



Promoting Temporal Investigations of Development in Context: a Systematic Review of Longitudinal Research Linking Childhood Circumstances and Learning-related Outcomes

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Abstract

Children’s learning and cognitive development have a distinct receptivity to the circumstances of childhood. However, not all children have equal opportunities and learning inequities continue to be influenced by the social and economic circumstances of childhood. Examining factors within the environments that children are growing up in, and the associations of these factors with learning, can help to identify leverage points for change, enabling more children to be supported to reach their potential. Specifically, turning attention to the timing and duration of exposure to specific social and economic factors across childhood can provide essential details to determine who is most susceptible to contextual effects and at what ages. This paper presents a systematic review of 75 longitudinal studies of families and children carried out between 2000 and 2021. These studies tracked social and economic circumstances between pregnancy and early adolescence in relation to educational and cognitive outcomes across the lifespan. The results of the included studies were examined and grouped into themes using reflexive thematic analysis. The findings largely suggest that the degree to which educational and cognitive outcomes are affected by specific social and economic circumstances depends on the duration, timing, and mobility across childhood. In particular, findings relating to the developmental timing of exposure, as well as persistent exposure, revealed distinct evidence of the effects of temporality. These findings provide detail into how much and in what instances temporality should be considered—results which can be used to inform avenues for reducing learning disparities.

Keywords Longitudinal · Life course · Education · Cognitive development · Social and economic circumstances · Childhood

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Introduction

Learning and cognition are fundamental for wellbeing and development across the lifespan, yet are linked to the social and economic contexts of childhood (Fiscella & Kitzman, 2009). Indeed, multidisciplinary research has reached a consensus that educational and cognitive outcomes are, in part, dictated by childhood experiences—the consequences of which exert effects that last beyond the childhood years and into adulthood (Boyce & Hertzman, 2017; Commission On Social Determinants of Health, 2008). Extensive research has been undertaken to identify the specific features of children’s environments that are associated with educational and cognitive outcomes (see systematic reviews from Gartland et al., 2019; Pillas et al., 2014; Saitadze & Lalayants, 2021). Such research has revealed a wide array of factors as important for development. Within the field of educational psychology, the temporal dimensions through which these specific social and economic features of children’s environments operate have also been of interest. The elements of duration and timing of exposure require longitudinal considerations to reveal at what ages and in what patterns associations between context and development are evident.

The circumstances of childhood are consistently shown to be predictive of educational and cognitive outcomes, yet relatively less is known about the effects of the duration and timing of these circumstances. Nurturing environments that support children in their learning help to set healthy developmental pathways, whereas adverse experiences pose a threat to development (Graham & Power, 2004; Shonkoff et al., 2012). However, to determine if children with varying lengths of exposure are differentially affected by these supportive and adverse factors, childhood circumstances need to be tracked in relation to the length of exposure. Equally, to ascertain if there are periods in childhood where exposure is more relevant for development, research which investigates the developmental stage of exposure is required. Such work can help to explain the complex pathways through which context influences development and to what extent duration and timing of exposure matter.

Perspectives on Duration, Timing, and Development

Theoretical perspectives on duration and timing are largely grounded in the position that earlier and later life experiences are interrelated (Alwin, 2012; Ben-Shlomo & Kuh, 2002; Elder et al., 2003). Though early circumstances are not wholly deterministic of adult life, there is substantial empirical evidence supporting the echo of early circumstances into lifelong outcomes (e.g., Duncan et al., 2010; Dunn et al., 2016; Liu & Hannum, 2017). Drawing on ecological systems theory, children’s development is shaped by the interactions between an individual and context, where nested spheres of varying proximity (e.g., family, neighborhood, culture) interact to influence development (Bronfenbrenner, 1979, 1977). Temporality (i.e., the chronosystem) is highlighted in this theory, where the timing and duration of children’s contextual interactions play an important role in development (Bronfenbrenner, 1986). In this regard, children’s interactions with contextual factors, and the influence of

these interactions on development, have the potential to differ in terms of the duration, onset, and discontinuation of exposure (Schoon, 2012). Consequently, measuring circumstances at a single time point may underestimate the complex exchanges between an individual and contexts across childhood and fail to account for the unique contribution of timing and duration. Therefore, to address the limitations of cross-sectional work, current thinking of temporality offers explanations for how contextual factors influence development longitudinally.

Duration of Exposure

The length of time that children are exposed to specific social and economic factors may have differential effects on developmental outcomes (Ben-Shlomo & Kuh, 2002; Bronfenbrenner, 1986). Studies examining the influence of context have indeed found associations between duration of exposure and developmental outcomes, with longer periods of exposure having stronger effects (e.g., Korenman et al., 1995; Najman et al., 2009; NICHD, 2005). Children exposed to chronic material hardship, for example, have been shown to be at greater risk for poorer cognitive skills (Najman et al., 2009), socioemotional development (Korenman et al., 1995), and behavior problems (NICHD, 2005). Persistent or prolonged exposure tends to have stronger effects on development than exposure at a single time point or intermittent time points. As explained in life course theory, circumstantial effects can accumulate over time, where every additional period of exposure increases the magnitude of influence on developmental outcomes, regardless of the timing of exposure (Ben-Shlomo et al., 2016; Mishra et al., 2009). However, there may be developmental periods where effects have a greater impact on development than factors operating at other time points (Dunn et al., 2016; Gabard-Durnam & McLaughlin, 2019). Thus, particular time periods in childhood may be more susceptible to contextual influences and exert greater effects on development than other periods.

Timing of Exposure

Childhood is a period where development is considered to be more responsive to contextual influences than at later times in the life course (Cantor et al., 2021). The dramatic physical, socioemotional, and cognitive growth that occurs in the childhood years sets foundational blueprints for later life outcomes (Duncan et al., 2010; Dunn et al., 2016). Certain periods within childhood may be more sensitive to influence than other periods. For instance, the influence of the early childhood stages on development has been guided by research into fetal origins of adult disease (later progressed into the theory of developmental origins of health and disease) which suggests that early life is especially susceptible to contextual effects (Barker et al., 2002; Ben-Shlomo et al., 2016). Other childhood stages are also recognized as times of heightened sensitivity. For example, early adolescence marks the beginning of the dramatic brain reorganization that occurs throughout adolescence and into young adulthood, making it a particularly responsive time to environmental inputs (Osher et al., 2018). Therefore, empirical investigations into the timing of exposure to specific contextual factors can help to determine if there

are particular time points within childhood that drive the association between context and developmental outcomes to reveal specific ages where children may have a more acute receptivity to their surroundings than at other time points.

Changes in Circumstances Across Childhood

Temporal perspectives on development can also account for childhood circumstances which are not necessarily static. The social mobility hypothesis from life course research can be used to consider changes in social and economic exposure across childhood (Cable, 2014; Hallqvist et al., 2004). Generally, the concept of social mobility has been applied to studies of socioeconomic position where mobility refers to flux in socioeconomic circumstances, either inter-generationally or intra-generationally across childhood and adulthood. However, the concept of mobility is also relevant for shorter periods of time, such as in childhood, and can be used to understand how social and economic circumstances change across these years. For the purposes of this review, mobility will refer to contextual factors that are not static across childhood. Movement in and out of exposure is of interest, and disparate sequences of mobility and stability across childhood may have differential associations with educational and cognitive outcomes. Therefore, mobility can help to conceptualize contextual factors as dynamic and potentially changeable events throughout childhood and be used to investigate if changes in specific circumstances pose a particular risk/benefit to developmental outcomes.

Duration, Timing, and Mobility

Together, perspectives on duration, timing, and mobility demonstrate longitudinal characteristics through which context can operate to affect development. Therefore, in this study, the terms “temporal” and “temporality” refer to the timing-related dynamics of the duration of exposure, developmental time points of exposure, and changes in exposure to contextual factors across time. When applied to educational and cognitive outcomes, empirical studies which track specific contextual factors in relation to episodes of exposure and developmental stages can help with identifying the points where children are particularly vulnerable to contextual effects—insights which are essential for intervention design and implementation to support children to reach their learning potential. Interventions at the childhood stage are an essential component of any attempt to address learning inequities as evidence shows that children who develop earlier knowledge are in a better position to gain knowledge as they grow, with childhood learning being predictive of achievement, occupation, and socioeconomic position in later life (Lloyd & Hertzman, 2009; Tamis-LeMonda et al., 2019). However, a fundamental first step in structuring effective responses to promote learning equity is a comprehensive knowledge base detailing the specific points and lengths of exposure where children are susceptible to contextual effects.

Evaluating Temporality

Several empirical studies have examined longitudinal pathways of specific social and economic circumstances and their associations with educational and cognitive outcomes to assess how theoretical perspectives of temporality are supported (e.g., Gee, 2018; Smith et al., 2000; van Zwieten et al., 2020). These studies explored the duration and timing of various childhood social and economic factors in relation to educational and cognitive outcomes in different sample populations. However, whether there are common temporal pathways through which social and economic factors are associated with educational and cognitive outcomes is currently unclear, as a systematic review of this research has not yet been conducted.

This systematic review aims to review the relevant evidence linking children's social and economic pathways to educational and cognitive outcomes. Examining the literature on this topic gives an indication of the breadth of studies in this research area, insights into the generalisability and consistency of results in this field, and the instances where temporality is critical. Thus, this paper provides a comprehensive picture of current evidence and clearly identifies areas for further research. Specifically, the research question guiding this review is "how are educational and cognitive outcomes influenced by temporal exposures to social and economic circumstances in childhood?".

This review focuses on studies exploring social and economic circumstances within children's familial and neighborhood environments, with a particular focus on factors that are amenable to change. Many contextual factors that influence development within the familial and neighborhood contexts hold the potential for modification to see more children supported in their development (van der Waerden et al., 2017). However, in such research, it is important to acknowledge systemic and structural issues as the root sources of inequitable circumstances and not individuals, families, or certain subgroups (Munari et al., 2021; Thurber et al., 2020). Unequal opportunities for children often stem from uneven policies, programs, and provision of access to resources, creating barriers to equal opportunities and resulting in an uneven distribution of sustaining and damaging experiences across childhood (Commission On Social Determinants of Health, 2008). Examining the temporality of modifiable factors can help to provide solutions that direct attention to removing structural and systematic causes of disparities and not reproduce harmful narratives that stigmatize certain groups of individuals based on their disadvantage. Therefore, this review focuses on a range of factors within children's familial and neighborhood environments to provide information that can aid efforts to remove systematic and structural barriers to equitable learning for children. Specifically, this review focuses on factors relating to the economic resourcing of the families children are growing up in, social adversity, and aspects of the home and neighborhood environment (e.g., learning resources in the home, caregiver involvement). By assessing the temporality of this selection of factors, we aim to provide a perspective of the different temporal pathways through which proximal factors operate through to affect education and cognitive development.

