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Preventive Medicine 185 (2024) 108061



Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed





Adolescent behavioral problems, preterm/low birth weight children and adult life success in a prospective Australian birth cohort study

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ARTICLE INFO

Keywords:
Low birth weight
Preterm birth
Adolescent problem behaviors
Life success
Cumulative disadvantage
Life course

ABSTRACT

Background: Preterm and/or low birthweight (PT/LBW) is predictive of a range of adverse adult outcomes, including lower employment, educational attainment, and mental wellbeing, and higher welfare receipt. Existing studies, however, on PT/LBW and adult psychosocial risks are often limited by low statistical power. Studies also fail to examine potential child or adolescent pathways leading to later adult adversity. Using a life course framework, we examine how adolescent problem behaviors may moderate the association between PT/LBW and a multidimensional measure of life success at age 30 to potentially address these limitations.
Methods: We analyze 2044 respondents from a Brisbane, Australia cohort followed from birth in1981–1984 through age 30. We examine moderation patterns using obstetric birth outcomes for weight and gestation, measures of problem behaviors from the Child Behavioral Checklist at age 14, and measures of educational attainment and life success at 30 using multivariable normal and ordered logistic regression.
Results: Associations between PT/LBW and life success was found to be moderated by adolescent problem behaviors in six scales, including CBCL internalizing, externalizing, and total problems (all $p < 0.01$). In comparison, associations between LBW and educational attainment illustrate how a single-dimensional measure may yield null results.
Conclusion: For PT/LBW, adolescent problem behaviors increase risk of lower life success at age 30. Compared to analysis of singular outcomes, the incorporation of multidimensional measures of adult wellbeing, paired with identification of risk and protective factors for adult life success as children develop over the lifespan, may further advance existing research and interventions for PT/LBW children.

1. Introduction

Preterm and/or low birth weight (PT/LBW) children face a range of potential adverse outcomes beyond the stages of infancy and early childhood in the life course. In adolescence and early adulthood, PT/LBW is associated with increased risk for mental and physical health, lower educational attainment, lower employment rates, reduced income, and higher rates of welfare and disability support (Basten et al., 2015; Bilgin et al., 2018; Black et al., 2007; Lærum et al., 2017; Risnes et al., 2011; Stein et al., 2006). However, the prominence of these effects varies by severity of PT/LBW, for example, among adolescents born very preterm (≥32 wks.), compared to those born moderate to late preterm (33–37 wks.) (Bilgin et al., 2021a). Adversities for PT/LBW children may be statistically significant, yet not impair the majority at risk; for example, while there is a relationship between birth weight and lower intelligence quotient (IQ), meta-analyses find that average IQs among adolescents and adults are within the normal range even for those born with a very or extremely LWB (Eves et al., 2021; Gu et al., 2017). It is within this context that, while varying levels severity of PT/LWB in children may be associated with slightly lower rates of educational attainment, work, and health, most children live similar lives to those who are not PT/LBW (Bilgin et al., 2018; Cooke, 2004; Darlow et al.,

Abbreviations: BW, Birth weight; CBCL, Child behavioral checklist; g, Gram; GA, Gestational age; IQ, Intelligence quotient; Kg, Kilogram; LBW, Low birth weight; NBW, Normal birth weight; PT/LBW, Preterm and/or low birth weight; Wks, Weeks..

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https://doi.org/10.1016/j.ypmed.2024.108061
Received 5 January 2024; Received in revised form 2 July 2024; Accepted 4 July 2024
Available online 5 July 2024
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2013; Lindström et al., 2007; Saigal et al., 2006b).

However, the number of children at risk for adverse adult outcomes associated with PT/LBW is still substantial. For example, out of ~306,000 births in Australia in 2019, approximately 6.7% of births were LBW, with 1% of the population being born very low birth weight, while 8.6% were born preterm (Fox and Callander, 2021; Welfare, 2020). In 2015, approximately 6.5% of all births were LBW in developed countries, while ~14.6% of all births were LBW in low and middle-income countries (Alonso-Molero et al., 2020; Blencowe et al., 2019). Some early interventions have been found to improve development and increase children's IQ and educational attainment (Bharadwaj et al., 2013; McCarton et al., 1997; Walker et al., 2004), while policies targeting correlates of PT/LBW, such as maternal trauma and childhood adversity, low socio-economic status, and food insecurity are thought to also improve child outcomes (Hardcastle et al., 2022; Kenyhercz et al., 2022). However, the efficacy of early interventions on adult outcomes are generally found to disappear in the life course by adolescence; we identified only one study finding that an intervention on PT/LBW was successful among respondents born between 2000 and 2499 g, but not for LBW children >2000 g; this suggests a need for continued research to potentially reduce the impact of PT/LBW on adult outcomes (Lemola, 2015; McCormick et al., 2006).

The lack of research showing the efficacy of early interventions over the life course highlights the need to examine how PT/LBW and subsequent developments influence health and wellbeing (Msall et al., 2018; Power et al., 2013). Life-span development is central to the life course perspective, with the idea that advantages or disadvantages cumulatively impact health and wellbeing (Elder et al., 2003). However, while analyses have examined low birth weight and long-term outcomes over phases of development (early childhood, adolescence, mid-life), the concept of life-span has very rarely been incorporated in research on PT/LBW children and, to our knowledge, not in markers of adult life success (Kormos et al., 2013; Matsushima et al., 2018). Examining LBW and physical health, one recent study illustrates the value of incorporating life-span development by demonstrating that a combination of LBW and young adult obesity compounded risk of cardiovascular disease in later life (Bygdell et al., 2021). Existing studies examining PT/LBW children and adult psychosocial outcomes, however, have examined adult psychosocial outcomes outside of this developmental context, thus failing to identify cumulative risk or resiliency factors for psychosocial outcomes that cumulatively impact individuals with PT/LBW (Conley and Bennett, 2000; Lærum et al., 2017; Saigal et al., 2006a). The rarity of birth cohort data and the limited application of life course theory have cumulatively limited research in this area.

Applying the concept of cumulative disadvantage, it is possible that the non-universal effects of PT/LBW on adult psychosocial outcomes may impact those who experience additional adversities over time, with PT/LBW becoming a factor worsening outcomes in the context of a pattern of disadvantage. For example, research has linked adolescent behavioral problems, such as internalizing/externalizing behaviors, with poorer employment and educational outcomes, along with higher rates of welfare receipt (Alaie et al., 2021; Plenty et al., 2021; Sallis et al., 2019; Veldman et al., 2015). It within this context that, while research has found that PT/LBW children may exhibit similar levels of behavioral problems in adolescence and young adulthood to normal birth weight children, the combined impact of PT/LBW and behavioral problems may lead to poorer adult outcomes (Bohnert and Breslau, 2008; Hack et al., 2004). In the current study, we use a prospective birth cohort with adolescent problem behaviors and adult outcomes at age 30 to examine if PT/LBW and behavioral problems may adversely impact the successful transition into adulthood. Additionally, due to a main effect between behavioral problems and life success for all respondents, we would expect an additive effect of PT/LBW to moderate high levels of adolescent behavioral problems and lower life success as a form cumulative disadvantage.

