shortening or even retard the aging process are still under debate (Buttet et al., 2022).

Examining the literature linking parenting quality to offspring's TL reveals a consistent association between negative parenting and the offspring's accelerated aging process (Ridout et al., 2018). Specifically, maltreatment (Chen et al., 2022; Coimbra et al., 2017; Nelles-McGee et al., 2021), adversity (Blaze et al., 2015), and offspring's acute traumatic experiences (Küffer et al., 2016; Lang et al., 2020) have all been linked to shorter TL in offspring.

Given this evidence, how does parenting quality impact offspring's TL? Researchers have identified parental stress as a mechanism that interacts with parenting quality and a child's TL. Some have suggested that stress may result in shortened telomere, thereby leading to negative development trajectories (Houben et al., 2008; Shalev et al., 2013). Indeed, even in utero, the mother's stress levels influence the initial newborn programing of TL, and maternal psychological stress results in a shortening in the TL of the newborn (Shalev et al., 2013). Post-natally, stress seems to mediate the associations between negative parenting patterns and a proportionate increase in the likelihood of disruptions in the child's psychological, physiological, and biological development. Presumably, these disruptions result from exposure to ongoing stress that disrupts the establishment of emotional regulation (Wolfe & McIsaac, 2011), resulting in elevated health risks imprinted in the child's TL (Epel, 2009; Sosnowski et al., 2021).

Although parenting is inherently stressful, there is a dose-response relationship between parental stress and harmful developmental outcomes. Negative parenting, characterized by toxic, chronic, acute stress, can lead to devastating effects (Boyce, 2016; Dohrenwend, 2000; Shonkoff et al., 2020). In contrast, low to moderate short-term stress could even have positive effects that strengthen the child's biological functioning. It can improve the child's immune system (Simon et al., 2015) and telomere functioning, evident in longer telomeres (e.g., Verner et al., 2021).

Although there is extensive research regarding the consequences of high-risk, negative parenting and a child's shorter TL, very few studies have focused on the role of typical, normative parenting and the child's TL. Thus, investigating the impact of normative parenting, which can promote parental resilience and includes beneficial, regulated, anti-stressogenic practices and behaviors, on the child's TL, is paramount.

The current meta-analysis examines normative parenting from a psychobiological perspective. Our goal is twofold. First, we seek to determine whether positive parental resilience is associated with advantageous biological developmental trajectories in offspring, evident in their longer telomeres. Second, we investigate whether negative, poor parenting is associated with sub-optimal biological developmental trajectories in offspring, evident in their shorter telomeres. Based on the research we reviewed, we hypothesize that positive parental resilience will be associated with longer TL in offspring, whereas poor, maladaptive, negative parenting will be associated with shorter TL in them.

Method

We followed the Meta-Analysis of Observational Studies in Epidemiology reporting guidelines (Stroup et al., 2000). We included (1) peer-reviewed studies published in a scientific journal, (2) written in English, (3) published before June 31, 2024, (4) assessments and reports of at least one index of positive or negative parenting (maternal, paternal or both; trauma-related indices were not eligible), (6) quantitative polymerase chain reaction assessments and reports of offspring's TL, and (7) reports on the association between parental quality and offspring's TL.

Search strategy and selection process

We searched the MEDLINE, PsycINFO, and Web of Science databases using the terms «parenting» and «child's telomeres». All terms related to parenting (*i.e.*, parenting, parental, parents, parenthood, typical parenting, normative parenting, adaptive parenting, maternal, paternal, supportive parenting, sensitive parenting, positive parenting, responsiveness parenting, warmth parenting, maternal support, paternal support, attachment, family resilience, cold parenting, non-adaptive parenting, maladaptive parenting, non-supportive parenting, negative parenting, childhood maltreatment, adversity, and early life stress) were combined using the Boolean «OR». All terms related to offspring's TL (*i.e.*, telomere, telomeres, telomere length) were also combined. These two sets of terms were combined with the Boolean «AND». When appropriate, truncation symbols were used in word searches to capture variant endings or spellings of a word. Further efforts were made to trace records using Google Scholar and a manual search of the reference lists of relevant studies, and by contacting authors considered to be specialists in this area and asking them for pertinent references on the subject. We also contacted the authors of studies on parenting and offspring's TL who did not report a statistic evaluating the association between the two and asked them for additional information.