Method

We conducted a systematic search of the existing literature to identify longitudinal studies that had examined the association between social and/or economic factors in childhood and educational and/or cognitive outcomes. Specifically, we aimed to identify current studies which had accounted for the temporal dimensions of social or economic factors in childhood. Articles were obtained through four electronic databases—PubMed, Education Research Complete, Scopus, and PsycInfo. The abstracts and titles of sources in each database were searched using the following keywords: (longitudinal OR repeated OR timing OR trajector* OR pattern OR pathway OR cumulat*) AND ('education outcome' OR achievement OR academic OR 'cognitive ability' OR 'cognitive development' OR 'cognitive outcome') AND (protective OR resilien* OR advant* OR 'social determinant' OR socioeconomic OR depriv* OR hardship OR advers* OR 'social class' OR 'social position' OR 'social circumstance' OR poverty) AND (child* OR primary OR elementary). Searches were restricted to articles distributed between January 2000 and September 2021 to locate the most recent literature and ensure findings were contemporary. Published and unpublished works were retained to include all relevant studies and minimize publication bias effects.

Screening Process

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines when extracting sources to be analyzed (Page et al., 2021). Figure 1 shows that, consistent with these guidelines, empirical sources were

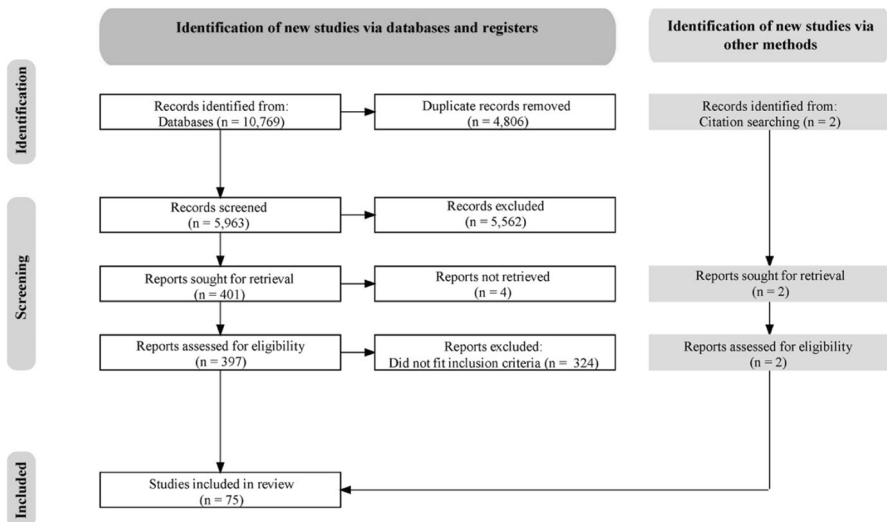


Fig. 1 PRISMA diagram of the search process

extracted from the four databases and duplicates were removed, resulting in 5963 studies. Titles and abstracts were screened according to the following criteria:

- a measure relating to educational and/or cognitive outcomes, captured at any time point throughout the lifespan, was used as an outcome variable,
- a measure of social and/or economic circumstances was used as an independent variable,
- the social and/or economic circumstance was assessed at least twice within the childhood years (i.e., data were collected and utilized from more than one time-point between when mothers were pregnant, and children were 12 years old).

The age restriction of 0–12 years was chosen to focus the time of exposure to within the childhood years and aligns with the child development stages ranging from the antenatal period to early adolescence (Osher et al., 2018). Studies were excluded if the time between data collection points was only a matter of weeks to retain studies that tracked exposure at substantially different time points in the childhood years and not those examining circumstantial exposure within the same developmental stage. Additionally, social and economic circumstances were limited to the family and neighborhood levels to focus on these proximal environments and manage the scope of the review. Therefore, factors at the early childhood education and school level, for example, were not included in this review.

After title and abstract screening, 401 studies were selected for full-text screening. Full-text copies were downloaded, except in four cases where a copy could not be accessed. Attempts to locate the full copies by emailing the authors were unsuccessful, resulting in these four studies being excluded. The remaining 397 studies were all fully screened according to the same criteria for title and abstract screening. Seventy-three studies were identified for inclusion. An additional two sources were identified through reference lists of the included studies, resulting in a final sample of 75 studies. Given the longitudinal focus of this review and the parameters of the inclusion criteria, all included studies were quantitative in design. Additionally, results were not restricted to the English language, but all 75 sources were available in English.

Data Analysis

The final sample of 75 studies was reviewed through reflexive thematic analysis (TA). Braun and Clarke (2019, 2022) describe reflexive TA as a process to generate patterns of meaning in a dataset—where themes are constructed at the intersection of the data, the analytic process, and the researcher’s subjectivity. Reflexive thematic analysis is a qualitative method developed for, and typically applied to, the analysis of qualitative data, yet the empirical methodologies across the 75 included studies were quantitative in design. However, thematic analysis is extensively used in systematic reviews of quantitative data (e.g., Berti et al., 2019; Ekholm et al., 2018; Miller et al., 2018) and was considered appropriate for use in this review to allow the researchers to embrace their subjectivity and acknowledge that the conclusions

made about the data were influenced by theoretical underpinnings of temporality. These ideas are further unpacked in the sections below.

Researcher Positionality

Reflexive thematic analysis is firmly grounded within a qualitative paradigm which values the subjectivity of researchers as an integral aspect of the analytic process (Braun & Clarke, 2019). Accordingly, the researchers in this study adopted the position of constructing themes through deep and prolonged engagement with the data—patterns of meaning in the data were not viewed as pre-existing and waiting for the researchers to uncover, rather the researchers generated themes which were inevitably influenced by theoretical considerations and researcher positionality (Braun & Clarke, 2022). Aligned with reflexive TA, this subjectivity was not viewed as threatening the credibility of the findings but called for the researchers to critically reflect on the assumptions that were underlying their interpretations of the data. In this sense, it is acknowledged that the decisions made by the researchers influenced the results and interpretations of the data. To account for this subjectivity, the research process is made transparent and outlined in detail in the following subsections and results section, with examples provided to give confidence to the robustness of the analysis.

Reflexive Thematic Analysis

The reflexive thematic analysis process outlined by Braun and Clarke (2022) was followed, which details six key phases of analysis: data familiarization, systematic coding, generating initial themes, developing and reviewing themes, defining themes, and reporting. First, key details about each study were extracted (e.g., sample population, variables, key results) so that the researchers could familiarize themselves with the data (Braun & Clarke, 2021, 2022). Codes were then used to label the data based on the findings in the results section relating to temporal instances that study participants were exposed to social and/or economic circumstances, and the effects of exposure on educational and/or cognitive outcomes. Note that this review focuses on results at the overall group level—if studies also reported within-group differences, these were not included. For example, van Zwieten and colleagues (2020) evaluated associations between timing and duration of low-socioeconomic status across childhood and academic achievement in secondary school, using data from a large population-based study of Australian children. In this study, patterns of temporality were explored for the sample as a whole and also assessed for effect modification of socioeconomic status by child sex. However, only overall group-level results were reviewed in this study, and not sex-specific results. This group-level focus allowed for results across the 75 studies to be meaningfully compared, as some studies accounted for participants' different characteristics, whereas others did not.

Additionally, we reviewed results that included the greatest number of covariates in analyses (e.g., “full models”) and not results in which covariates were included/omitted sequentially. Furthermore, where initial correlation analyses indicated a temporal

effect, if subsequent analyses were conducted to explore these associations further, then results from these later tests were examined so that the more detailed results were taken for review. However, where correlation analysis was the only exploration of temporality, these results were included in the review.

Studies were organized based on the codes, under meaningful themes relating to conclusions about the temporal effects of contextual factors on developmental outcomes. The codes and themes were predominantly generated by the primary researcher through deep and prolonged engagement in the data over several months. Throughout the coding and theme construction phases, continual questioning, revising, and refining were undertaken by all three researchers in order to construct strong themes and to engage in “a richer and more nuanced reading of the data” (Braun & Clarke, 2019, p. 594).

The themes were defined by the authors as:

1. duration effects,
2. developmental timing effects,
3. mobility effects, and
4. no temporal effects.

Theoretical Perspectives

The four themes broadly relate to current theoretical perspectives on how the duration and timing of contextual factors can influence development (e.g., ecological systems theory, Bronfenbrenner, 1977; life course theory, Ben-Shlomo et al., 2016). While the current theory was used as a guide, reflexive thematic analysis is a flexible process that allowed the creation of the themes to be influenced by theory but not to be guided by theory alone. Consequently, four themes were created which are loosely based on the theoretical underpinnings of this study yet were equally determined based on the researchers' engagement with the studies included in this review. The theme of “duration effects” relates to instances where varying lengths of exposure to specific social and economic circumstances contribute differentially to educational and cognitive outcomes. “Developmental timing effects” describe specific stages in childhood where exposure is more relevant for educational and cognitive outcomes. “Mobility effects” relate to movement in and out of exposure to specific social and economic circumstances. The fourth theme describes instances where no evidence of temporality was found. Importantly, these themes summarize key findings across this group of 75 studies. Each of the studies was categorized into at least one theme. Studies were included in multiple themes when results provided evidence for more than one temporal category.

Results

The findings from the reflexive thematic analysis are reported in this section. Study characteristics are described to contextualize the sample before the findings related to four themes are then explained. These themes outline the commonly recurring results across the included studies relating to temporality.

Study Characteristics

The studies included in this review were conducted in the USA (61%, $n=46$), United Kingdom (15%, $n=11$), Australia (8%, $n=6$), Canada (4%, $n=3$), and China (3%, $n=2$). Seven studies (9%) were categorized as being conducted in “Other” countries across Europe, Oceania, and South America. One study did not state the country. Sample sizes ranged from 74 to ~1.5 million (interquartile range, 733–8287), with children and families used as the unit of analysis. The types of statistical analytic methods for determining temporal effects varied across the studies and included structural equation modeling, analysis of variance, regression analyses, and growth curve modeling. Most studies indicated the use of large data sources, such as birth cohort studies or data repositories (93%, $n=70$). Full details of study characteristics can be found in the Appendix Table 4.

Educational and Cognitive Outcomes

The distinct categories of “educational outcomes” and “cognitive outcomes” have been used to describe the outcome variables in the included studies. In this review, educational outcomes relate to the extent to which students have attained academic-related knowledge and skills or other outcomes directly related to the education context (Kennedy et al., 2006). Cognitive outcomes refer to mental processes such as thinking, reasoning, attention, and problem solving (Fisher et al., 2019). While there is an overlap between these two categories, especially given the bidirectional associations between cognitive outcomes and educational outcomes (Lövdén et al., 2020; Peng & Kievit, 2020), we grouped each study according to whether outcome variables were of most relevance to the education or cognitive domain. Where multiple outcomes were assessed, studies could be placed into both categories. The breadth of educational and cognitive variables is explained further in the following paragraphs.