Focusing on a life course perspective also recognizes that successfully transitioning to adulthood involves a multi-modal attainment of status markers of being an adult, establishing relationships, completing education, finding employment, psychological wellbeing, and living independently (Reifman et al., 2007; Schulenberg and Schoon, 2012). While meta-analyses, as noted previously, have been used in the study of low birth weight as one way to aggregate findings for individual outcomes like employment and educational attainment, use of multi-dimensional scales and indices can also help to comprehensively capture successful transitions into adulthood by incorporating greater variance of markers of successful adult transitions in statistical analyses. With this in mind, we use a multi-dimensional model of life success which has been previously incorporated into measuring successful transitions into adulthood in adverse life circumstances (Farrington et al., 2009; Najman et al., 2023; Sampson et al., 2011). To illustrate the potential benefits of using a composite life measure, we also compare our results with a singular measure of education.

2. Data and methods

The present study uses the Mater Hospital-University of Queensland Study of Pregnancy (MUSP). The study comprises 7223 singleton birth children born from 1981 to 1984 in Brisbane, Australia. A number of waves of follow-up were conducted for both mothers and children, incorporating mother and child-completed surveys and additional collection of obstetric and biometric data collected by trained health professionals. For this study, we incorporate maternal data collected during early pregnancy, obstetric data from the Mater Hospital for gestation and birth weight, maternal interviews of respondents at age 14, and interviews of children at age 30. These and further details of the MUSP study are available in the published literature (Najman et al., 2005; Najman et al., 2015).

At age 30 interviews, 2257 individuals with obstetric data completed nine items used to calculate a measure of life success, described later. From this subsample, we use data where mothers completed (1) prenatal interviews and (2) age 14 measures of child behavioral problems. Our sub-sample contains 2044 respondents, 95 of whom were born either preterm (<37 weeks) or with a low birth weight (<2500 g). Among the 95 respondents, 64 were of low birth weight, while 59 were born preterm.

Ethics approval for all data collection was obtained from the relevant human ethics research committees at The University of Queensland and the Mater Misericordiae Hospital, South Brisbane, Australia. For the present study, we use de-identified secondary data exempt from Human Ethics approval by the Australian National University.

MUSP data are not publicly freely available due to privacy and ethical issues. Researchers wishing to access the MUSP data may apply for data access via the study website maintained by the University of Queensland at: https://social-science.uq.edu.au/mater-university-queensland-study-pregnancy?p=9#9

2.1. Outcome variables

2.1.1. Total life success

This scale captures the respondent's level of transitions at age 30 marking some level of successful transition to adulthood along three dimensions that include (a) socio-economic success; (b) family life/stability; and (c) happiness/life satisfaction. For (a), socioeconomic status success is defined having an annual income >$50,000 AUD, completing at least secondary or tertiary school, and owning or renting their own accommodation. For (b), success in family life/stability involves ever having one or two partners, living with a partner (cohabiting or married), and being satisfied with the relationship. For (c), success in happiness or life satisfaction was defined as being satisfied with life, being happy with life, and having a good/excellent quality of life. Each indicator of life success was coded as '1', with all items being summed together for a total life success score of 0–9. The Crombach's alpha (α)

for the scale is 0.76. Further details of the scale are available elsewhere (Najman et al., 2022; Najman et al., 2023). The life success measure, originally developed by Farrington and colleagues, has been used to measure how adversity and resiliency in disadvantaged populations is linked to achieving overall success in young and middle adulthood in Australia and the United Kingdom (Farrington et al., 2006; Farrington et al., 1988; Najman et al., 2023).

2.1.2. Educational attainment

Highest educational attainment by the respondent at age, using four categories: *1 = Less than secondary school; 2 = Completed secondary school; 3 = Post-secondary qualification beyond secondary school; and 4 = Bachelors degree or higher university qualification*. Educational attainment is one measure of success in young adulthood negatively associated with PT/LBW.

2.2. Predictor variables

2.2.1. Preterm and/or low birth weight

An indicator variable for if the respondent was born preterm (>37 weeks) or had a birth weight > 2500 g. These data were collected at the time of birth by hospital staff at the Mater-Misericordiae Hospital.

2.2.2. Child behavioral problems

At age 14 interviews, mothers completed items from the Child Behavioral Checklist (CBCL), Ages 4–18 (Achenbach, 1991). We use six subscales for the data that include Social-Attention-Thought (SAT) disorder (23-items, $\alpha = 0.87$), Externalizing (33-items, $\alpha = 0.92$), Aggression (20-items, $\alpha = 0.90$), Internalizing (31-items $\alpha = 0.88$), Depression (10-items, $\alpha = 0.69$), and Total Problems (116-items, $\alpha = 0.95$). Further details of these scales, including scale items, used in the MUSP have been published elsewhere (Najman et al., 2000). All CBCL scales sum items used in the scale for a total score.

2.3. Controls

2.3.1. Respondent ethnicity

Mother-reported child ethnicity, with indicators for if the child was of Indigenous Australian or Asian descent.

2.3.2. Respondent sex at birth

An indicator for if the child was classified as male or female at birth.

2.3.3. Mother's education

During initial interviews, mothers reported their highest level of education. We categorize education as not completing secondary education, completing secondary education, or completing some form of post-secondary education.

2.3.4. Mother's age at birth

Mother's age at the birth of the respondent.

2.3.5. Mother's pre-pregnancy body mass index (BMI; kg/m^2)

Mother's pre-pregnancy BMI, based on mother-reported height and weight in initial interviews.

2.3.6. Mother's prenatal smoking

The number of times mothers reported smoking during the prior 7 days while in the first trimester of pregnancy.

2.3.7. Mother's prenatal depression

A 7-item scale ($\alpha = 0.79$) from the Delusions-Symptoms-States-Inventory used to measure prenatal depression (Bedford and Foulds, 1977; Najman et al., 2000). The seven items are scored and added together for a total depression score.

2.4. Analytical strategy

We use multivariable OLS regression to estimate models presented in Table 2 to examine if an association between CBCL behavioral problems and life success is moderated by PT/LBW. As we noted previously, we expect PT/LBW to be a cumulative disadvantage that may reduce life success at high levels of problem behavior, but the impact of PT/LBW may not exert an independent effect on life success given that the vast majority of those born PT/LBW may have similar outcomes to those of NBW in existing research.

