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

Ayten Bilgin, PhD[1,2], Dieter Wolke, PhD, Dr rer nat hc[2,3], Nicole Baumann, BSc[2], Hayley Trower, PhD[2], Asteria Brylka, PhD[2], Katri Räikkönen, PhD[4], Kati Heinonen, PhD[4,5], Eero Kajantie, MD, DMSc[6,7,8,9], Daniel Schnitzlein, PhD[10,11,12] & Sakari Lemola, PhD[2,13]

Affiliations: [1]School of Psychology, University of Kent, Canterbury, UK; [2]Department of Psychology, University of Warwick, Coventry, UK; [3]Division of Mental Health and Wellbeing, Warwick Medical School, University of Warwick, Coventry, UK; [4]Department of Psychology & Logopedics, University of Helsinki, Helsinki, Finland; [5] Psychology/ Welfare Sciences, Faculty of Social Sciences, Tampere University, Finland; [6]National Institute for Health and Welfare, Helsinki, Oulu, Finland; [7]PEDEGO Research Unit, Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Oulu, Finland; [8]Children's Hospital, Pediatric Research Center, University of Helsinki and Helsinki University Hospital, Helsinki, Finland; [9]Department of Clinical and Molecular Medicine, Norwegian University of Science and Technology, Trondheim, Norway; [10]Leibniz University of Hannover, Hannover, Germany; [11]DIW Berlin, Berlin, Germany; [12]IZA Bonn, Bonn, Germany; [13]Department of Psychology, University of Bielefeld, Bielefeld, Germany

Correspondence: Ayten Bilgin, School of Psychology, University of Kent, Canterbury, UK; email: a.bilgin@kent.ac.uk

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Abstract

Background: Preterm birth is a risk factor for the development of emotional and behavioural problems in childhood and adolescence. Given the substantial improvements in neonatal care across decades, it has been expected that the difference in emotional problems, hyperactivity, and conduct problems between moderate-to-late preterm (MLPT) and full-term (FT) children and adolescents have declined in recent years.

Methods: Data from four UK population-based studies were used: The National Child Development Study (NCDS; 1958), the British Cohort Study (BCS70; 1970), the Avon Longitudinal Study of Parents and Children (ALSPAC, 1991-1992) and the Millennium Cohort Study (MCS; 2000-2002). Emotional problems, hyperactivity and conduct problems were assessed with mother-reports in early childhood (5-7 years), late childhood (10-11 years) and adolescence (14- 16 years). Furthermore, emotional problems were self-reported in adolescence in BCS70, ALSPAC and MCS.

Results: In the most recent cohort, the MLPT group had higher mother-reported emotional problems than those born FT in late childhood and adolescence, whereas there were no differences in self-reported emotional problems in adolescence. Regarding mother-reported hyperactivity symptoms, the MLPT group had higher scores than the FT group in the two most recent cohorts in late childhood and in the most recent cohort in adolescence. Regarding mother-reported conduct problems, MLPT children had significantly higher scores than the FT children in the oldest and in the most recent cohort in late childhood. On the other hand, in adolescence, MLPT children had significantly lower scores in conduct problems in comparison to FT children in the cohort born in 1991-1992.

Conclusions: Mother-reported emotional problems and hyperactivity symptoms of those born MLPT have increased from the birth years 1958 to 2000-2002 during late childhood and adolescence, whereas self-reported emotional problems were similar in MLPT and FT groups

during adolescence from 1970 to 2000-2002. Findings are less consistent regarding conduct problems. The current findings highlight the importance of raising the awareness of teachers about the association between MLPT birth and behavioural and emotional problems in late childhood and adolescence to prevent the long-term negative outcomes associated with the sequalae of MLPT birth.

Keywords: Preterm, emotional problems, hyperactivity, conduct problems, ALSPAC, MCS, NCDS, BCS70

Preterm birth is a risk factor for the development of emotional and behavioural problems in childhood and adolescence (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009; Bhutta, Cleves, Casey, Cradock, & Anand, 2002). Preterm birth rates (< 37 weeks of gestation) have increased significantly with one in ten babies being born preterm (Chawanpaiboon et al., 2019). Among preterm children, those born moderate-to-late preterm (MLPT; born between 32nd-36th completed weeks of gestation) constitute the largest subgroup, accounting for 84.7% of preterm births worldwide (Chawanpaiboon et al., 2019) and 85.3% of preterm births in the UK (Euro-Peristat Project, 2018). However, our knowledge regarding the behavioural and emotional development of MLPT born children has been limited in two ways.