Forty-nine studies (65%) were included in the educational outcomes category. These studies were grouped into three sub-categories for analysis and can be described as academic performance, education qualifications, and school engagement. Studies could be included in more than one category where multiple educational outcomes were examined. Academic performance ($n=41$) describes the assessment of knowledge or skills relating to academic material, for example, math or reading tests. Education qualifications ($n=7$) relate to milestones achieved through the education system such as secondary school completion or graduation from university. School engagement includes elements assessed within the school context relating to children’s involvement in school, such as approaches to learning ($n=3$) and school absences ($n=1$). Across these 49 studies, education-related variables were observed at various points in the life course—throughout childhood, adolescence, and adulthood (see Appendix Table 4 for study-specific information). Where educational outcomes were measured at multiple points across the lifespan, the final time point was examined in this review.

Thirty-four studies (45%) described cognitive outcomes, where assessments of mental functioning and processes were conducted. Some studies had a specific cognitive focus and used test scores from one aspect of cognition, for example, language abilities ($n=11$), attention ($n=2$), memory ($n=2$), and non-verbal abilities ($n=2$). Other studies ($n=19$) utilized participants' scores across tests of different aspects of cognition to form a general cognitive composite score. An additional four studies tested executive function where assessments of inhibitory control, cognitive flexibility, or a battery of executive function tasks were administered. Again, studies were included in multiple categories where more than one type of cognitive outcome was examined. Cognitive outcomes were predominantly assessed throughout the childhood years, with a noticeable lack of focus on cognitive outcomes in adulthood (two studies; see Appendix Table 4 for study-specific information). Where outcomes were measured at multiple points across the lifespan, the final measure was taken for review.

Correlates of Educational and Cognitive Outcomes

A range of social and economic correlates was observed across the included studies. Within each study, correlates were measured at least twice within childhood (0–12 years). Where correlates were also examined at a later point (e.g., in adolescence), these analyses were not included to focus the review on the childhood years. Due to the wide range of contextual factors that were examined and the different operationalizations of these factors, three categories were used to gauge the breadth of social and economic factors represented in the included studies: economic resources (41%, $n=31$), social adversity (21%, $n=16$), and home and neighborhood environment (47%, $n=35$). Studies were included in multiple categories when more than one variable was examined.

The economic resourcing category is focused on factors directly relating to the financial situation of the family, for example, socioeconomic position, poverty status, food insecurity, and eligibility for benefit receipt. Social adversity describes social factors that pose a threat to children's development and increase the risk of poorer outcomes in later life such as institutionalization, maltreatment, and homelessness. Home and neighborhood environment relates to factors connected with the social, emotional, and physical contexts children live and grow up in, such as low-income neighborhoods, household structure, residential mobility, school mobility, learning resources in the home, parental health, and caregiving practices. Details of the specific constructs and indicators used in each study can be found in the Appendix Table 4. For the instances where similar constructs were examined, it is important to note that measures often differed between studies.

Much overlap between these three social and economic categories is evident, and there are instances where one factor may equally be suited to a different category. For example, school mobility could be categorized into "social adversity", as moving schools is shown to increase the risk of poorer education and cognitive outcomes due to disruptions to learning experiences and social relationships (Reynolds

et al., 2019). However, explanations for why students moved schools are not always detailed in the reviewed studies and may be attributable to positive reasons, such as a student's desire to move school or families moving to a safer neighborhood, and not necessarily for negative reasons. Therefore, studies examining school mobility have been included in "home and neighborhood environment" as a descriptor of the community contexts in which children grow and develop. This example illustrates the interconnectedness of these categories.

Themes

In the sample of 75 studies, there was variation in how educational and cognitive outcomes were influenced by temporal pathways of specific social and economic factors in childhood. Four themes were constructed to describe this variation in findings: duration effects, developmental timing effects, mobility effects, and no temporal effects. The first three themes provide evidence for how contextual factors relate to educational and cognitive outcomes through different temporal dimensions. Importantly, many of these results are from studies which support correlational inferences, not causal, and therefore, the conclusions drawn in this review should be interpreted accordingly.

Across these three themes, a total of 66 studies (88%) found evidence to support temporality. Forty-one studies (55%) found evidence for duration effects, 26 studies (35%) described developmental timing effects, and 22 studies (29%) found mobility effects. The final theme, no temporal effects, describes nine studies (12%) that found no evidence for temporality. Overall, 17 studies (23%) found evidence to support multiple temporal dimensions, and therefore, these are included in multiple themes. These studies were identified through analyzing the results section of each study and identifying the ones where significant results were indicative of multiple temporal pathways. However, results are discussed separately within each theme to give an overview of the evidence as it relates to each temporal dimension and to ensure nuance is retained in accordance with reflexive TA.

In the following subsections, the four themes are described in more detail. However, when interpreting these themes, it is important to note that the focus of each study varied, as did the methods employed to explore temporality. In some studies, the purpose of the investigation was to establish the extent to which contextual factors acted through a specific temporal dimension (e.g., Bask et al., 2020; Coohy et al., 2011; Sanson et al., 2011). For example, Bask and colleagues (2020) investigated the timing effects of childhood social assistance reciprocity and early school leaving, but did not investigate other temporal dimensions (e.g., duration of receipt). In contrast, other studies accounted for multiple temporal dimensions by either (a) exploring multiple temporal hypotheses in separate analyses within one study (e.g., Ackerman et al., 2004; Johnson & Markowitz, 2018); (b) modeling multiple temporal effects concurrently, such as duration and timing (e.g., Hernandez & Jackowitz, 2009; Kiernan & Mensah, 2011; Wagmiller et al., 2006); or (c) disentangling temporal effects by contrasting temporal models to find which model best explained the associations between context and development (Evans et al., 2012; Roos &

Wall-Wieler, 2017; van Zwieten et al., 2020). This variation between the included studies provides contextual insight as to how evidence to support temporal hypotheses was established. Despite this variation in study design, findings were examined concurrently, as the results of each study were the focus of this review and not the aims or methods. Studies were grouped into themes to give an overview of what evidence exists to support temporality. The nuances and variations within these themes are discussed in the following sections.

Theme One: Duration Effects

Theme one describes 41 studies which focused on the number of exposures to specific social and/or economic factors. Of these studies, 36 studies found that repeated exposure to specific social and economic factors was significantly relevant for educational and cognitive outcomes. In these studies with significant results, the temporal element of duration was of focus and findings suggest that varying lengths of exposure to specific social and economic circumstances result in inequities in educational and cognitive outcomes. Consistently across these studies, chronic exposure was found to amplify effects on development—children with continued exposure to specific social and economic circumstances across time had their educational and cognitive outcomes affected to a greater extent when compared to those with intermittent exposure and no exposure at all. For example, Smith and colleagues (2005) found that children who were parented with consistently high levels of maternal responsiveness across the infancy and preschool periods had more optimal cognitive development trajectories than those who received this type of parenting only during infancy, the preschool period, or not at all. These findings suggest that the length of exposure to contextual factors can lead to differential cognitive development pathways. Taken together, the studies in theme one suggest that duration effects are important, with variations in the length of exposure being associated with differential educational and cognitive outcomes across over half the studies in this review.

Eleven studies found no evidence for duration effects. In these studies, the length of exposure to specific social and/or economic factors was examined; however, no duration effects were established. In five of these studies, duration effects were found in one instance but not another, and therefore, these studies were also counted in the 36 studies that did find duration effects (Ackerman et al., 2004; Friedman-Krauss & Cybele Raver, 2015; Letourneau et al., 2013; Schoon et al., 2012; Tessier et al., 2018). For example, Schoon and colleagues (2012) found persistent poverty to have negative effects on cognitive functioning, but family instability across early childhood had no significant association. In six studies, although duration was investigated, no evidence supported duration effects (Hill, 2021; Kimbro & Denney, 2015; Kurstjens & Wolke, 2001; Pears et al., 2015; Sonuga-Barke et al., 2017; Turney, 2011). For example, Turney (2011) investigated whether children's language scores at age five differed between those whose mother was never depressed, depressed at one wave, depressed at two waves, or depressed at all three data collection waves. No significant difference in language scores was observed between the duration of depression and those who had mothers who were never depressed. However, the author notes that this finding is

inconsistent with other research and that the duration of maternal depression may be more influential for children's cognition at a later developmental stage.

The studies that did find duration effects ($n=36$) were further examined for patterns of findings within this theme. Fifteen studies examined cognitive outcomes, and 27 studies analyzed educational outcomes. All three categories for the social and economic correlates were represented: economic resourcing ($n=14$), home and neighborhood environment ($n=21$), and social adversity ($n=6$). These findings suggest that, across a wide range of contextual factors, persistent effects are evident for both educational and cognitive outcomes. Additionally, one sub-theme describes a specific manifestation of these duration effects where effects accumulate with increasing exposure over time.

Sub-theme: Accumulation Nineteen studies examined duration effects to find whether each additional period of exposure to specific social and economic factors resulted in an increase in the strength of effect on the outcome variable. Accumulation was measured through calculating the number of periods participants were exposed to during childhood, and differential effects for educational and cognitive outcomes were found depending on the number of exposures. The study by Johnson and Markowitz (2018) is typical of accumulation where increasing periods of exposure to food insecurity were found to have an increasingly detrimental effect on learning in a representative sample of US-born children living in low-income households. Similar results were found in a study of low-socioeconomic status where an increasingly greater number of time points of exposure across early and middle childhood were associated with poorer numeracy scores in early adolescence for Australian children (van Zwieten et al., 2020). The 19 studies of accumulation are displayed in Table 1 and illustrate that each additional period of exposure resulted in a greater effect on education and cognition. For comparability, the exposure to specific social/economic factors have been categorized from 0 to 4 exposures which denote either a period of exposure (e.g., exposed to poverty for one year) or instance of exposure (e.g., one substantiated report of maltreatment). The number of exposures was obtained from the methods section of each study. Shading is used to visualize the accumulation effect, where darker shading indicates that a longer duration of exposure has a greater effect on the outcome. Dots (.) are representative of the number of exposures examined by each study.