In Table 3, we use ordered logistic regression models to examine if similar moderation patterns are observed for LBW moderating CBCL behavioral problems and education. This allows us to examine the potential benefit of using a multi-dimensional scale for life success in adulthood, compared to single outcome measures, such as lower educational attainment or unemployment, which existing psychosocial research has linked to PT/LBW.

We test six models of the CBCL measures used in analysis. Our main measures include CBCL Internalizing, Externalizing, and Total Problems which are extensively reported in research due to their combination of multiple subscales (Duhig et al., 2000). In addition, we examine the CBCL Depression and CBCL Aggression that are subscales included, respectively, in CBCL Internalizing and CBCL Externalizing to examine if patterns may vary from these main scales. CBCL SAT scale is also used, given that social, thought, and attention disorders are reported as being more prevalent for PT/LBW children (Mathewson et al., 2017).

We use complete case analysis in all presented models due to the risk of Type II error associated with adding random noise to interaction terms in multiple imputation (Graham, 2009, 2012; Zhang et al., 2019). While attrition in the overall sample is significant, prior research has found that attrition bias does not significantly alter outcomes for child outcomes in research using the MUSP data, as has been generally found in similar studies (Howe et al., 2013; Najman et al., 2005; Najman et al., 2015). Prior analysis using the MUSP data does find attrition to occur by ethnicity and socioeconomic status; to address potential attrition bias, we include controls for maternal education and ethnicity in all analyses (Saiepour et al., 2019).

To examine the risk of false-positives, we explore how results may vary when controlling for increased risk of false-positives using the Benjamini-Hochberg, Bonferroni-Holm, and Bonferroni tests for multiple-testing, which have progressively increased risk for false-negatives (Lee and Lee, 2018; Menyhart et al., 2021). We note that Menyhart et al. (2021) suggest using stepwise correction tests, such as Benjamini-Hochberg or Bonferroni-Holm, to reduce risk of false-negatives in exploratory or new topical studies.

3. Results

Table 1 contains descriptive statistics for PT/LBW respondents and those born at full-term and normal birth weight. Being PT/LBW was associated with a lower mean level of educational attainment at age 30 ($p < 0.05$) and significantly higher rates of prenatal maternal smoking ($p < 0.001$). We note that no significant differences emerged for life success and CBCL age 14 scores.

Table 2 contains the main and moderation effects for PT/LBW and CBCL scores on life success. For main effects, we find no direct association between PT/LBW and life success; however, increasing CBCL scores are associated with declining life success ($p < 0.001$). A significant moderation effect of PT/LBW is observed for CBCL and life success. The moderation effect is $p < 0.05$ for SAT disorders and Anxious/Depressed, while moderation effects are $p < 0.01$ for Internalizing, Externalizing, Aggression, and Total Problems. Similar patterns are observed for LBW interactions in Supplemental Table 1.

The moderation effect for CBCL interactions, as shown by the coefficients in Table 2, is similar across all CBCL measures. To show this effect, we present the moderating effect of CBCL Internalizing (Fig. 1)

Table 1
Means and standard deviations for variables in a Brisbane, Australia birth cohort born between 1981 and 1984, by Preterm/Low Brith Weight Status.

	Normal gestation & birth weight (n = 1949)		Preterm or lowb irth weight (PL/LBW) (n = 95)		
	Mean/ %	SD	Mean/ %	SD	p–value
Educational attainment (ordinal scale measure)	2.78	0.91	2.63	0.96	0.043
Educational attainment categories					
Not completed secondary school	10.4		13.8		0.211
Completed secondary school	29.5		32.6		0.444
Tertiary qualification (less than bachelors)	31.8		32.6		0.847
Bachelors degree	28.2		21.0		0.066
Life success	8.57	1.78	8.41	2.03	0.397
Child birth weight (kg)	3.47	0.44	2.30	0.49	0.000
Gestational age at birth (wks.)	39.66	1.26	35.34	2.68	0.000
Low birth weight	0		67.4		0.000
CBCL measures					
SAT	5.83	5.50	6.68	6.07	0.143
Internalizing	10.70	7.31	11.06	8.17	0.640
Anxious/depressed	5.94	4.66	5.93	4.86	0.985
Externalizing	9.54	7.38	9.64	7.72	0.896
Aggressive behavior	4.01	3.18	3.93	3.14	0.791
Total problems	29.78	19.78	31.28	22.02	0.471
Other predictors					
Female	59.9		59.0		0.849
Maternal smoking	44.89	72.06	70.44	84.47	0.001
Mother tertiary education	22.2		17.9		0.327
Mother non-secondary education	12.5		11.6		0.787
Respondent Indigenous Australian	3.0		3.2		0.919
Respondent Asian	3.2		5.3		0.266
Pre-natal depression	8.7		9.5		0.787
Mother's age	25.63	4.99	25.14	5.20	0.347
Mother's pre-pregnancy BMI	21.84	3.68	22.04	4.52	0.607

and Externalizing (Fig. 2) on the relationship between PT/LBW and overall life success. Comparing CBCL internalizing at the 0th and 90th percentile, we find that predicted life success declines for those with PT/LBW by ~20% from a score of 9.48 [95% CI: 8.87, 10.04] to a score of 7.46 [95% CI: 6.91, 8.01]; in contrast, for normal BW, life success declines more gradually from a score of 8.86 [95% CI: 8.72, 9.00] to a score of 8.29 [95% CI: 8.16, 8.43]. A similar pattern is observed for CBCL externalizing at the 0th and 90th percentiles, where predicted life success declines for those with PT/LBW by ~25% from a score of 9.44 [95% CI: 8.90, 10.00] to a score of 7.08 [95% CI: 6.44, 7.72]; in contrast, for normal BW, predicted life success declines from 8.98 [95% CI: 8.85, 9.11] to a score of 8.04 [95% CI: 7.89, 8.19]. Thus, PT/LBW is associated with significantly lower life success at higher CBCL measures, compared with non-PT/LBW children.

Supplemental Table 2 shows the significance of Table 2 interactions adjusting for multiple-testing 12 tests at $p < 0.05$. Our analyses find that CBCL SAT drops below significance for any type of multiple-testing, while CBCL-Anxious Depressed also drops below significance using the stepwise Bonferroni-Holm method. Bonferroni corrections use a cutoff of $p < 0.0042$, only CBCL internalizing and total problems remaining significant.

Supplemental Table 3shows the main and interaction effects where LBW is interacted with CBCL scores to predict the singular outcome of educational attainment. There are no main effects for PT/LBW; however, higher CBCL problem behaviors were predictive of lower education attainment ($p < 0.05$ to $p < 0.001$). The interaction coefficient for LBW and CBCL Anxious/Depressed score was significant ($p < 0.05$) in predicting educational attainment; however, other moderations were marginal and did reach statistical significance.