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Two of the authors of this study conducted the literature search independently. Both authors screened the titles, abstracts, and full articles of potentially relevant studies. Cases of conflict were resolved by dialog.

Data extraction

We collected data regarding parenting outcomes, offspring's TL, and the association between the two. In addition, we gathered information relevant to our study that appeared in the research articles we selected. Examples include details about the offspring's age, gender, the year of the article's publication, the design of the study, and the sample type for the TL assessment. A standard data form was developed to record all relevant information. We also calculated Pearson's *r* values for the main outcome (i.e., the association between the parenting index and the offspring's TL). If other statistics were reported such as the means and standard deviations [SDs]; *t* or *F* statistics), they were converted into *r* values using the *esc* package (Lüdecke, 2019). In studies with multiple TL assessments that did not compute an average TL score, we considered the last TL measurement for the analysis. In cases of multiple assessments of parenting indices, we considered and synthesized all correlations to compute a single global estimate. Indices of parenting quality were classified into positive or negative (excluding traumatizing or abusive parenting indices). The included measures were obtained via observations, interviews, and maternal, paternal, or child reports.

Within-study risk of bias

We used a modified version of the Newcastle-Ottawa Scale (NOS) to assess the quality of the cohort studies (Wells et al., 2000). All included studies were evaluated based on aspects of the sample selected and the studies' outcome measures. Comparisons of the groups were irrelevant because the studies involved only one group. The modified scale consists of four items pertaining to the representativeness of the cohort, independence and reliability of the assessment, blinding, and data loss. Scores below 2 were considered indicative of a high risk of bias. See Table S1 for further details.

Data synthesis

To stabilize the variance and make it approximately normally distributed, each extracted correlation coefficient was converted to Fisher's *z* (Fisher, 1921). Analyses were performed on the transformed *z* values and then transformed back to Pearson's *r* for a more intuitive presentation of the results (Borenstein et al., 2009). Given that factors related to the sample such as the participants' age, country, and birth decade and those involving the methods used in the studies such as their design and measures of parenting very likely influenced the outcomes, we used random-effects meta-analyses with the restricted maximum likelihood method to assess the between-studies variance (Langan et al., 2019).

We utilized Cochran's *Q* statistic to determine whether there was significant heterogeneity between the studies, with $p < .10$ indicating genuine heterogeneity. We also used the I^2 statistic to assess the extent of inconsistencies across the studies, with values above 50% and 75% indicating substantial and considerable heterogeneity, respectively (Higgins et al., 2021). Moreover, we conducted moderation analyses to determine whether pertinent factors–including offspring mean age at TL assessment, offspring sex, sample type (*i.e.*, blood or mucosal-associated fluids), parenting index (*i.e.*, observational or questionnaire-based), and geographical region (*i.e.*, America, Asia, Europe)– explained variability in study outcomes. We conducted sensitivity analyses to determine whether the results remained robust independent of study quality. Finally, we evaluated the risk of publication bias using the Egger regression test, which weighs the degree of asymmetry of the funnel plot (Egger et al., 1997). All data were analyzed using the *metafor* package (Viechtbauer, 2010) in RStudio v2023.12.1 + 402 (with R v4.3.3; Posit team, 2024).

Results

Descriptive statistics

Of the 17,477 records we identified by screening the abstracts and titles, we chose 81 articles for full-text screening. Fifteen studies (Asok et al., 2013; Beijers et al., 2020; Brody et al., 2017; Carroll et al., 2020; Chen et al., 2019; Daoust et al., 2023; Elam et al., 2022; Enokido et al., 2014; Esteves et al., 2020; Hoferichter et al., 2024; Knutsen et al., 2019; Pesca et al., 2023; Robles et al., 2016; Sullivan et al., 2023; Verner et al., 2021) were included in the meta-analysis, with 23 distinct effect sizes – 13 for positive and 10 for negative parenting outcomes. Figure 1 diagrams the screening process and the reasons for exclusion in each step.