An additional three studies found that longer periods of exposure increased the strength of association with educational and cognitive outcomes, but this effect was not linear and there was a threshold effect (Ackerman et al., 2004; Croft et al., 2007; van Zwieten et al., 2020). For example, Croft and colleagues (2007) examined accumulating periods of institutionalization in children before they were adopted. Periods of time spent in institutions were categorized for analysis in this review as no institutionalization, 0–6 months of institutionalization representing one period, 6–24 months representing two periods, and 24–42 months representing three. The language abilities of children with different periods of

Table 1 Studies with accumulation effects (*n* = 19)

Author(s)	Social/Economic Domain	Outcome (age assessed)	Number of exposures to social/economic factor				
			No exposure/ comparison group	1 (Shorter)	2	3	4 (Longer)
Bramson et al. (2016)	Residential mobility	AP (Adolescence)	•	•	•	•	•
Coohey et al. (2011)	Maltreatment	AP (Early adolescence)		•	•	•	•
Dickerson & Popli (2016)	Poverty	CC (Middle childhood)	•	•	•	•	•
Evans et al. (2012)	Maternal mental health	CC (Middle childhood)		•	•	•	•
Friedman-Krauss & Cybele Raver (2015)	School mobility	AP (Early adolescence)	•	•	•	•	•
Gibb et al. (2012)	Poverty	EQ (Adulthood)		•	•	•	•
Johnson & Markowitz (2018)	Food insecurity	CC (Preschool)	•	•	•	•	•
Kiernan & Mensah (2011)	Poverty	AP (Preschool)	•	•	•	•	•
Mensah & Kiernan (2011)	Maternal mental health	CC (Preschool)	•	•	•	•	•
Morrissey et al. (2014)	Poverty	AP & SA (Preschool–early adolescence)	•	•	•	•	•
NICHHD (2005)	Poverty	CC (Toddler–middle childhood)	•	•	•	•	•
Potter & Morris (2017)	Parental involvement in learning	AP (Preschool–adolescence)	•	•	•	•	•
Potter & Roksa (2013)	Parental involvement in learning	AP (Preschool–adolescence)	•	•	•	•	•
Quevedo et al. (2012)	Maternal mental health	Language (Toddler years)	•	•	•	•	•
Roos & Wall-Wieler (2017)	Low-income neighbourhood	EQ (Adulthood)	•	•	•	•	•
	Residential mobility		•	•	•	•	•
Smith et al. (2005)	Caregiver involvement	CC (Preschool–early adolescence)	•	•	•	•	•
Tessier et al. (2018)	Placement stability	AP (Adolescence)	•	•	•	•	•
van Zwieten et al. (2020)	Socioeconomic position	AP (Adolescence)	•	•	•	•	•
Zhang & Han (2017)	Socioeconomic position	AP (Preschool–adolescence)	•	•	•	•	•

Duration of time has been categorized from 0 to 4 time periods for comparability across studies; however, each study has a definition for how long each period is. Shading indicates the accumulation effect, where darker shading indicates that a longer duration of exposure has a greater effect on the outcome. Dots (.) indicate the number of exposures

AP, academic performance; CC, cognitive composite; SA, school absences; EQ, educational qualifications

time spent in institutions were compared, and the length of exposure was found to have an increasingly detrimental effect on children’s non-verbal abilities. However, children with two and three periods of institutionalization did not differ in their non-verbal abilities, indicating that a threshold effect may have been reached at two periods of exposure. These findings suggest that, in some instances, contextual effects may no longer accumulate once a particular duration of exposure is reached. However, overall, the included studies finding accumulation effects suggest that different lengths of exposure are likely to be associated with differential educational and cognitive outcomes, and that as exposure increases in length, effects on development are likely to be greater.

Theme Two: Developmental Timing Effects

Distinct findings relating to developmental stages in childhood were observed in 35% of studies ($n=26$). These studies found that specific time points of exposure to specific social and economic circumstances had statistically significant effects on educational and cognitive outcomes. An additional three studies examined timing effects but did not find any statistically significant results (Burchinal et al., 2008; Kurstjens & Wolke, 2001; Li et al., 2019). Within each study on this theme, exposure to contextual factors was examined in at least two different developmental stages to identify which points in childhood had significant, and potentially enduring, effects on developmental outcomes. Studies in theme two were analyzed by organizing the findings based on the developmental stage of exposure and whether this time point was significantly related to developmental outcomes. The developmental stages of pregnancy, newborn, infancy, toddler, preschool years, middle childhood, and early adolescence were used and aligned with child development research (e.g., Osher et al., 2018). Table 2 provides a summary of the studies on this theme. The contextual variables that are significantly associated with educational/ and or cognitive outcomes are denoted by a tick (✓), while those that are not significant at the $p < 0.05$ threshold are denoted by a dash (–). Shading establishes the time points as being examined. Studies are repeated where both educational and cognitive outcomes were analyzed.

A typical study to illustrate developmental timing effects comes from Barker and colleagues (2013) who investigated the effect of maternal depression in pregnancy and early childhood and established that exposure at both developmental time points was independently associated with children's cognitive development at age eight. In a different study by Fox and colleagues (2011), a foster care intervention for children experiencing psychosocial deprivation resulted in typical cognitive composite scores for those who received the intervention before the toddler years but lower cognitive scores for those who received the intervention during the toddler years or later. These studies demonstrate that specific periods in childhood can have a unique receptivity to contextual factors.

Studies with significant timing effects were examined in further detail to identify clear patterns of findings that might indicate explicit timing effects. A distinct pattern was observed in the pregnancy stage, where all sources found contextual factors at this time point to be significant ($n=3$; Barker et al., 2013; Evans et al., 2012; Urizar & Muñoz, 2021). All three studies found that antenatal maternal mental health had a direct effect on cognitive composite scores in childhood (see Table 2). Cognitive composite scores were assessed across early childhood in one study (Urizar & Muñoz, 2021) and middle childhood in the other studies (Barker et al., 2013; Evans et al., 2012). These findings indicate the potential of maternal mental health in pregnancy as having unique effects on children's cognitive development.

Of all studies in this timing category, those which investigated the effects of economic resourcing in early childhood (newborn–preschool years; $n=13$) found some evidence for this early life stage as having a significant association with both educational and cognitive outcomes. For example, Dickerson and Popli (2016) used structural equation modeling to find poverty in the early years had a direct influence on

Table 2 Studies examining timing effects (*n* = 29)

Study	Social/Economic Correlate	Outcome	Developmental Time Points						
			Antenatal	New born	Infancy	Toddler	Preschool	Middle childhood	Early adolescence
Education Outcomes									
Ackerman et al. (2004)	Family income	AP (Early adolescence)						✓	✓
	Contextual risk							✓	–
Bask et al. (2020)	Benefit receipt	EQ (Adolescence)			✓			✓	
Burchinal et al. (2008)	Risk	AP (Early adolescence)				–		–	–
Duncan et al. (2010)	Family income	EQ (Adulthood)			✓			–	✓
Herbers et al. (2013)	School mobility	EQ (Adolescence)						–	✓
Holmes et al. (2018)	Maltreatment	AP (Preschool–adolescence)			✓		✓		✓
Johnson & Markowitz (2018)	Food insecurity	AP (Preschool)			✓	✓	✓		
		ATL (Preschool)			–	✓	✓		
Kobrosly et al. (2011)	Socioeconomic position	AP (Adolescence)			✓			✓	
Kurstjens & Wolke (2001)	Maternal mental health	AP (Middle childhood)			–		–		
Li et al. (2019)	Residential mobility	AP (Adulthood)				–			–
Liu & Hannum (2017)	Poverty	EQ (Adulthood)				✓			✓
Mistry et al. (2010)	Risk	AP (Preschool)			✓	✓			
Molfese et al. (2003)	Socioeconomic position/Learning environment	AP (Early adolescence)					✓		✓
O'Connor et al. (2019)	Socioeconomic position	AP (Early adolescence)			✓		✓		
Perlman & Fantuzzo (2010)	Maltreatment	AP (Middle childhood)			✓	✓	✓	✓	
	Homelessness				✓	✓	✓	–	
Roos & Wall-Wieler (2017)	Low-income neighbourhood	AP (Adulthood)			✓			✓	✓
	Family structure				✓			✓	✓
	Residential mobility				✓			✓	✓
Sansón et al. (2011)	Social adversity*	AP (Middle childhood)					–	–	
	Economic resourcing*						–	–	
	Home and neighbourhood environment*						–	–	
van Zwieten et al. (2020)	Socioeconomic position	AP (Adolescence)					✓	✓	✓
Votruba-Drzal (2006)	Family income	AP (Middle childhood)				✓			–
	Home learning environment					✓			✓

Table 2 (continued)

Cognitive Outcomes									
Barker et al. (2013)	Maternal nutrition	CC (Middle childhood)	✓				✓		
	Maternal mental health	CC (Middle childhood)	✓		✓				
Dickerson & Popli (2016)	Poverty	CC (Middle childhood)			✓	✓	✓	-	
Dunn et al. (2016)	Maltreatment (physical abuse)	Memory (Adulthood)			-		-	-	✓
	Maltreatment (sexual abuse)	Memory (Adulthood)			-		✓	-	-
Enlow et al. (2012)	Trauma exposure	CC (Toddler–middle childhood)			✓		-		
Evans et al. (2012)	Maternal mental health	CC (Middle childhood)	✓	✓	✓				
Fox et al. (2011)	Institutionalisation	CC (Middle childhood)			-		✓		
Kobrosly et al. (2011)	Socioeconomic position	Memory & Attention (Adolescence)			✓			✓	
Kurstjens & Wolke (2001)	Maternal mental health	CC (Middle childhood)		-	-				
Priel et al. (2020)	Caregiver involvement	EF (Early adolescence)			-			✓	-
Roos et al. (2016)	Substance exposure	EF (Middle childhood)			-			✓	
	Maltreatment	EF (Middle childhood)			-			✓	
	Violence exposure	EF (Middle childhood)			-			-	
Schoon et al. (2012)	Poverty	Language & NVA (Preschool)			✓	-	-		
	Family structure	Language & NVA (Preschool)			-	-	-		
Urizar & Muñoz (2021)	Maternal mental health	CC (Toddler–preschool)	✓		-				

In some studies, developmental stages were grouped into broader categories than the seven used in this review, in which case table cells are merged to reflect this (e.g., Bask et al., 2020)

*Multiple variables were used to assess each social/economic category; see the study for details

AP, academic performance; EQ, educational qualification; ATL, approaches to learning; EF, executive functioning; NVA, non-verbal abilities

cognitive development in middle childhood in a large sample of children born in the United Kingdom between 2000 and 2001. These findings suggest that in the early years, children are receptive to the economic environment of the family and that economic adversity has subsequent negative implications for educational and cognitive outcomes.