4. Discussion

In this study, we used a prospective Australian birth cohort data to examine the potential moderating effect of PT/LBW for an association between adolescent problem behaviors and a multi-dimensional measure life success at age 30. Adjusting for a range for prenatal factors which may act as confounders of PT/LBW, we controlled for maternal prenatal BMI, education, smoking during pregnancy, and age at birth, along with respondent sex and ethnicity. We find evidence of significantly lower levels of life success for PT/LBW children with high levels of behavioral problems, compared to non-PT/LBW children with high levels of adolescent behavioral problems; this suggests that PT/LBW respondents with levels of behavioral problems face cumulative disadvantages in life success in adulthood when compared to respondents who are not preterm or LBW. When examining a singular outcome for education, we find scant evidence cumulative disadvantage for LBW respondents with high CBCL scores.

The study makes several contributions to the current research literature on PT/LBW and adult outcomes. To our knowledge, this is the first

Table 2
Main and moderating effects for Adolescent CBCL problem behaviors on the association between preterm birth and/or low birth weight predicting life success at age 30 in a Brisbane, Australia birth cohort born between 1981 and 1984 (n = 2044).

		CBCL problem behavior scale predicting life success					
		SAT	Internalizing	Anxious/ depressed	Externalizing	Aggressive behavior	Total problems
Main effect models							
PT/LBW	Coefficient	−0.09	−0.12	−0.13	−0.13	−0.14	−0.11
	[95% CI]	[−0.45, 0.27]	[−0.48, 0.25]	[−0.49, 0.24]	[−0.49, 0.23]	[−0.5, 0.22]	[−0.47, 0.25]
CBCL scale	Coefficient	−0.06***	−0.03***	−0.04***	−0.05***	−0.09***	−0.02***
	[95% CI]	[−0.07, −0.04]	[−0.04, −0.02]	[−0.06, −0.02]	[−0.06, −0.04]	[−0.12, −0.07]	[−0.02, −0.01]
Moderating effect models							
PT/LBW	Coefficient	0.36	0.61	0.44	0.54	0.58	0.67*
	[95% CI]	[−0.18, 0.98]	[0.00, 1.22]	[−0.14, 1.01]	[−0.04, 1.11]	[0.00, 1.15]	[0.04, 1.3]
CBCL scale	Coefficient	−0.05***	−0.03***	−0.04***	−0.04***	−0.08***	−0.02***
	[95% CI]	[−0.07, −0.04]	[−0.04, −0.02]	[−0.05, −0.02]	[−0.05, −0.03]	[−0.11, −0.06]	[−0.02, −0.01]
PT/LBW X CBCL scale	Coefficient	−0.07*	−0.07**	−0.10*	−0.07**	−0.18**	−0.02**
	[95% CI]	[−0.13, −0.01]	[−0.11, −0.02]	[−0.17, −0.02]	[−0.12, −0.02]	[−0.30, −0.07]	[−0.04, −0.01]

95% confidence intervals in square brackets. All model estimates obtained from OLS regression, with results adjusted for conrols that include respondent's sex, maternal smoking, mother's education, ethnicity, pre-natal depression, mother's age, and mother's pre-pregnancy BMI. CBCL = Child Behavioral Checklist; PT/LBW=Preterm birth and/or low birth weight; SAT = Social-Attention-Thought Unadjusted Significance levels: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

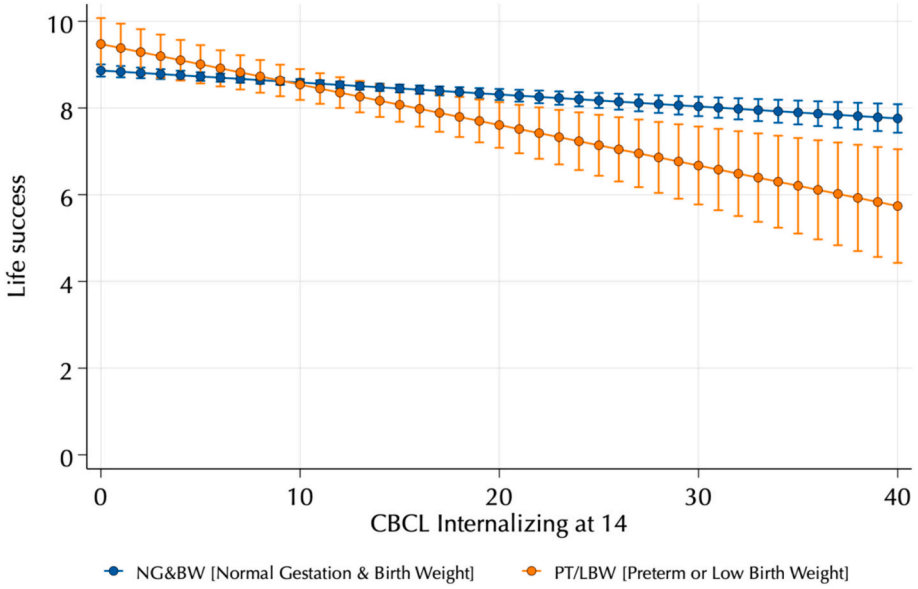


Fig. 1. Moderation of preterm birth and/or low birth weight association by adolescent internalizing behaviors on life success at age 30 in a Brisbane, Australia birth cohort born between 1981 and 1984

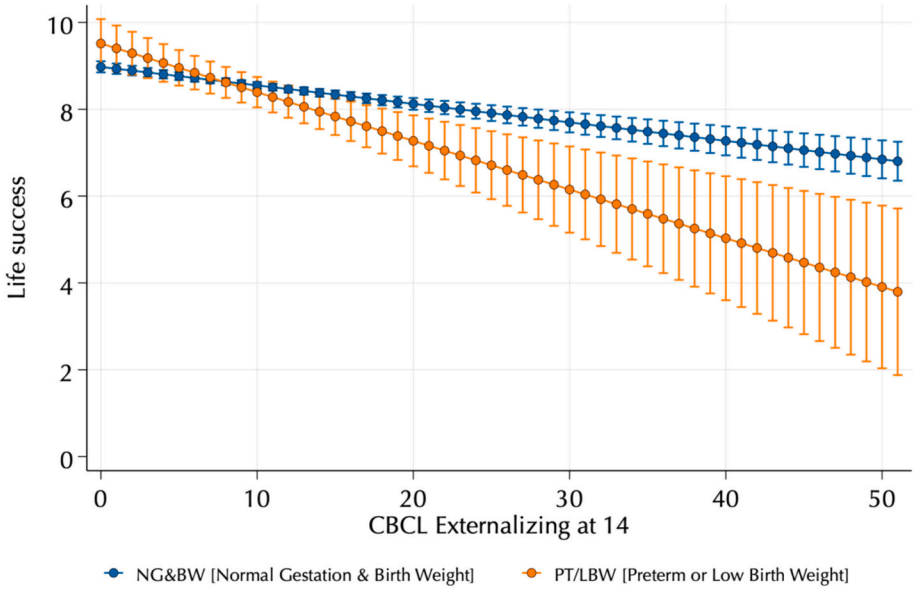


Fig. 2. Moderation of preterm birth and/or low birth weight association by adolescent internalizing behaviors on life success at age 30 in a Brisbane, Australia birth cohort born between 1981 and 1984.