The studies provided data about the direct assessment of the association between parenting quality and offspring's TL for 3,599 participants. The youngest cohort was assessed near birth, and the oldest was assessed at a mean age of 70.6 years ($M_{mean\ cohort's\ age} = 15.5$, SD = 17.5). Most studies were conducted in North America (53.3%), followed by Asia (13.3%) and Europe (33.3%). Table 1 provides a comprehensive depiction of the studies' characteristics. Table S2 lists the scores on the within-study risk of bias using the modified NOS.

Meta-analysis of all outcomes

We first conducted a meta-analysis of all outcomes, including the association between offspring's TL and indices of either positive or negative parenting, to explore the broad effect of parenting and assess whether the two parenting constructs yielded different effects. In studies reporting the association between offspring's TL and both positive and negative parenting indices in the same cohort, we adjusted the *n* to avoid double counting the participants (Higgins et al., 2021). Further, for this analysis, we inverted the effect sizes of the association between the parenting indices and the offspring's TL so that the magnitude of the association could be compared to studies involving positive parenting indices.

The overall meta-analysis indicated that higher positive and lower negative parenting scores were associated with longer TL ($r = .166$, 95% CI [.112, .219], $k = 23$). The analysis indicated that there was substantial heterogeneity between the studies ($Q_{(22)} = 56.5$, $p < .001$; $I^2 = 66.5\%$). However, the moderation analysis implied no differences in effect sizes between the outcomes of positive and negative parenting ($Q_{(1)} = .034$, $p = .855$). These results suggested that the associations between offspring's TL and both parenting indices are similar in magnitude (see Figure S1 in the online supplemental materials).

Subsequent moderation analyses revealed that mean age at TL assessment moderated ($Q_{(1)} = 26.7$, $p < .001$) the association between positive parental behavior and longer offspring's TL, indicating a stronger association in older ages ($\beta = .004$; see Figure S2) and accounting for 92.2% of inter-study variability. However, offspring sex ($p = .49$), sample type ($p = .12$), mode of parenting

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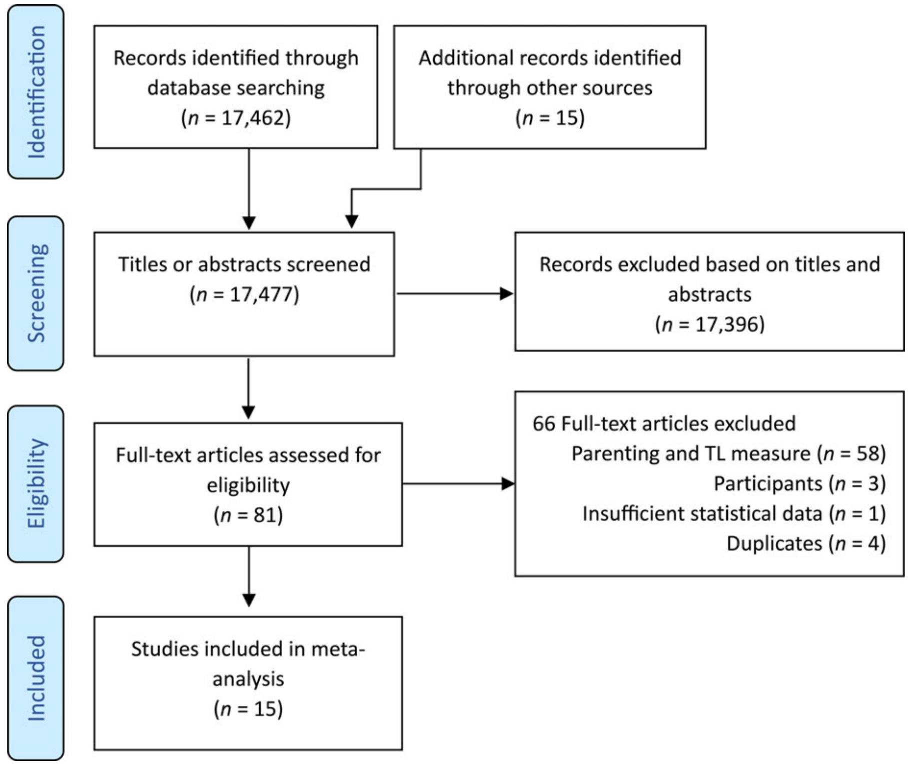

Figure 1. Flow diagram of the study selection process.

assessment ($p = .24$), and geographical location ($p = .34$) did not influence the association strength (see Table S3).