The 19 studies which examined timing effects for educational outcomes were investigated further, and evidence was found for all time points across the

newborn–early adolescence stages to be significant in 14 studies. In these studies, evidence was found for a range of contextual factors to have a significant influence on educational outcomes at all examined time points. Educational outcomes were examined across the preschool–adulthood years and included academic performance, approaches to learning, and educational qualifications. Table 2 displays this information and illustrates the general consistency of findings for the education domain across each developmental stage in childhood. Some of these studies had variations *within* study findings as to whether each time point was significant. For example, Ackerman and colleagues (2004) found economic resourcing to be significantly associated with academic performance in early adolescence, but social adversity at this time point did not uniquely contribute to academic performance. The consistency of findings contrasts with the studies examining cognitive outcomes, where only three of the 12 studies find all time points to be significant. However, it is noteworthy that only one study in this category examined cognitive outcomes in adulthood.

Theme Three: Mobility Effects

In 22 studies (29%), transient exposure was revealed to have implications for educational and cognitive outcomes. Transience, or mobility, describes the movement in and out of exposure to social and economic circumstances across childhood. Mobility was established in each of the 22 studies by grouping children into trajectories of contextual exposure over time based on similar experiences in or out of exposure. Children with patterns of mobility were typically compared with children who had more stable trajectories. For example, Letourneau and colleagues (2013) found that the language ability of children who had mothers with early depression (before the child was one year old) did not differ from those whose mothers were never depressed throughout the child's first five years. However, children with mothers who were persistently depressed, or had a later onset of depression, had significantly higher chances of lower language abilities than children of mothers who were never depressed. Regarding mobility, this example illustrates that early improvements to maternal health were beneficial to children, whereas later deterioration posed a threat to children's cognitive development. Therefore, changes in circumstances can have important implications. These mobility effects highlight the need to distinguish between the patterns of exposure across multiple time points in childhood, as various patterns of longitudinal exposure to specific contexts can differentially influence educational and cognitive.

Table 3 provides an overview of the mobility studies and visualizes upward and downward mobility. All trajectories are compared with a reference group where no mobility was observed (reference trajectories not displayed). Dots (.) are indicative of baseline measures of contextual exposure; stability over time is denoted by a 0 value, upwards mobility as + 1, and downwards mobility as - 1. Differences between the depicted transient group, as compared with the reference group, are listed in the final column as either a significantly better (+), significantly worse (-), or non-significant effect (ns). An additional four studies are included in Table 3 where

Table 3 Studies examining mobility ($n = 26$)

Study	Social/ Economic Correlate	Outcome (age)	Developmental Time Points						Comparison to reference group	
			New born	Infancy	Toddler	Preschool	Middle childhood	Early adulthood		
Awada & Shelley (2021)	Maternal education	AP (Early adolescence)	•			+1			+	
Burchinal et al. (2018)	Family income	L, AP (Preschool)		•		+1			ns	
				•		-1			-	
		EF (Preschool)		•		+1			ns	
Gee (2018)	Food insecurity	AP (Middle childhood)				•	+1		ns	
Grineski et al. (2018)	Food insecurity	AP & EF (Middle childhood)				•	+1		ns	
						•	-1		-	
Hayes et al. (2018)	Caregiver involve-ment	AP & L (Middle childhood)		•			-1		-	
		ATL (Middle childhood)		•			-1		ns	
Hernandez & Jacknowitz (2009)	Food insecurity	CC (Toddler years)		•		+1			ns	
				•		-1			-	
Hill (2021)*	Family income	AP (Middle childhood)		•		+1		+1	ns	
				•		-1		-1	ns	
Howard (2011)	Food insecurity	ATL (Early adolescence)							ns	
							•	+1	0	-
							•	-1	0	ns
							•	0	+1	ns
Jackson et al. (2017)	Family income	L (Preschool)	•			+1			-	
			•			-1			-	
Jaffee (2007)	Learning environment	L (Preschool)		•			+1		+	
Kiernan & Mensah (2009)	Poverty	CC (Preschool)		•		+1			-	
	Maternal mental health			•		-1			-	
				•		+1			ns	
Kiernan & Mensah (2011)	Poverty	AP (Preschool)		•		+1			-	
				•		-1			-	
Kimbro & Denney (2015)	Food insecurity	AP (Middle childhood)				•	+1		ns	
						•	-1		ns	
Letourneau et al. (2013)	Maternal mental health	L (Preschool)	•			+1			ns	
			•			-1			-	
		Attention (Preschool)	•			+1			ns	
			•			-1			-	
Liu & Hannum (2017)	Poverty	AP (Early adolescence)	•			+1			ns	
			•			-1			ns	
McKelvey et al. (2017)	Risk	EQ (Adulthood)		•				+1/-1	-	
		L (Preschool)		•		-1		-1		-
				•		-1		+1		ns
				•		+1		+1		ns
			•		-1		-1		-	
Mellborn et al. (2012)	Family structure	CC (Toddler years)		•		+1			ns	
				•		-1			ns	
				•				+1		-
NICHD (2005)	Poverty	CC (Toddler–middle childhood)		•				+1	-	
				•				-1		-

Table 3 (continued)

Pittman & Boswell (2007)*	Caregiver involvement	AP (Toddler–early adolescence)	•		-1	-	
			•		+1	ns	
Quevedo et al. (2012)	Maternal mental health	L (Toddler years)	•	+1		-	
			•	-1		-	
Raffington et al. (2018)	Family income	AP (Preschool–early adolescence)	•		+1	+	
		L (Preschool–early adolescence)	•		-1	-	
		•		+1	+		
		•		-1	-		
Low-income neighbourhood			•		-1	+1	
			•		0	-1	
			•		0	+1	
			•		+1	-1	
			•		+1	0	
			•		-1	+1	
Roes & Wall-Wieler (2017)	Family structure	EQ (Adulthood)	•		0	+1	
			•		+1	-1	
			•		-1	0	
			•		0	-1	
	Residential mobility			•		0	+1
				•		+1	-1
				•		-1	0
				•		0	+1
Schoon et al. (2012)	Poverty	L (Preschool)	•	0	-1	-	
			•	-1	+1	ns	
			•	-1	0	ns	
			•	+1	0	-	
	NVA (Preschool)	•	+1	-1	-		
		•	-1	+1	-		
		•	0	-1	ns		
		•	-1	+1	ns		
	Family structure	L & NVA (Preschool)	•	-1	0	-	
			•	+1	0	-	
			•	+1	-1	-	
			•	-1	+1	ns	
			•	0	-1	ns	
			•	-1	+1	ns	
			•	-1	0	ns	
			•	+1	0	ns	
Sun & Li (2014)	Family structure	CC (Toddler years)	•	+1		+	
			•	-1		-	
Wagmiller et al. (2006)	Poverty	EQ (Adulthood)	•		+1	+	
Zhang & Han (2017)*	Socioeconomic position	AP (Preschool–adolescence)	•		+1	-	
			•		-1	-	

All trajectories are compared with a reference group where no mobility was observed. Dots (•) are indicative of baseline measures, 0 = stability, +1 = upwards mobility, -1 = downwards mobility. The final column lists the differences between the depicted trajectory as compared with the reference group (i.e., stable trajectory) as either significantly better (+), significantly worse (-), or non-significant effect (ns)

* Sample of children ranged in age; therefore, social/economic circumstances span across multiple developmental time points

AP, academic performance; L, language; EF, executive functioning; ATL, approaches to learning; CC, cognitive composite; EQ, educational qualifications; NVA, non-verbal abilities

evidence was not found to support a mobility effect (Hill, 2021; Kimbro & Denney, 2015; Mollborn et al., 2012; Pittman & Boswell, 2007). Of the studies finding mobility effects, some studies find one pathway of mobility to be different when compared with more stable trajectories; however, this is not the case in all instances (e.g., Burchinal et al., 2018; Letourneau et al., 2013; Schoon et al., 2012). For example, Burchinal and colleagues (2018) found that children's language abilities and academic performance were differentially affected depending on poverty transition throughout early childhood; however, this was not the case for executive functioning. Similar findings in other studies can be seen in Table 3.

Most studies in theme three that found mobility effects focused on changes to the economic situation that children were reared in (i.e., "economic resourcing"; $n=13$). These studies focused on movement in and out of poverty, food insecurity, socioeconomic status, or family income to find disparate trajectories reflected differential patterns of educational and cognitive outcomes. Additionally, home and neighborhood environmental factors were of interest in nine studies, where changes to caregiver practices, maternal mental health, family structure, and neighborhood deprivation status resulted in inequitable educational and cognitive outcomes. Only one study examined variables relating to social adversity. Of the 22 studies with mobility effects, 12 examined educational outcomes and 14 examined cognitive outcomes. Three studies examined outcomes in both the education and cognitive domains. These findings suggest that mobility of circumstances, especially of economic resourcing and home and neighborhood environmental factors, can differentially affect both educational and cognitive outcomes. However, outcomes are predominantly assessed in the childhood years (0–12 years), and only four studies examine outcomes in adolescence–adulthood, all being in the education domain.

Theme Four: No Temporal Effects

Overall, nine studies (12%) found no evidence of specific social and economic circumstances to have a temporal effect on educational and cognitive outcomes. Although temporality was investigated in these studies, no evidence supported temporal effects. Six studies examined the duration of exposure, three investigated timing effects, and three studies examined mobility. However, no evidence was found to support temporality in these instances. For example, although Burchinal and colleagues (2008) found risk exposure to be negatively associated with academic outcomes, when operationalized as time-specific exposure, no evidence emerged indicating that the timing of risk exposure across early and middle childhood influenced academic performance in early adolescence. However, these non-significant findings may be a function of low statistical power, as noted by Burchinal and colleagues (2008).

Additional limitations in the other studies within this theme may explain the absence of temporal evidence. For example, Sonuga-Barke and colleagues (2017) initially found institutional deprivation had a temporal effect on cognitive abilities in childhood and adolescence, but this effect diminished when cognitive abilities were measured again in adulthood. However, the study also experienced large attrition between data collection points in adolescence and adulthood which may

have affected the results, although attrition appeared to be non-selective. Furthermore, four other studies with non-significant findings only examined one temporal dimension and found no evidence to support temporality. However, different temporal pathways that were not examined in these studies may better explain the relationships between context and educational/cognitive outcomes. Finally, one study in this category did find developmental timing effects; however, these were observed in adolescence, and this review only focused on results in childhood. Taken together, the nine studies in theme four did not find evidence to support temporality; however, it is not entirely clear that temporality had no effect, as study limitations may have prevented these effects from being observed.

Discussion

The 75 studies included in this systematic review investigated a wide range of social and economic circumstances and associations with different types of educational and cognitive outcomes, yet commonalities in results were observed across four areas relating to temporality. These themes each offer insights into the complex and diverse temporal pathways of contextual factors across childhood. In this section, these temporal findings are discussed with reference to broader conclusions about this research area. These interpretations illustrate that this area of longitudinal research offers promising and informative perspectives from which to understand children's learning and cognitive development in context.