study to show that high levels of problem behaviors in adolescents moderate the association between PT/LBW and life success at age 30. While some studies have reported that PT/LBW children may be at increased risk for attention issues, social problems, and lower rates of executive functioning, our study is consistent with research that PT/LBW children have similar levels of adolescent problem behaviors to normal birth children (Bohnert and Breslau, 2008; Burnett et al., 2013; Robinson et al., 2020). We identified no studies that have built upon the association between adolescent problem behaviors and poorer adult outcomes to examine if PT/LBW children may be at compounded risk for lower life success in the transition to adulthood. However, within the context of cardiometabolic diseases, factors such as low socioeconomic status in parents or children, neighborhood context, health behaviors, and development of risk factors such as hypertension or obesity, have been shown to create cumulative disadvantages in health for PT/LBW children as they age (Barker et al., 1989; Feng et al., 2018; Ferguson et al., 2015; Johnson and Schoeni, 2011; Wang et al., 2022). It is also important to consider how PT/LBW children who experience conditions that limit opportunity, such as poverty, low educational attainment, and disability, may be at risk for both lower life success and increased disease risk in later life (Matthews et al., 2010; Prus, 2007).

Our paper also contributes to the existing literature by examining PT/LBW outcomes using a multi-dimensional measure to examine broader life success in early adulthood. Our results show that examining singular adult outcomes may fail, by not comprehensively examining a successful transition to adulthood. Additionally, many studies rely on relatively small samples of PT/LBW children in analysis, a problem of particular concern for research on children born at very or extremely PT/LBW due to the rarity of these types of birth in populations (Bilgin et al., 2018; Gu et al., 2017). By increasing the variation in measurement

for adult outcomes and more fully capturing adversities and successes in adulthood, life success or other indices may be used to better identify risk and potential mediating or moderating factors that lead to potential cumulative disadvantages in the life course. Organizations such as the World Health Organization have advocated for person-centered approaches to fully treat the person, while identifying interventions and policies that improve both adult health and overall wellbeing for individuals born PT/LBW (Patel and Chatterji, 2015).

As mentioned above, an important implication of this study is considering how PT/LBW is linked with later processes over the life course that may create advantage or disadvantages in health and wellbeing as individuals progress through the stages of adulthood (McDonough et al., 2015; Montez and Hayward, 2014; Willson et al., 2007). Within this context, life events can moderate or reduce risk of poorer outcomes measured by life success. As an example, interventions that promote executive functioning are known to significantly reduce internalizing and externalizing behaviors in meta-analyses, along with related issues, like substance use or criminal justice involvement, that are known to limit life success such as educational attainment, employment, and mental wellbeing (Oesterle et al., 2011; Rava et al., 2017; Yang et al., 2022). By treating PT/LBW children for behavioral problems in adolescence and other factors that may impede a successful transition to adulthood, research on PT/LBW using a life course framework can substantially improve outcomes in adulthood.

The present study has important limitations. While very PT/LBW effects are generally stronger than for PT/LBW populations, <1% of our sample is very PT/LBW, making analyses impractical for this population (Boardman et al., 2002). Subsequent research is needed to verify the paper's findings; larger studies with low and high problem behaviors by PT/LBW status, for example, may have sufficient power to detect our results in main effects instead of moderation patterns. Differing effects for mother and child reports or sample consisting mainly of moderate to high PT/LBW children may also lead to null effects linking BW and CBCL outcomes, as has been found in the existent literature (Bilgin et al., 2021a; Bilgin et al., 2021b; Spiker et al., 1992). Due to insufficient sample size, we are unable to examine variations for ethnic minorities in the sample. Longitudinal data with more frequent measures in adolescence and adulthood may yield additional insights into how PT/LBW children may transition into increasing or declining life success in adulthood while progressing through childhood and adolescence. Lastly, our sample follows PT/LBW children through age 30; additional research into middle-age and beyond may provide greater insights into long-term trends of how adolescent problem behaviors may lead to disadvantages in later life.

5. Conclusion

This study finds that high levels of adolescent behavioral problems are associated with lower life success for PT/LBW individuals in the transition to adulthood, compared to those born at term and of normal birth weight. The use of a multi-dimensional scale of life success is also shown to have a greater ability to detect moderation patterns than a single-outcome measure for educational attainment. By adopting a life course framework, it is possible to inform the literature on PT/LBW to identify potential risk and resiliency factors cumulatively impacting the successful transition into adulthood. By focusing on factors that may improve successful transitions to adulthood for PT/LBW children, a more person-centered approach to health and wellbeing may improve outcomes for individuals born PT/LBW across the lifespan.

CRediT authorship contribution statement

Michael E. Roettger: Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Jolene Tan:** Writing – review & editing, Visualization, Validation, Methodology, Formal analysis. **Brian Houle:** Writing – review & editing, Methodology, Conceptualization. **Jake M. Najman:** Writing – review & editing, Data curation, Conceptualization. **Tara McGee:** Writing – review & editing, Investigation, Conceptualization.

Declaration of competing interest

All authors report no real or perceived conflicts of interest, financial or otherwise. We note the study incorporates secondary data analysis and does not involve clinical trial data that may be used for commercial purposes. Furthermore, the study has not received any funding, so no financial interests bear on the results and conclusions.

Data availability

The data are confidential and available through the study's website. A link to apply for data access is included in the paper.

Appendix A. Supplementary

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2024.108061.

References

Achenbach, T.M., 1991. Manual for the Child Behaviour Check-List/4–18 and 1991 Profile (No Title).

Alaie, I., Ssegonja, R., Philipson, A., von Knorring, A.-L., Möller, M., von Knorring, L., Ramklint, M., Bohman, H., Feldman, I., Hagberg, L., 2021. Adolescent depression, early psychiatric comorbidities, and adulthood welfare burden: a 25-year longitudinal cohort study. Soc. Psychiatry Psychiatr. Epidemiol. 56, 1993–2004.

Alonso-Molero, J., Erasun, D., Gómez-Acebo, I., Dierssen-Sotos, T., Llorca, J., Schneider, J., 2020. Low Birth Weight Trends in OECD Countries, 2000–2015: Economic and Health System Conditionings.

Barker, D.J., Osmond, C., Law, C.M., 1989. The intrauterine and early postnatal origins of cardiovascular disease and chronic bronchitis. J. Epidemiol. Community Health 43 (3), 237–240. https://doi.org/10.1136/jech.43.3.237.