Positive parenting and offspring's telomere length

Positive parenting was associated with offspring's longer TL ($r = .154$, 95% CI [.113, .194], $k = 13$; see Figure 2), suggesting that positive, sensitive, warm, and more attuned parenting safeguards offspring from the risk of shorter TL. There were no indications of heterogeneity between the studies ($Q_{(12)} = 10.1$, $p = .612$; $I^2 = 0.1\%$) or any publication bias ($t_{(11)} = 0.58$, $p = .572$), thus strengthening the validity of this finding. No significant moderation effects were detected (see Table S3).

Negative parenting and offspring's telomere length

Negative parenting was associated with shorter TL ($r = -.171$, 95% CI [-.273, −.065], $k = 10$; see Figure 3), suggesting that conflictual, cold, or more intrusive parenting intensifies shorter TL in offspring. The Egger test did not suggest the likelihood of any publication bias ($t_{(8)} = -0.41$, $p = .693$). However, there was an indication of considerable heterogeneity between the studies ($Q_{(9)} = 46.4$, $p < .001$; $I^2 = 84.0\%$). Subsequent moderation analyses demonstrated that the mean age of TL assessment was significantly associated with differences between the studies in effect sizes ($Q_{(1)} = 42.4$, $p < .001$), accounting for all of the variability ($R^2 = 100\%$; $I^2 = 0\%$). This result suggests that the association between negative parenting and decreased offspring's TL becomes more robust in older ages ($\beta = .01$, $p < .001$; Figure 4). No additional moderation effects were detected (see Table S3).

Sensitivity analyses

Sensitivity analyses revealed that results across all three meta-analyses remained robust in low-risk-of-bias studies, with no significant differences between high- and low-risk studies (see Table S4), thereby reinforcing the reliability of the observed effects.

Discussion

This meta-analysis aimed to synthesize the research amassed up to June 2024 on the association between normative parenting and offspring's TL, a biological marker of aging (Aubert & Lansdorp, 2008). Considering the findings from 15 studies, including 3,599 participants, our review revealed that positive resilience parenting, characterized by attunement to offspring's needs and warm, positive, responsive, sensitive parenting that gives them a sense of security is associated with delayed aging processes, evident in the offspring's longer TL. In contrast, negative, poor, sub-optimal parenting, characterized by cold, harmful, insecure parental practices, is associated with an accelerated aging process, evident in the offspring's shorter TL.

From an evolutionary perspective, poor, non-resilient parenting demands that offspring mature precociously, a process evident in their early puberty. This accelerated maturation, referred to as "growing up young" (e.g., Pinto, 2007), is probably also mirrored in the offspring's TL, reflecting their biological age (Vaiserman & Krasnienkov, 2021). Stressful circumstances often act as a developmental task (Masten & Braswell, 1991), requiring people to cultivate the internal resources needed to cope with the situation and equipping them evolutionarily against future stress (Trad & Greenblatt, 1990). Indeed, Belsky and colleagues (1991) posit that stressful parenting catalyzes a child's early puberty as a physiological response (Belsky et al., 1991), and, in the current review—a biological one. In the presence of harmful stress, the child must develop survival skills, such as "growing up young," because the parent cannot guarantee the child's survival. Resilient parenting, on the other hand, provides offspring with the security

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Table 1. Studies included in meta-analysis