The Importance of Temporality

Largely, educational and cognitive outcomes are demonstrated in this review to be related to the duration, timing, and mobility of specific social and economic factors of childhood. Indeed, the vast majority of studies found temporality to be significant in the associations between context and learning-related outcomes. These findings illustrate the specific avenues through which temporality may differentially affect development. Results from the duration theme revealed that chronic exposure increased the effects of context on educational and cognitive outcomes. In contrast, studies which investigated time-specific exposures found distinct points within childhood to be relevant for educational and cognitive outcomes. Additionally, mobility effects were observed and illustrated that disparate patterns of exposure in childhood were found to have differential associations with educational and cognitive outcomes. Broadly, these three themes provide empirical evidence for current theoretical perspectives on duration and timing (Ben-Shlomo et al., 2016; Bronfenbrenner, 1986), where varying trajectories of social and economic circumstances over time lead to educational and cognitive inequities. Finally, the fourth theme described instances where a temporal dimension was not supported; however, study limitations may have prevented an effect from being observed. Taken together, the findings across these four themes point to the importance of characterizing not just if but

also when and for how long circumstantial exposures occur, as these dimensions are likely to have differential effects on educational and cognitive outcomes.

Substantial evidence was found to favor temporal effects across a range of social and economic circumstances for various educational and cognitive outcomes. Each social and economic category (economic resourcing, social adversity, home and neighborhood environment) was observed in each theme, and no clear patterns were found to suggest that certain social and economic factors operated through a particular temporal dimension. Equally, educational and cognitive outcomes were represented across the themes, suggesting that duration, timing, and mobility effects are all important for these outcomes. These findings serve as a reminder that temporal effects are confounded with one another (Hallqvist et al., 2004; Mishra et al., 2009). The intertwining effects of duration, timing, and mobility likely result in a distortion of the association between contextual factors and educational and cognitive outcomes unless multiple hypotheses are accounted for. Consequently, methodological approaches to accommodate the complexities of temporal effects are essential for providing robust analyses, and future research should adopt such approaches.

Benefits of Repeated Measures

The publications included in this review examined multiple instances (i.e., longitudinal patterns) of specific social and economic circumstances in childhood. Findings relating to the themes of duration, developmental timing, and mobility effects suggest that the use of repeated measures can provide essential information as to how children's environments are related to educational and cognitive outcomes. These results indicate that providing information about the specific instances of childhood circumstances and the amount of time exposed, not only *what* circumstances children are exposed to, can offer key insights into how inequities in educational and cognitive outcomes arise. However, such approaches are at odds with a large portion of the research on determinants of development, where measures without temporal distinction are utilized instead (e.g., Gao et al., 2021; He et al., 2014; Shen et al., 2012). Circumstantial measures that fail to account for the unique contribution of timing and duration may underestimate the complex exchanges between an individual and the many contexts of childhood.

Much of the research into Adverse Childhood Experiences (ACEs) provides examples of the limitations of an approach where temporality is not accounted for. The ACEs framework explores different forms of childhood hardship and has served as a useful tool for directing awareness toward the prevalence and effects of childhood adversity (Foege, 1998). In ACEs research, exposure to adversity is typically measured using a binary indicator of presence or absence of experience at any point in childhood (e.g., Mc Elroy & Hevey, 2014; Reuben et al., 2016; Schmidt et al., 2020). Multiple experiences are then summed together to give an index score of a range of adversities. However, this approach ignores temporal dimensions and conflates risk among children who are exposed to adversity for brief times with those who have had more sustained exposure in childhood or exposure during different

developmental periods. By conflating these experiences, important distinctions of how adversities are affecting development may be underestimated. Consequently, developmental processes may be misunderstood or oversimplified. The results from this review indicate that future work in this area should consider the measurement of timing, chronicity, and discontinuity of adversities, in addition to identifying what circumstances are important for development to maximize understanding of childhood adversity.

The use of repeated measures of circumstances throughout childhood can also help to explain why some children go on to demonstrate trajectories of resilience. A large portion of the research into social and economic determinants of education and cognitive development has focused solely on disadvantageous circumstances (see systematic review by Pillas et al., 2014). However, the results from this review suggest that temporal research can be instrumental in efforts to reposition toward strength-based models and identify avenues for positive change. For example, McKelvey and colleagues (2017) examined patterns of social adversity across early childhood to find children with consistently low exposure or decreasing exposure to adversity had more optimal cognitive development than those with increasing exposure or consistently high exposure. The examination of disparate pathways of adversity allowed the researchers to have a nuanced approach to understanding risk exposure, which could lead to more accurately identifying resilient children and the circumstances which facilitate resilience. Therefore, the implementation of procedures and analytic techniques to capture disparate trajectories, including mobility, can provide the insight needed to understand why some children have differential outcomes despite their exposure to risk. Such an approach means that avenues for enhancing positive change can be more easily identified.

Repeated Exposures are Meaningful

Duration effects were supported in the current literature by over half the studies included in this review. These studies found that the duration of exposure had significant associations with educational and cognitive outcomes and emphasized that persistent or chronic exposure to a wide range of social and economic factors has enduring effects. Such findings point to the frequency and prolongation of exposure as important for understanding the extent to which both education and cognition are influenced by childhood circumstances. Put differently, specific circumstances in childhood may be especially meaningful for educational and cognitive outcomes when children are exposed across multiple developmental time points. Additionally, some evidence was found to suggest that effects accumulate gradually as the duration of exposure increases. Implications of the findings from this study suggest that policymakers and practitioners working with children should be aware of the effects of sustained exposure and target support accordingly. For researchers, continued investigation to determine thresholds of persistent effects across different contextual factors would help to establish which children are especially vulnerable to specific circumstantial effects. Additionally, further research is needed where the duration of exposure is compared with other temporal dimensions (e.g., timing) to establish

if duration effects are the primary pathway that social and economic factors operate through or whether duration has received the most attention from researchers in this area, and therefore, duration effects are most consistently observed.

Time-specific Exposures are Relevant

Specific developmental stages were examined to identify time points during childhood where contextual factors had significant effects on developmental outcomes. Clear patterns of findings were identified. Firstly, all articles which examined time-specific effects in pregnancy found this time point to be a significant predictor of cognition. These studies all examined contextual variables relating to the home and neighborhood environment, specifically maternal mental health. These findings align with other non-temporal research investigating antenatal depression and child outcomes that find a negative correlation between poor maternal health in pregnancy and children's cognitive development (e.g., Waters et al., 2014). A discussion of the mechanisms through which maternal mental health can affect child development is beyond the scope of this review. However, the temporal studies in this study offer an understanding of maternal mental health antenatally, alongside other timepoints postnatally, as being key for understanding the correlates of cognitive outcomes. Although many mothers experiencing antenatal depression do not go on to experience postnatal depression (see review by Underwood et al., 2017), interventions during pregnancy remain important for both maternal wellbeing and children's development, given the evidence in this review to suggest a direct effect of antenatal maternal mental health on children's cognition. However, these conclusions should be interpreted with caution due to the small number of studies which examined time-specific influence during pregnancy. Further research could focus on substantiating these findings.

Additional age-specific findings indicated that economic resourcing in early childhood had a significant association with both education and cognitive outcomes. All sources of time-specific effects in the early childhood stages found this stage to be a significant predictor of educational and cognitive outcomes. Economic resourcing variables were related to family income, poverty, socioeconomic position, and social benefit receipt. These findings suggest that the early childhood stage is especially sensitive to the economic position of the family. Other research exploring economic adversity in early childhood outside of the studies in this review also finds the early years to be influential for long-term development (e.g., Black et al., 2017; Luby, 2015; Shonkoff et al., 2012). Strengthening the financial situations of families with young children may be one avenue to see more children grow up to reach their educational and cognitive potential. However, these results warrant further investigation, given that different measures of economic resourcing were utilized across these studies.

Consistently, the research categorized in the "timing effects" theme found evidence for each developmental stage across the newborn–early adolescence years to be significantly associated with educational outcomes. These studies provide

robust evidence to support each of these developmental stages as important for education. When targeting interventions to reduce learning disparities, this evidence suggests that early interventions can have long-lasting effects. Equally, this evidence advocates that it is not too late to direct interventions toward children throughout middle and early adolescence too. For cognitive outcomes, the findings were less clear, and no distinguishable pattern of timing effects was observed. This indistinctness may be attributable to the variety in contextual measures as well as the various aspects of cognition that were examined, making it difficult to compare the studies and draw clear conclusions. It is also important to note that only one study examined the timing effects of contextual factors for cognitive outcomes in adulthood. Further research is needed which examines the developmental timing effects of contextual factors in childhood and cognitive outcomes across childhood and into adulthood.

Future Directions

A better understanding of the temporal patterns of circumstances is necessary to understand how contextual factors promote or hinder educational and cognitive outcomes. Future directions for this research area are to investigate and report associations between timing and duration of childhood circumstances and educational and cognitive outcomes. As indicated by studies included in this review, evidence suggests that specific childhood circumstances affect not only development but do so through various temporal pathways. Where a common approach to conducting child development research has been to identify *what* factors influence development, a complementary line of research that also considers *how* factors influence development has demonstrated that educational and cognitive outcomes vary in terms of patterns of circumstances. Integrating the role of timing, duration, and mobility into future research may offer more sophisticated ways of examining how circumstances contribute to development. To do this, a greater shift toward longitudinal research design will help make distinguishable associations more detectable and make way for resilient pathways to be recognized.

For the purposes of this review, the temporal dimensions of timing, duration, and mobility were separated out to provide clear conclusions about the results across these areas of temporality. However, temporal elements are intertwined, and specific statistical analytic techniques have been developed to account for confounding effects of duration, timing, and mobility. For example, a structured modeling approach has been developed by Mishra and colleagues (2009) to formally compare alternative temporal hypotheses. We encourage researchers to employ statistically appropriate methods to investigate multiple dimensions of temporality concurrently and note that some studies in this review have done so (e.g., Roos & Wall-Wieler, 2017), although a discussion of these combined effects was out of scope.

Further research focusing on pregnancy and the early childhood years is needed to establish the unique effects of context during these times. Findings from this review indicate that these developmental stages may have unique contributions to

both education and cognitive development, irrespective of subsequent exposure. However, further work is needed to explore these findings in further detail, particularly as they relate to maternal mental health and economic resourcing.