Basten, M., Jaekel, J., Johnson, S., Gilmore, C., Wolke, D., 2015. Preterm birth and adult wealth: mathematics skills count. Psychol. Sci. 26 (10), 1608–1619. https://doi.org/10.1177/0956797615596230.

Bedford, A., Foulds, G., 1977. Validation of the delusions-symptoms-states inventory. Br. J. Med. Psychol. 50 (2), 163–171.

Bharadwaj, P., Løken, K.V., Neilson, C., 2013. Early life health interventions and academic achievement. Am. Econ. Rev. 103 (5), 1862–1891.

Bilgin, A., Mendonca, M., Wolke, D., 2018. Preterm birth/low birth weight and markers reflective of wealth in adulthood: a meta-analysis. Pediatrics 142 (1). https://doi.org/10.1542/peds.2017-3625.

Bilgin, A., Brylka, A., Wolke, D., Trower, H., Baumann, N., Lemola, S., 2021a. Subjective well-being and self-esteem in preterm born adolescents: an individual participant data meta-analysis. J. Dev. Behav. Pediatr. 42 (8), 613–620.

Bilgin, A., Wolke, D., Baumann, N., Trower, H., Brylka, A., Räikkönen, K., Heinonen, K., Kajantie, E., Schnitzlein, D., Lemola, S., 2021b. Changes in emotional problems, hyperactivity and conduct problems in moderate to late preterm children and adolescents born between 1958 and 2002 in the United Kingdom. JCPP Adv. 1 (2), e12018.

Black, S.E., Devereux, P.J., Salvanes, K.G., 2007. From the cradle to the labor market? The effect of birth weight on adult outcomes*. Q. J. Econ. 122 (1), 409–439. https://doi.org/10.1162/qjec.122.1.409.

Blencowe, H., Krasevec, J., de Onis, M., Black, R.E., An, X., Stevens, G.A., Borghi, E., Hayashi, C., Estevez, D., Cegolon, L., Shiekh, S., Ponce Hardy, V., Lawn, J.E., Cousens, S., 2019. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: a systematic analysis. Lancet Glob. Health 7 (7), e849–e860. https://doi.org/10.1016/s2214-109x(18)30565-5.

Boardman, J.D., Powers, D.A., Padilla, Y.C., Hummer, R.A., 2002. Low birth weight, social factors, and developmental outcomes among children in the United States. Demography 39, 353–368.

Bohnert, K.M., Breslau, N., 2008. Stability of psychiatric outcomes of low birth weight: a longitudinal investigation. Arch. Gen. Psychiatry 65 (9), 1080–1086. https://doi.org/10.1001/archpsyc.65.9.1080.

Burnett, A.C., Scratch, S.E., Anderson, P.J., 2013. Executive function outcome in preterm adolescents. Early Hum. Dev. 89 (4), 215–220. https://doi.org/10.1016/j.earlhumdev.2013.01.013.

Bygdell, M., Ohlsson, C., Lilja, L., Celind, J., Martikainen, J., Rosengren, A., Kindblom, J. M., 2021. Birth weight and young adult body mass index for predicting the risk of developing adult heart failure in men. Eur. J. Prev. Cardiol. 29 (6), 971–978. https://doi.org/10.1093/eurjpc/zwab186.

Conley, D., Bennett, N.G., 2000. Is biology destiny? Birth weight and life chances. Am. Sociol. Rev. 458–467.