Study	N	Country	TL assessment age in years; mean (range)	% Females	TL sample	Design	Parenting outcome	Measure
Asok et al. (2013)	51	USA	4.9 (3.6–6.2)	35	Buccal mucosa	Cross-sectional	Positive	Parental Responsiveness to Non-distress (NICHD Early Child Care Research Network, 1999).
	38	USA	5.0 (4.1–6.5)	58	Buccal mucosa	Cross-sectional	Positive	Parental Responsiveness to Non-distress (NICHD Early Child Care Research Network, 1999).
Beijers et al. (2020)	193	Netherlands	6.1	47.2	Buccal mucosa	Prospective	Positive	Maternal Caregiving Quality Composite including the Maternal Sensitivity and Cooperation indices (Ainsworth, 1978) and the Supportive Presence and Respect for the Child's Autonomy indices (Erickson et al., 1985).
Brody et al. (2017)	293	USA	22 (20–25)	64.5	Blood	Prospective	Positive	The Family Support Inventory (Wills et al., 1992).
							Negative	Ineffective Arguing Inventory (Kurdek, 1994).
Carroll et al. (2020)	111	USA	3.8 (3.4–5.5)	55	Buccal mucosa	Prospective	Negative	Perceived Stress Scale (Cohen et al., 1983).
Chen et al. (2019)	662	China	16.9 (12–21)	87.3	Buccal mucosa	Retrospective	Negative	Persistent childhood separation from parents (*i.e.*, more than 6 months per year during the first 6 years of life).
Daoust et al. (2023)	409	Canada	3.4	50.9	Saliva	Cross-sectional	Negative	Parental Intrusiveness Scale (Kryski, 2014).
Elam et al. (2022)	41	USA	15.5 (13–17)	42	Saliva	Cross-sectional	Positive	Positive Parenting Composite including the Child Report of Parenting Behavior Inventory (Schaefer, 1965), Child Monitoring Scale (Roth & Reiss, 1994), and Parent-Adolescent Communication Scale (Barnes & Olson, 1985).
							Negative	Children's Perceptions of Interparental Conflict Scale (Grych et al., 1992).
Enokido et al. (2014)	340	Japan	23.4 (20–29)	0	Blood	Retrospective	Positive	Parental Bonding Instrument – Paternal Care Index (Parker et al., 1979).
	241	Japan	23.5 (20–29)	100	Blood	Retrospective	Positive	Parental Bonding Instrument – Maternal Care Index (Parker et al., 1979).
Esteves et al. (2020)	136	USA	1.5	46.5	Buccal mucosa	Prospective	Negative	Prenatal Maternal Stress Index.
Hoferichter et al. (2024)	80	Germany	13.7	48	Saliva	Cross-sectional	Positive	Parental Support Index from the Social Capital Instrument (Kunter et al., 2002).
Knutsen et al. (2019)	199	USA	70.6	60.3	Blood	Prospective	Positive	"Warm" maternal parenting style (Knutsen et al., 2019).
							Negative	"Cold" maternal parenting style (Knutsen et al., 2019).
Pesca et al. (2023)	49	Italy	38.3	16.3	Blood	Retrospective	Positive	Parental Bonding Instrument – Paternal and Maternal Care Indices (Parker et al., 1979).
Robles et al. (2016)	39	USA	(8–13)	59.3	Blood	Prospective	Positive	Composite score of the Parental Warmth (Repetti, 1996) and Child Daily Positive Mood (Cohen et al., 2003) indices.
							Negative	Composite score of the Parent-Child Conflict (Repetti, 1996) and Child Daily Negative Mood (Cohen et al., 2003) indices.
Sullivan et al. (2023)	61	USA	4	29	Saliva	Prospective	Positive	Positive Parenting Behaviors (Eyberg et al., 2014).
							Negative	Negative Parenting Behaviors (Eyberg et al., 2014).
Verner et al. (2021)	656	Finland	Neonates	48	Umbilical cord blood	Prospective	Positive	Maternal Positivity Factor (Verner et al., 2021).
							Negative	Maternal Stress Factor (Verner et al., 2021).

Note. TL = telomere length. Study designs: Cross-sectional = Parenting outcome and TL assessment were conducted at the same time; Prospective = Parenting outcome was assessed prior to TL assessment; Retrospective = Parenting outcome was assessed at the same time as TL but referred to the past.

they need to ensure their survival, enabling them to develop at their natural pace, as reflected in their biological age.