Limitations

This review is not without its limitations. The studies and results included within this review have been synthesized thematically, but each study used markedly different variables, tools, and analytic methods. This variation posed challenges when comparing results and restricted some of the conclusions that could be made about this area of research. Consequently, the themes and conclusions in this review are focused on grouping findings that are able to be compared despite the study design, which aligns with the aims of this review to provide an overview of the breadth of studies on this research topic. Accordingly, the conclusions about general categories (i.e., economic resourcing, social adversity, and home and neighborhood environment) should be interpreted with caution due to the different factors that are grouped into these categories and the different approaches used to measure these factors. Future research could focus on reviewing a smaller number of longitudinal studies based on similarities in study design or specific contextual factors (e.g., socioeconomic status or residential mobility) to provide more targeted conclusions. Furthermore, there was a noticeable lack of studies examining cognitive outcomes beyond the childhood years. Therefore, findings should be interpreted with caution as the applicability of these results to cognitive outcomes in later life may be limited. Additional research is needed to investigate the temporality of contextual factors in childhood for cognition in adolescence and adulthood.

This review has neither considered specific results for subgroups of participants nor where multiple social and economic factors have been examined concurrently. However, some studies we analyzed included results with interaction terms of sociodemographic characteristics or substitutive/compensatory effects of other social/economic factors (e.g., Kiernan & Mensah, 2009). This review focused on results at the overall group level and examined findings relevant to specific social/economic factors separately. Sociodemographic details were excluded from this review to ensure studies could be meaningfully compared, to manage the scope of this review, and because approaches used to account for participants' characteristics were inconsistent. Future work should review the existing work to establish the consequences of inequitable circumstances for children of varied sociodemographic characteristics to better understand the lived experiences of different groups of children and identify avenues for future research. Such work could supplement this review by identifying specific contextual factors, and the temporal dimensions of these factors, that may offer benefits/consequences to certain children, particularly those who are more at risk for underachievement and poorer cognitive skills.

Conclusion

This review provides a comprehensive overview of the existing knowledge base regarding how time points and duration of exposure to specific social and economic factors in childhood influence educational and cognitive outcomes—a fundamental overview to aid ongoing, effective responses to reduce learning disparities. We found ample evidence to suggest that temporality should not be overlooked, given children with disparate patterns of contextual exposures across childhood are likely to have their educational and cognitive outcomes influenced depending on these patterns. Educational and cognitive outcomes were found to be differentially affected by the duration, timing, and mobility of specific social and economic circumstances. While temporality is not the only pathway through which childhood circumstances operate, this evidence suggests that temporal dimensions should not be left unnoticed and future research should account for longitudinal circumstances where possible. Future research should also focus on longitudinal explorations of development in context to disentangle the temporal processes through which circumstances are affecting children's learning. Specific information on chronicity and cumulative circumstances, as well as developmental timing, revealed nuanced effects of temporality. These insights can provide essential information about the developmental timing of interventions to those who are involved with intervention design (e.g., policymakers, school staff, families), as well as indicate the children who are more vulnerable to contextual effects, specifically those with prolonged exposure to adversity.

Appendix

Table 4 Included studies of temporality ($n = 75$)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Ackerman et al. (2004)	US	117	Economic resourcing	Family income	Maternal earned income-to-needs ratio	Academic performance (early adolescence)	Correlation analysis	Timing effects and no temporal effects
Awada and Shelleby (2021)	US (FFS)	4898	Home and neighborhood environment	Maternal education	Completed educational program	Academic performance (early adolescence)	Correlation analysis	Timing effects
Barker et al. (2013)	UK (ALSPAC)	6979	Home and neighborhood environment	Maternal mental health	Maternal depression	Cognitive composite (middle childhood)	Tukey B tests	Duration effects
				Maternal nutrition	Maternal food consumption frequency		Structural equation modeling	Mobility effects
Bask et al. (2020)	Finland (1987 Finnish Birth Cohort)	59,476	Economic resourcing	Benefit receipt	Social assistance reciprocity	Educational qualifications (adolescence)	Path analysis	Timing effects
Bramson et al. (2016)	Sweden (Medical Birth Register)	1,510,463	Home and neighborhood environment	Residential mobility	Annual residential relocation	Academic performance (adolescence)	Logistic regression	Timing effects
Burchinal et al. (2008)	US	74	Social adversity	Risk index	Multiple*	Academic performance (early adolescence)	Logistic regression	Duration effects (accumulation)
							Hierarchical linear modeling	No temporal effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Burchinal et al. (2018)	US (Family Life Project)	1292	Economic resourcing	Family income	Family income-to-needs ratio	Language (pre-school) Executive functioning (preschool) Academic performance (preschool)	Hierarchical linear modeling	Mobility effects No temporal effects
Coohy et al. (2011)	US (NSCAW)	702	Social adversity	Maltreatment	Substantiated child maltreatment	Academic performance (early adolescence)	Generalized estimating equation method	Duration effects (accumulation) and no temporal effects
Croft et al. (2007)	UK (English and Romanian Adoptees study)	217	Social adversity	Institutionalization	Institutional rearing or profound deprivation	Language (middle childhood)	ANOVA	Duration effects
Dickerson and Popli (2016)	UK (MCS)	8741	Economic resourcing	Poverty	Relative income poverty	Cognitive composite (middle childhood)	Structural equation modeling	Duration effects (accumulation) and timing effects
Duncan et al. (2010)	US (MCS)	1589	Economic resourcing	Family income	Total family income	Educational qualifications (adulthood)	Ordinary least square regressions	Timing effects
Dunn et al. (2016)	US (Add Health)	10,788	Social adversity	Maltreatment	Physical abuse Sexual abuse	Memory (adulthood)	Linear regression modeling	Timing effects Timing effects
Enlow et al. (2012)	US (Minnesota Longitudinal Study of Parents and Children)	206	Social adversity	Trauma exposure	Interpersonal trauma exposure	Cognitive composite (toddler–middle childhood)	Mixed effects modeling	Timing effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Evans et al. (2012)	UK (ALSPAC)	6735	Home and neighborhood environment	Maternal mental health	Maternal depression	Cognitive composite (middle childhood)	Structured modeling approach	Duration effects (accumulation) and timing effects
Fox et al. (2011)	Romania (Bucharest Early Intervention Project)	136	Social adversity	Institutionalization	Time spent in institutional care	Cognitive composite (middle childhood)	Structural equation mixture modeling	Timing effects
Friedman-Krauss and Cybele Raver (2015)	US (Chicago School Readiness Project)	381	Home and neighborhood environment	School mobility	Changing schools	Academic performance (early adolescence)	Hierarchical linear modeling	Duration effects (accumulation)
Gee (2018)	US (ECLS—Kindergarten Cohort)	1040	Economic resourcing	Food insecurity	Food deprivation	Academic performance (middle childhood)	Multilevel growth model	Duration effects and no mobility effects
Gibb et al. (2012)	New Zealand (Christchurch Health and Development Study)	1265	Economic resourcing	Poverty	Equivalized family income	Educational qualifications (adulthood)	Multiple logistic regression analysis	Duration effects (accumulation)
Goldfield et al. (2018)	Australia (LSAC)	5107	Social adversity	Risk	Multiple*	Academic performance (early adolescence)	Linear regression modeling	Duration effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Grimeski et al. (2018)	US (ECLS—Kindergarten Cohort)	11,958	Economic resourcing	Food insecurity	Household food security	Academic performance (middle childhood)	Hierarchical linear modeling	Mobility effects and no temporal effects
Hayes and Berthelsen (2020)	Australia (LSAC)	3836	Home and neighborhood environment	Caregiver involvement	Parent–child book reading	Executive functioning (middle childhood)	Logistic regression	Mobility effects
Hayes et al. (2018)	Australia (LSAC)	3836	Home and neighborhood environment	Caregiver involvement	Parent–child book reading	Academic performance (middle childhood)	Latent growth curve modeling	Duration effects
Herbers et al. (2013)	US (Chicago Longitudinal Study)	1410	Home and neighborhood environment	School mobility	School changes	Language (middle childhood)	Linear regression and binary logistic regression	Mobility effects
Hernandez and Jackowitz (2009)	US (ECLS—Birth Cohort)	~7900	Economic resourcing	Food insecurity	Food insecurity due to financial constraints	Approaches to learning (middle childhood)	Ordinary least square regressions	No temporal effects
						Educational qualifications (adolescence)		Duration effects and timing effects
						Cognitive composite (toddler years)		Mobility effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Hill (2021)	US (PSID—Child Development Supplement)	3485	Economic resourcing	Family income	Family income level above or below median income of sample	Academic performance (middle childhood)	Ordinary least square regressions	No temporal effect
Holmes et al. (2018)	US (NSCAW)	1776	Social adversity	Maltreatment	Physical abuse and physical neglect	Academic performance (preschool—adolescence)	Multinomial logistic regression	Timing effects
Howard (2011)	US (ECLS—Kindergarten Cohort)	4710	Economic resourcing	Food insecurity	Household food deprivation	Approaches to learning (early adolescence)	Fixed effects regression models	Mobility effects
Jackson et al. (2017)	US and UK (FFS; MCS)	~5000; 18,818	Economic resourcing	Family income	Equalized household income	Language (preschool)	Ordinary least square regressions	Duration effects and mobility effects
Jaffee (2007)	US (NSCAW)	1720	Home and neighborhood environment	Learning environment	Cognitive stimulation and emotional support	Language (preschool)	Ordinary least square regressions	Mobility effects
Johnson and Markowitz (2018)	US (ECLS—Birth Cohort)	2800–3700	Economic resourcing	Food insecurity	Household food deprivation	Approaches to learning (preschool)	Ordinary least square regressions	Duration effects (accumulation) and timing effects
					Academic performance (preschool)			Duration effects (accumulation) and timing effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Kiernan and Men-sah (2009)	UK (MCS)	14,777	Economic resourcing	Poverty	Household income was 60% below the median	Cognitive composite (preschool)	Logistic regression	Duration effects and mobility effects
Kiernan and Men-sah (2011)	UK (MCS)	5462	Home and neighborhood environment Economic resourcing	Maternal mental health Poverty	Maternal depression Equalized family income was 60% below the UK median	Academic performance (preschool)	Logistic regression	Duration effects (accumulation) and mobility effects
Kimbro and Denney (2015)	US (ECLS—Kindergarten Cohort)	6300	Economic resourcing	Food insecurity	Household food deprivation	Academic performance (middle childhood)	Ordinary least square regressions	No temporal effects
Kobrosly et al. (2011)	US (Seychelles Child Development Study)	463	Economic resourcing	Socioeconomic position	Maternal employment and occupation	Academic performance (adolescence) Memory (adolescence) Attention (adolescence)	Regression analyses	Timing effects Timing effects Timing effects
Kurstjens and Wolke (2001)	German (Bavarian Longitudinal Study)	1329	Home and neighborhood environment	Maternal mental health	Maternal depression	Academic performance (middle childhood) Cognitive composite (middle childhood)	ANOVA	No temporal effects No temporal effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Letourneau et al. (2013)	Canada (Canadian National Longitudinal Survey of Children and Youth)	10,033	Home and neighborhood environment	Maternal mental health	Maternal depression	Language (preschool)	Logistic regression	Duration effects and mobility effects
Li et al. (2019)	China	3753	Home and neighborhood environment	Residential mobility	Residential relocation	Academic performance (early adolescence)	Linear regression modeling	Duration effects and mobility effects
Li et al. (2018)	US (NICHD Study of Early Child Care)	1364	Economic resourcing	Family income	Household income-needs-ratio	Academic performance (preschool)	Linear regression modeling	No temporal effects
Liu and Hannum (2017)	China (China Health and Nutrition Survey)	627	Economic resourcing	Poverty	Household income below poverty line	Educational qualifications (adulthood)	Cox proportional hazard regression	Mobility effects and timing effects
Lombardi and Coley (2013)	US (Welfare, Children, and Families: A Three-City Study)	538	Home and neighborhood environment	Maternal employment	Stability or transition between employment and unemployment	Academic performance (early adolescence)	Ordinary least square regressions	Duration effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
McKelvey et al. (2017)	US (Early Head Start Research and Evaluation Project)	2250	Social adversity	Risk	Adverse childhood experiences	Language (preschool)	ANCOVA	Mobility effects
Mensah and Kieran (2011)	UK (MCS)	7906	Home and neighborhood environment	Maternal mental health	Maternal depression	Cognitive composite (preschool)		Mobility effects
Mistry et al. (2010)	US (Early Head Start Research and Evaluation Project)	1851	Social adversity	Risk	Multiple*	Cognitive composite (preschool)	Linear regression modeling	Duration effects (accumulation)
Molfese et al. (2003)	US	113	Economic resourcing/ Home and neighborhood environment	Socioeconomic position/Learning environment (Combined for analyses)	Parental education, occupation, and income/cognitive stimulation and emotional support	Academic performance (preschool)	Structural equation modeling	Timing effects
Mollborn et al. (2012)	US (ECLS—Birth Cohort)	8550	Home and neighborhood environment	Family structure	People living in the household	Cognitive composite (toddler years)	Multiple regression analyses	No temporal effect