Cooke, R., 2004. Health, lifestyle, and quality of life for young adults born very preterm. Arch. Dis. Child. 89 (3), 201–206. https://adc.bmj.com/content/archdischild/89/3/201.1.full.pdf.
Darlow, B.A., Horwood, L.J., Pere-Bracken, H.M., Woodward, L.J., 2013. Psychosocial outcomes of young adults born very low birth weight. Pediatrics 132 (6), e1521–e1528.
Duhig, A.M., Renk, K., Epstein, M.K., Phares, V., 2000. Interparental agreement on internalizing, externalizing, and total behavior problems: a meta-analysis. Clin. Psychol. Sci. Pract. 7 (4), 435–453.
Elder, G.H., Johnson, M.K., Crosnoe, R., 2003. The Emergence and Development of Life Course Theory. Springer.
Eves, R., Mendonça, M., Baumann, N., Ni, Y., Darlow, B.A., Horwood, J., Woodward, L. J., Doyle, L.W., Cheong, J., Anderson, P.J., Bartmann, P., Marlow, N., Johnson, S., Kajantie, E., Hovi, P., Nosarti, C., Indredavik, M.S., Evensen, K.-A.I., Räikkönen, K., Wolke, D., 2021. Association of very preterm birth or very low birth weight with intelligence in adulthood: an individual participant data Meta-analysis. JAMA Pediatr. 175 (8), e211058. https://doi.org/10.1001/jamapediatrics.2021.1058.
Farrington, D.P., Gallagher, B., Morley, L., Ledger, R.J.S., West, D.J., 1988. Are there any successful men from criminogenic backgrounds? Psychiatry 51 (2), 116–130.
Farrington, D.P., Coid, J.W., Harnett, L., Jolliffe, D., Soteriou, N., Turner, R., West, D.J., 2006. Criminal Careers up to Age 50 and Life Success up to Age 48: New Findings from the Cambridge Study in Delinquent Development, vol. 94. Home Office Research, Development and Statistics Directorate London, UK.
Farrington, D.P., Ttofi, M.M., Coid, J.W., 2009. Development of adolescence-limited, late-onset, and persistent offenders from age 8 to age 48. Aggres. Behav.: Off. J. Intern. Soc. Res.Aggres. 35 (2), 150–163.
Feng, C., Osgood, N.D., Dyck, R.F., 2018. Low birth weight, cumulative obesity dose, and the risk of incident type 2 diabetes. J. Diabetes Res. 2018.
Ferguson, T.S., Younger-Coleman, N.O., Tulloch-Reid, M.K., Knight-Madden, J.M., Bennett, N.R., Samms-Vaughan, M., Ashley, D., McCaw-Binns, A., Molaodi, O.R., Cruickshank, J.K., 2015. Birth weight and maternal socioeconomic circumstances were inversely related to systolic blood pressure among afro-Caribbean young adults. J. Clin. Epidemiol. 68 (9), 1002–1009.
Fox, H., Callander, E., 2021. Cost of preterm birth to Australian mothers: assessing the financial impact of a birth outcome with an increasing prevalence. J. Paediatr. Child Health 57 (5), 618–625. https://doi.org/10.1111/jpc.15278.
Graham, J.W., 2009. Missing data analysis: making it work in the real world. Annu. Rev. Psychol. 60, 549–576.
Graham, J.W., 2012. Missing Data: Analysis and Design. Springer Science & Business Media.
Gu, H., Wang, L., Liu, L., Luo, X., Wang, J., Hou, F., Nkomola, P.D., Li, J., Liu, G., Meng, H., Zhang, J., Song, R., 2017. A gradient relationship between low birth weight and IQ: a meta-analysis. Sci. Rep. 7 (1), 18035. https://doi.org/10.1038/s41598-017-18234-9.
Hack, M., Youngstrom, E.A., Cartar, L., Schluchter, M., Taylor, H.G., Flannery, D., Klein, N., Borawski, E., 2004. Behavioral outcomes and evidence of psychopathology among very low birth weight infants at age 20 years. Pediatrics 114 (4), 932–940.
Hardcastle, K., Ford, K., Bellis, M.A., 2022. Maternal adverse childhood experiences and their association with preterm birth: secondary analysis of data from universal health visiting. BMC Pregn. Childbirth 22 (1), 129. https://doi.org/10.1186/s12884-022-04454-z.
Howe, L.D., Tilling, K., Galobardes, B., Lawlor, D.A., 2013. Loss to follow-up in cohort studies: bias in estimates of socioeconomic inequalities. Epidemiology 24 (1), 1–9.
Johnson, R.C., Schoeni, R.F., 2011. Early-life origins of adult disease: national longitudinal population-based study of the United States. Am. J. Public Health 101 (12), 2317–2324. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222421/pdf/2317.pdf.
Kenyhercz, F., Kósa, K., Nagy, B.E., 2022. Perinatal, neonatal, developmental and demographic predictors of intelligence at 4 years of age among low birth weight children: a panel study with a 2-year follow-up. BMC Pediatr. 22 (1), 88. https://doi.org/10.1186/s12887-022-03156-x.
Kormos, C.E., Wilkinson, A.J., Davey, C.J., Cunningham, A.J., 2013. Low birth weight and intelligence in adolescence and early adulthood: a meta-analysis. J. Public Health 36 (2), 213–224. https://doi.org/10.1093/pubmed/fdt071.
Lærum, A.M., Reitan, S.K., Evensen, K.A.I., Lydersen, S., Brubakk, A.-M., Skranes, J., Indredavik, M.S., 2017. Psychiatric disorders and general functioning in low birth weight adults: a longitudinal study. Pediatrics 139 (2).
Lee, S., Lee, D.K., 2018. What is the proper way to apply the multiple comparison test? Korean J. Anesthesiol. 71 (5), 353.
Lemola, S., 2015. Long-term outcomes of very preterm birth. Eur. Psychol. 20 (2), 128–137. https://doi.org/10.1027/1016-9040/a000207.
Lindström, K., Winbladh, B., Haglund, B., Hjern, A., 2007. Preterm infants as young adults: a Swedish national cohort study. Pediatrics 120 (1), 70–77.
Mathewson, K.J., Chow, C.H., Dobson, K.G., Pope, E.I., Schmidt, L.A., Van Lieshout, R.J., 2017. Mental health of extremely low birth weight survivors: a systematic review and meta-analysis. Psychol. Bull. 143 (4), 347–383. https://doi.org/10.1037/bul0000091.
Matsushima, M., Shimizutani, S., Yamada, H., 2018. Life course consequences of low birth weight: evidence from Japan. J. Japan. Intern. Econ. 50, 37–47. https://doi.org/10.1016/j.jjie.2018.07.001.
Matthews, K.A., Gallo, L.C., Taylor, S.E., 2010. Are psychosocial factors mediators of socioeconomic status and health connections? A progress report and blueprint for the future. Ann. N. Y. Acad. Sci. 1186 (1), 146–173.
McCarton, C.M., Brooks-Gunn, J., Wallace, I.F., Bauer, C.R., Bennett, F.C., Bernbaum, J. C., Broyles, R.S., Casey, P.H., McCormick, M.C., Scott, D.T., Tyson, J., Tonasela, J., Meinen, C.L., 1997. Results at age 8 years of early intervention for low-birth-weight premature infants: the infant health and development program. JAMA 277 (2), 126–132. https://doi.org/10.1001/jama.1997.03540260040033.
McCormick, M.C., Brooks-Gunn, J., Buka, S.L., Goldman, J., Yu, J., Salganik, M., Scott, D. T., Bennett, F.C., Kay, L.L., Bernbaum, J.C., 2006. Early intervention in low birth weight premature infants: results at 18 years of age for the infant health and development program. Pediatrics 117 (3), 771–780.
McDonough, P., Worts, D., Booker, C., McMunn, A., Sacker, A., 2015. Cumulative disadvantage, employment–marriage, and health inequalities among American and British mothers. Adv. Life Course Res. 25, 49–66.
Menyhart, O., Weltz, B., Győrffy, B., 2021. MultipleTesting.com: a tool for life science researchers for multiple hypothesis testing correction. PLoS One 16 (6), e0245824. https://doi.org/10.1371/journal.pone.0245824.
Montez, J.K., Hayward, M.D., 2014. Cumulative childhood adversity, educational attainment, and active life expectancy among US adults. Demography 51 (2), 413–435. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4465758/pdf/nihms-695816.pdf.
Msall, M.E., Sobotka, S.A., Dmowska, A., Hogan, D., Sullivan, M., 2018. Life course health development outcomes after prematurity: developing a community, clinical, and translational research agenda to optimize health, behavior, and functioning. Handb. Life Course Health Develop. 321–348.
Najman, J., Bor, W., O'Callaghan, M., Williams, G., Aird, R., Shuttlewood, G., 2005. Cohort profile: the mater-University of Queensland Study of pregnancy (MUSP). Int. J. Epidemiol. 34 (5), 992–997. https://doi.org/10.1093/ije/dyi119.
Najman, J.M., Williams, G.M., Nikles, J., Spence, S.U.E., Bor, W., O'Callaghan, M., Le Brocque, R., Andersen, M.J., 2000. Mothers' mental illness and child behavior problems: cause-effect association or observation Bias? J. Am. Acad. Child Adolesc. Psychiatry 39 (5), 592–602. https://doi.org/10.1097/00004583-200005000-00013.
Najman, J.M., Alati, R., Bor, W., Clavarino, A., Mamun, A., McGrath, J.J., McIntyre, D., O'Callaghan, M., Scott, J., Shuttlewood, G., 2015. Cohort profile update: the mater-University of Queensland study of pregnancy (MUSP). Int. J. Epidemiol. 44 (1), 78-78f.
Najman, J.M., Farrington, D.P., Bor, W., Clavarino, A.M., McGee, T.R., Scott, J.G., Williams, G.M., McKetin, R., 2022. Do cannabis and amphetamine use in adolescence predict adult life success: a longitudinal study. Addict. Res. Theory 30 (5), 314–322.
Najman, J.M., Scott, J.G., Farrington, D.P., Clavarino, A.M., Williams, G.M., McGee, T.R., Kisely, S., 2023. Does childhood maltreatment lead to low life success? Comparing agency and self-reports. J. Interpers. Violence 38 (1–2), 1320–1342.
Oesterle, S., Hawkins, J.D., Hill, K.G., 2011. Men's and women's pathways to adulthood and associated substance misuse. J. Stud. Alcohol Drugs 72 (5), 763–773. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3174023/pdf/jsad763.pdf.
Patel, V., Chatterji, S., 2015. Integrating mental health in care for noncommunicable diseases: an imperative for person-centered care. Health Aff. 34 (9), 1498–1505.
Plenty, S., Magnusson, C., Låftman, S.B., 2021. Internalising and externalising problems during adolescence and the subsequent likelihood of being not in employment, education or training (NEET) among males and females: the mediating role of school performance. SSM – Popul. Health 15, 100873. https://doi.org/10.1016/j.ssmph.2021.100873.
Power, C., Kuh, D., Morton, S., 2013. From developmental origins of adult disease to life course research on adult disease and aging: insights from birth cohort studies. Annu. Rev. Public Health 34, 7–28.
Prus, S.G., 2007. Age, SES, and health: a population level analysis of health inequalities over the lifecourse. Sociol. Health Illn. 29 (2), 275–296.
Rava, J., Shattuck, P., Rast, J., Roux, A., 2017. The prevalence and correlates of involvement in the criminal justice system among youth on the autism spectrum. J. Autism Dev. Disord. 47 (2), 340–346. https://doi.org/10.1007/s10803-016-2958-3.pdf.
Reifman, A., Arnett, J.J., Colwell, M.J., 2007. Emerging adulthood: theory, assessment and application. J. Youth Develop. 2 (1), 37–48.
Risnes, K.R., Vatten, L.J., Baker, J.L., Jameson, K., Sovio, U., Kajantie, E., Osler, M., Morley, R., Jokela, M., Painter, R.C., Sundh, V., Jacobsen, G.W., Eriksson, J.G., Sørensen, T.I.A., Bracken, M.B., 2011. Birthweight and mortality in adulthood: a systematic review and meta-analysis. Int. J. Epidemiol. 40 (3), 647–661. https://doi.org/10.1093/ije/dyq267.
Robinson, R., Lahti-Pulkkinen, M., Schnitzlein, D., Voit, F., Girchenko, P., Wolke, D., Lemola, S., Kajantie, E., Heinonen, K., Räikkönen, K., 2020. Mental health outcomes of adults born very preterm or with very low birth weight: a systematic review. Semin. Fetal Neonatal Med. 25 (3), 101113 https://doi.org/10.1016/j.siny.2020.101113.
Saiepour, N., Najman, J.M., Ware, R., Baker, P., Clavarino, A.M., Williams, G.M., 2019. Does attrition affect estimates of association: a longitudinal study. J. Psychiatr. Res. 110, 127–142. https://doi.org/10.1016/j.jpsychires.2018.12.022.
Saigal, S., Stoskopf, B., Streiner, D., Boyle, M., Pinelli, J., Paneth, N., Goddeeris, J., 2006a. Transition of extremely low-birth-weight infants from adolescence to young adulthood: comparison with normal birth-weight controls. JAMA 295 (6), 667–675.
Saigal, S., Stoskopf, B., Streiner, D., Boyle, M., Pinelli, J., Paneth, N., Goddeeris, J., 2006b. Transition of extremely low-birth-weight infants from adolescence to young AdulthoodComparison with Normal birth-weight controls. JAMA 295 (6), 667–675. https://doi.org/10.1001/jama.295.6.667.
Sallis, H., Szekely, E., Neumann, A., Jolicoeur-Martineau, A., Van IJzendoorn, M., Hillegers, M., Greenwood, C.M., Meaney, M.J., Steiner, M., Tiemeier, H., 2019. General psychopathology, internalising and externalising in children and functional outcomes in late adolescence. J. Child Psychol. Psychiatry 60 (11), 1183–1190.
Sampson, J.P., Hooley, T., Marriot, J., 2011. Fostering College and Career Readiness: How Career Development Activities in Schools Impact on Graduation Rates and students' Life Success.