From a psychophysiological, genetic, and neural perspective, there are differences in the response to stress based on people's individual temperaments (Almeida, 2005; Clauss et al., 2015; Enlow et al., 2023). Not all offspring who are exposed to stress, in its variety of intensities and durations, will develop negative or accelerated developmental trajectories. Some offspring react and

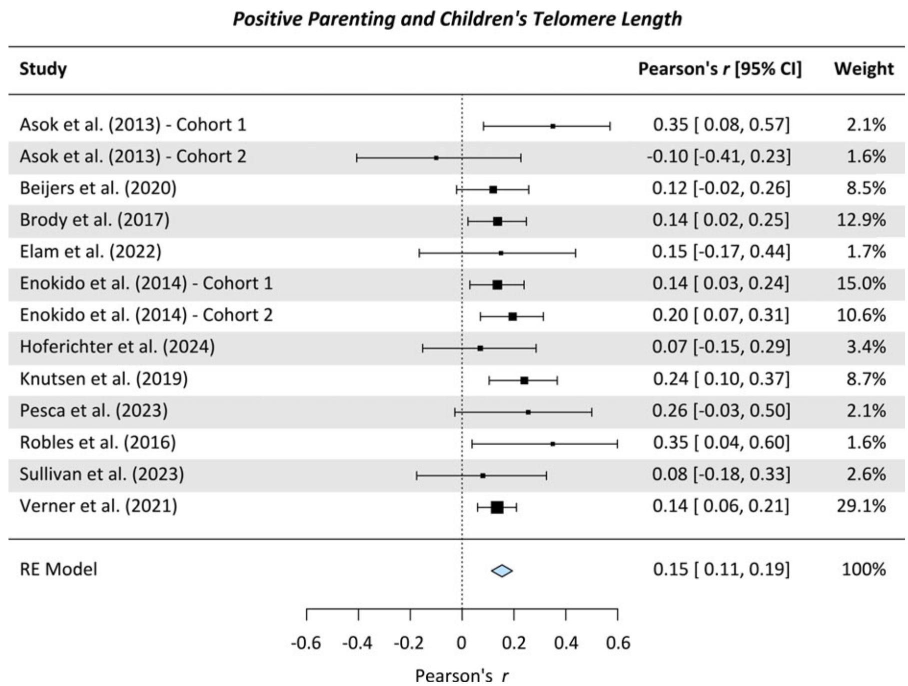

Figure 2. Forest plot for the association between positive parenting and offspring's telomere length. The analysis involved 2,050 participants. Squares represent the correlation coefficients, with size reflecting the studies' weight and the horizontal lines representing the 95% CIs.