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Morrissey et al. (2014)	US (Miami School Readiness Project)	35,419	Economic resourcing	Poverty	Eligibility for free or reduced-price lunch at school	Academic performance (preschool–early adolescence)	Random-effects models and within-child fixed-effects regressions	Duration effects (accumulation)
NICHD (2005)	US (NICHD Study of Early Child Care)	1364	Economic resourcing	Poverty	Family income-to-needs ratio	Cognitive composite (toddler–middle childhood)	Hierarchical linear modeling	Duration effects (accumulation) and mobility effects
Netsi et al. (2018)	UK (ALSPAC)	8287	Home and neighborhood environment	Maternal mental health	Maternal depression	Academic performance (adolescence)	Logistic regression	Duration effects
O'Connor et al. (2019)	Australia (Australian Temperament Study; LSAC)	2443; 5107	Economic resourcing	Socioeconomic position	Parent education and occupation	Academic performance (early adolescence)	Marginal structural models	Timing effects
Pears et al. (2015)	US (Multidimensional Treatment Foster Care for Pre-schoolers)	141	Home and neighborhood environment	School mobility	School changes	Academic performance (early adolescence)	Path analysis	No temporal effects
Perlman and Fantuzzo (2010)	US (Kids Integrated Data System)	12,045	Social adversity	Maltreatment	Substantiated child maltreatment	Academic performance (middle childhood)	Linear regression modeling	Timing effects
				Homelessness	Placement in homeless shelter			Timing effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Pittman and Boswell (2007)	US (Welfare, Children, and Families: A Three-City Study)	2402	Home and neighborhood environment	Caregiver involvement	Grandmother involvement	Academic performance (toddler–early adolescence)	Ordinary least square regressions	Mobility effects and no temporal effects
Potter and Morris (2017)	US (ECLS—Kindergarten Cohort)	9300	Home and neighborhood environment	Parent involvement in learning Learning environment	Parental educational expectations Books in home	Academic performance (preschool–adolescence)	Mixed-effects growth curve model	Duration effects (accumulation) Duration effects (accumulation)
Potter and Roksa (2013)	US (ECLS—Kindergarten Cohort)	9298	Home and neighborhood environment	Parent involvement in learning Learning environment	Parental educational expectations & Parental involvement in school Books in home	Academic performance (preschool–adolescence)	Hierarchical linear modeling	Duration effects (accumulation)
Priel et al. (2020)	Not stated	680	Home and neighborhood environment	Caregiver involvement Maternal mental health	Maternal regulatory caregiving Maternal depression	Executive functioning (early adolescence) Language (toddler years)	Structural equation modeling Linear regression modeling	Duration effects (accumulation) Timing effects Duration effects (accumulation) and mobility effects
Quevedo et al. (2012)	Brazil	296	Home and neighborhood environment	Maternal mental health	Maternal depression	Language (toddler years)	Linear regression modeling	Duration effects (accumulation) and mobility effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Raffington et al. (2018)	US (NICHD Study of Early Child Care)	1168	Economic resourcing	Family income	Household income	Academic performance (pre-school—early adolescence)	Longitudinal dual change-score models	Mobility effects
Roos et al. (2016)	US (NSCAW)	694	Social adversity	Caregiver substance exposure	Caregiver substance dependence	Language (pre-school—early adolescence) Executive functioning (middle childhood)	Structural equation modeling	Mobility effects Timing effects
Roos and Wall-Wieler (2017)	Canada (Manitoba Population Research Data Repository)	89,831	Home and neighborhood environment	Low-income neighborhood	Physical abuse and neglect Caregiver domestic violence	Educational qualifications (adulthood)	Logistic regression	Timing effects No temporal effects
				Family structure	Parental death, divorce, remarriage, marriage			Duration effects (accumulation), mobility effects and timing effects
				Residential mobility	Movement between postal codes			Duration effects (accumulation), mobility effects and timing effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Sansone et al. (2011)	Australia (L.SAC)	10,000	Social adversity	Multiple*	Multiple*	Academic performance (middle childhood)	Hierarchical multiple regression analyses	Timing effects and no temporal effects
			Economic resourcing	Multiple*	Multiple*			Timing effects and no temporal effects
			Home and neighborhood environment	Multiple*	Multiple*			Timing effects and no temporal effects
Schoon et al. (2012)	UK (MCS)	8874	Economic resourcing	Poverty	Equalized household income was 60% below the median before housing costs	Language (pre-school)	Ordinary least square regressions	Duration effects and mobility effects and timing effects
			Home and neighborhood environment	Family structure	Mother relationship status	Non-verbal abilities (preschool)		Duration effects and mobility effects and timing effects
Smith et al. (2005)	US	360	Home and neighborhood environment	Caregiver involvement	Maternal responsiveness	Cognitive composite (pre-school-early adolescence)	Growth curve modeling	Duration effects (accumulation)
								No temporal effects

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category(age)	Statistical method for determining temporality	Theme
Smith et al. (2000)	US	364	Home and neighborhood environment	Caregiver involvement	Maternal responsiveness	Cognitive composite (preschool)	Discriminant function analysis	Duration effects
Sonuga-Barke et al. (2017)	UK (English and Romanian Adoptees study)	217	Social adversity	Institutionalization	Time spent in institutional care	Cognitive composite (adult-hood)	Mixed-effects logistic regression models	No temporal effects
Sun and Li (2014)	US (ECLS—Birth Cohort)	8650	Home and neighborhood environment	Family structure	People living in the household	Cognitive composite (toddler years)	Regression analyses	Mobility effects
Tessier et al. (2018)	Canada (Ontario Looking After Children Project)	3659	Home and neighborhood environment	Placement stability	Time spent living with foster family	Academic performance (adolescence)	Hierarchical regression analyses	Duration effects (accumulation) and no temporal effects
Turney (2011)	US (FFS)	2427	Home and neighborhood environment	School mobility	School changes	Language (preschool)	Ordinary least square regressions	No temporal effects
Urizar and Muñoz (2021)	US	96	Home and neighborhood environment	Maternal mental health	Maternal depression	Cognitive composite (toddler-preschool)	Hierarchical regression analyses	Timing effects
van der Waerden et al. (2017)	France (The EDEN Mother-Child Cohort Study)	1039	Home and neighborhood environment	Maternal mental health	Maternal depression	Cognitive composite (pre-school/middle childhood)	Linear regression modeling	Duration effects
van Zwieten et al. (2020)	Australia (LSAC)	3734	Economic resourcing	Socioeconomic position	Parent education, income, and occupation	Academic performance (adolescence)	Life course structured modeling approach	Duration effects (accumulation) and timing effect

Table 4 (continued)

Author(s)	Context	Sample size	Social/economic domain	Social/economic construct	Social/economic indicators	Outcome category (age)	Statistical method for determining temporality	Theme
Votruba-Drzal (2006)	US (NLSY)	3551	Economic resourcing	Family income	Household income	Academic performance (middle childhood)	Regression analyses	Timing effects
Wagmiller et al. (2006)	US (PSID)	1070	Home and neighborhood environment Economic resourcing	Learning environment Poverty	Cognitive stimulation and emotional support Equivalized household income was below United States poverty line	Educational qualifications (adulthood)	Logistic regression	Timing effects Duration effects and mobility effects
Yan et al. (2019)	US (NICHD Study of Early Child Care)	1364	Social adversity	Risk	Multiple*	Academic performance (middle childhood)	ANOVA	Duration effects
Yoshikawa and Seidman (2001)	US (NLSY)	733	Economic resourcing	Benefit recipient/maternal Employment	Welfare receipt/ Welfare receipt exits	Academic performance (middle childhood)	MANCOVA	Duration effects
Zhang and Han (2017)	US (ECLS—Kindergarten Cohort)	21,260	Economic resourcing	Socioeconomic position	Household income, parental education, and parental occupation	Academic performance (preschool-adolescence)	Growth curve analysis	Duration effects (accumulation) and mobility effects

* Individual variables are not listed as multiple variables assessed. Refer to the study for further details

ALSPAC, Avon Longitudinal Study of Parents and Children; ECLS, Early Childhood Longitudinal Study; FFS, Fragile Families and Child Wellbeing Study; LSAC, Longitudinal Study of Australian Children; MCS, Millennium Cohort Study; NICHD, National Institute of Child Health and Human Development; NLSY, National Longitudinal Survey of Youth; NSCAW, National Survey on Child and Adolescent Wellbeing; PSID, Panel Study of Income Dynamics; UK, United Kingdom; US, United States of America

Declarations

Competing Interests The authors declare no competing interests.

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