Schulenberg, J., Schoon, I., 2012. The transition to adulthood across time and space: overview of special section. Longitud. Life Course Stud. 3 (2), 164.
Spiker, D., Kraemer, H.C., Constantine, N.A., Bryant, D., 1992. Reliability and validity of behavior problem checklists as measures of stable traits in low birth weight, premature preschoolers. Child Dev. 63 (6), 1481–1496.
Stein, R.E., Siegel, M.J., Bauman, L.J., 2006. Are children of moderately low birth weight at increased risk for poor health? A new look at an old question. Pediatrics 118 (1), 217–223.
Veldman, K., Reijneveld, S.A., Ortiz, J.A., Verhulst, F.C., Bültmann, U., 2015. Mental health trajectories from childhood to young adulthood affect the educational and employment status of young adults: results from the TRAILS study. J. Epidemiol. Community Health 69 (6), 588–593.
Walker, S.P., Chang, S.M., Powell, C.A., Grantham-McGregor, S.M., 2004. Psychosocial intervention improves the development of term low-birth-weight infants. J. Nutr. 134 (6), 1417–1423.
Wang, Y.-X., Li, Y., Rich-Edwards, J.W., Florio, A.A., Shan, Z., Wang, S., Manson, J.E., Mukamal, K.J., Rimm, E.B., Chavarro, J.E., 2022. Associations of birth weight and later life lifestyle factors with risk of cardiovascular disease in the USA: a prospective cohort study. eClinicalMedicine 51, 101570. https://doi.org/10.1016/j.eclinm.2022.101570.
Welfare, A.I.o.H. a, 2020. Australia's Children, vol. Cat. no. CWS 69. AIHW.
Willson, A.E., Shuey, K.M., Elder, J., Glen, H., 2007. Cumulative advantage processes as mechanisms of inequality in life course health. Am. J. Sociol. 112 (6), 1886–1924.
Yang, Y., Shields, G.S., Zhang, Y., Wu, H., Chen, H., Romer, A.L., 2022. Child executive function and future externalizing and internalizing problems: a meta-analysis of prospective longitudinal studies. Clin. Psychol. Rev. 97, 102194. https://www.sciencedirect.com/science/article/pii/S0272735822000794?via%3Dihub.
Zhang, Q., Yuan, K.H., Wang, L., 2019. Asymptotic bias of normal-distribution-based maximum likelihood estimates of moderation effects with data missing at random. Br. J. Math. Stat. Psychol. 72 (2), 334–354. https://doi.org/10.1111/bmsp.12151.