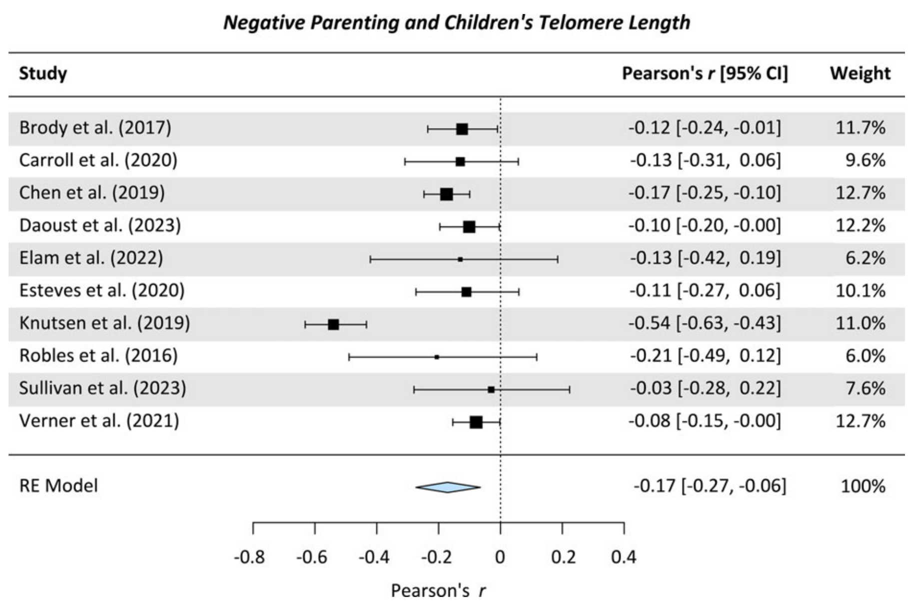

Figure 3. Forest plot for the association between negative parenting and offspring's telomere length. The analysis involved 2,505 participants. Squares represent the correlation coefficients, with size reflecting the studies' weight and the horizontal lines representing the 95% CIs.

respond to stress in more adaptive ways. One possible explanation for this difference is the offspring's ability to regulate their emotions and responses to stress (Troy & Mauss, 2011). Emotion regulation is a critically important factor in determining one's resilience and vulnerability, as it plays a key factor in many psychopathologies (Loman & Gunnar, 2010; Sheppes et al., 2015).

Parenting is a crucial co-regulation mechanism that helps offspring develop self-regulatory capacities (Lobo & Lunkenheimer, 2020). Beginning in the womb, parents scaffold their offspring's development by providing external regulation while supporting the offspring's development of their intrinsic capacity for self-regulation (Gianino & Tronick, 2020; Hofer, 1978). Although the nature of parental involvement in offspring's regulation shifts substantially as the latter develop, it remains a core contributor to the development of the intrinsic capacity for self-regulation from birth and throughout life (Cohodes et al., 2022). Extraordinarily stressful parenting interferes with the child's ability to establish emotion regulation, resulting in a range of emotional dysregulation and susceptibility and vulnerability to stress (Girme et al., 2021). Parental resilience, in contrast, helps the child feel supported and emotionally safe and is a prerequisite for regulating emotions effectively (Morris et al., 2017).

Thus far, a substantial body of research–including studies, review papers, and meta-analyses–has consistently highlighted the robust association between high-risk parenting and offspring's shorter TL (Ridout et al., 2018). Our findings are novel in exploring the association between positive and poor parenting and a child's TL among typical, normative parents and their offspring. To our

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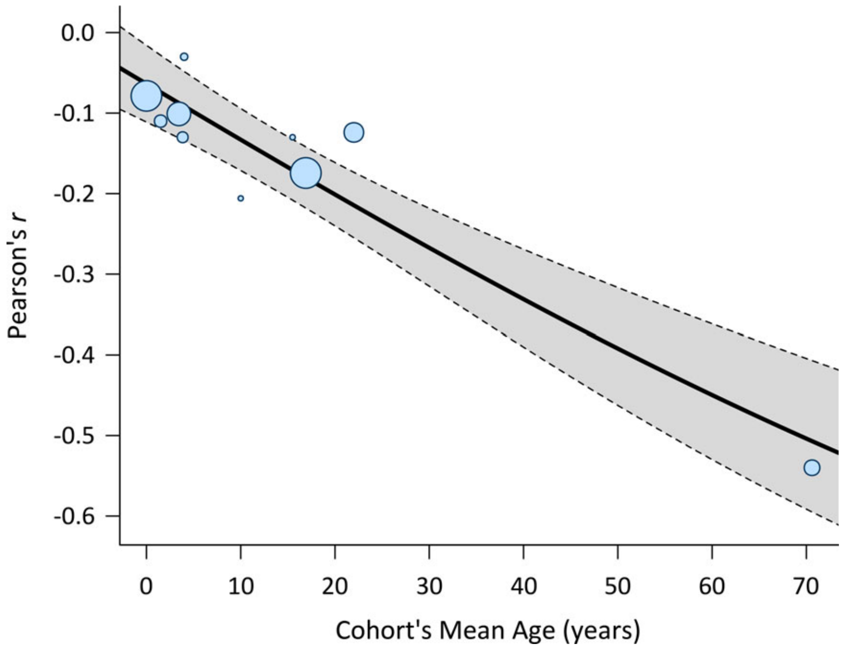

Figure 4. Moderation analysis of the effect of mean age at telomere length (TL) assessment on the association between negative parenting and offspring's TL. Circles denote the correlation coefficients of individual studies, with their size corresponding to the study weight.

knowledge, no previous review study or meta-analysis has comprehensively investigated the relationship between typical parenting and a child's TL, particularly in the context of positive resilient parenting. By identifying the importance of and cultivating parenting resilience, our meta-analysis demonstrates that parents can enhance their offspring's positive development trajectories, also reflected in the latter's biological functioning. These practices and behaviors provide offspring with the necessary framework to navigate and cope with life's stressors effectively, potentially mitigating the aging process and safeguarding against its detrimental effects. Such parenting resilience has protective, therapeutic, and anti-aging qualities. Therefore, the most promising finding from our review is that positive parenting benefits the child's biology. Adopting an integrative approach involving psychological and biological processes, our review emphasizes the importance of considering positive parenting as a resilience factor, beyond the factors associated with negative, risky, and poor parenting, in the broader context of a child's development.

Lastly, the moderation analysis further revealed that the association between poor parenting and the child's diminished TL becomes more robust with time. Poor parenting may have a long-term, imprinted, exponential effect that becomes programed in offspring's developmental trajectories beyond their early development (e.g., Girme et al., 2021). Moreover, it could be that poor parenting, including the lack of security it provides offspring, reinforces and paves the way for negative psychological, neuronal, biological, and physiological developmental paths that become more robust with time.

Limitations

Despite the promising findings of the current study, it is essential to consider its limitations. First, the demographic bias resulting from the overrepresentation of studies from North America (63.6%), followed by Asia and Europe (18.2% each), limited the ecological validity of the findings vis-à-vis other non-represented global populations. Second, the age range of the offspring examined in the study was broad, as the youngest offspring were near birth and the oldest were in their 70s, making it difficult to generalize the results.

In addition, we had to use moderating analyses to capture the extensive variation in the studies. Although we categorized the studies as a function of the quality of parenting, the studies still varied with regard to the various categories, populations, ages of the offspring, the studies' measures, and the designs used. In particular, describing the differences between positive resilience parenting and poor, negative parenting is challenging. Despite the widely accepted definitions of these terms, the ability to capture all the terms, theories, and speculations in different studies regarding normative parenting in the normative population is an almost impossible mission. Additional work on the characteristics of "normative parents" will help us understand the developmental trajectory of resilience and non-resilience parenting, with the goal of establishing appropriate clinical interventions. Lastly, our review includes just a few studies focusing on normative parenting and the child's TL. The link between parenting and the child's TL is yet to be fully explored and understood.

Future directions

Meta-analytic procedures help us draw general conclusions regarding the validity of research hypotheses. However, several questions still need to be answered. Incorporating critical perspectives from theories such as Differential Susceptibility (Belsky, 2016), which posits that some offspring, for reasons of temperament or genetics, are more susceptible to both the adverse effects of unsupportive parenting and the beneficial effects of supportive rearing, may enable us to consider individual differences and whether and how they interact with environmental factors such as parenting behaviors. Doing so will provide a more comprehensive understanding of this triad interaction and the child's biological and aging processes.

Lastly, exploring offspring's TL in various cultures is an intriguing avenue for research, given the variations in parenting

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attitudes, perceptions, norms, and behaviors evident across countries and cultures (e.g., Pinquart, 2021). By delving into cross-cultural comparisons, we can discern whether these parenting differences will manifest in the child's TL, adding a layer of depth to our understanding of aging processes worldwide.

Conclusions

This systematic review and meta-analysis introduces a novel psychobiological perspective on the association between positive and negative parenting and a child's TL by focusing explicitly on normative parenting. The data suggest that negative parenting accelerates the aging process in offspring, as evidenced in their shorter TL. Conversely, the most promising finding from our review is that positive parenting is linked to the lengthening of the child's TL, signifying a potential delay in the child's aging process. Using an integrative approach involving psychological and biological processes, we produced findings underscoring the impact of normative parenting in influencing the child's biological developmental trajectories. We also highlighted the importance of considering parental resilience in the broader context of all offspring's development, not just offspring at risk.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S095457942500015X.

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