First, most studies on the behavioural and emotional outcomes of preterm children have focused on those born very (VPT) or extremely preterm (EPT) rather than MLPT born children. Higher rates of behavioural and emotional problems in the VPT or EPT group have been consistently reported in childhood (Adams-Chapman, 2006; Johnson & Wolke, 2013; Shapiro-Mendoza & Lackritz, 2012). To illustrate, it was shown that hyperactivity problems were more pronounced in EPT born children with ratings being 0.46 SD higher than FT children (Mathewson et al., 2017) and very recently it was shown that children born VPT were at 5.6-fold elevated risk of meeting the criteria for any mental health disorders at 13 years of age (Yates et al., 2020).

Traditionally it was thought that MLPT born children are only little affected in their development. However, there is increasing evidence that MLPT born children show suboptimal neurodevelopmental outcomes during the early years (Johnson, Evans, et al., 2015; Morse, Zheng, Tang, & Roth, 2009; Woythaler, McCormick, & Smith, 2011). This could be due to the fact that MLPT birth coincides with rapid brain development, it puts infants at an increased risk for brain injury and it is related to a smaller and less mature brain

size (Walsh, Doyle, Anderson, Lee, & Cheong, 2014). Thus, it is important to understand if emotional, hyperactivity and conduct problems are also more common in MLPT born children given that they represent the majority of the preterm births.

Existing studies on emotional problems in MLPT born children focused on the age range from preschool to 8 years (de Jong, Verhoeven, & van Baar, 2012; McGowan, Alderdice, Holmes, & Johnston, 2011; Potijk, de Winter, Bos, Kerstjens, & Reijneveld, 2012; Rogers, Lenze, & Luby, 2013; Talge et al., 2010; van Baar, Vermaas, Knots, de Kleine, & Soons, 2009; Westrupp, Mensah, Giallo, Cooklin, & Nicholson, 2012), and the studies on hyperactivity focused on early childhood (Huddy, Johnson, & Hope, 2001; Talge et al., 2010; van Baar et al., 2009). Moreover, there is less focus on conduct problems, where one study reported higher externalizing problems at 4 years of age (Potijk et al., 2012), while another one reported lower levels of aggression from 4 to 15 years of age compared to the FT group (Gurka, LoCasale-Crouch, & Blackman, 2010). Some of these studies revealed that higher MLPT born children have higher scores in both internalizing and externalizing problems than FT born children, whereas others showed that MLPT children have higher scores only in attention problems and internalizing problems, along with some other studies which showed no significant differences between the MLPT and FT group (Fitzallen, Sagar, Taylor, & Bora, 2021; Gurka et al., 2010; Potijk et al., 2012; Talge et al., 2010; van Baar et al., 2009). Thus, there is a lack of studies that has investigated emotional problems, hyperactivity and conduct problems following MLPT birth during late childhood and adolescence with existing studies revealing conflicting results.

Second, no studies have investigated whether differences between MLPT and FT children in emotional problems, hyperactivity and conduct problems have changed across recent decades during which major changes in prenatal and neonatal care practices have taken place. It may be expected that any differences between MLPT and FT children may have

decreased over time due to advances in obstetric and neonatological care (Dunn, 2007), such as improved nutrition, treatment of infections and, in particular for the moderately preterm infants in high-income countries, the introduction of assisted ventilation in the late 1960s, antenatal glucocorticoids in the 1970s and postnatal surfactant therapy in the 1980s (March of Dimes, 2012; Philip, 2012). In addition to the technical developments in neonatal care, the introduction of family-centered care have been shown to be beneficial for infant morbidity and psychological development (Boundy et al., 2016).

In the current study, we examine whether the difference in emotional problems, hyperactivity and conduct problems between MLPT and FT born individuals has changed over a 40-year period in the UK at three distinct time points in development: early childhood, late childhood and adolescence. We used mother ratings for all outcomes. In addition, we used self-reports of emotional problems in adolescence where such data was available since self and mother reports on emotional problems may differ from each other (Eg, Bilenberg, Costello, & Wesselhoeft, 2018). Several factors which may play a role in the development of emotional and behaviour problems such as sex, multiple birth, parity, low parental education, minority ethnicity status, neurosensory impairments, foetal growth restriction, maternal age and maternal smoking during pregnancy were considered as covariates (Gray, Indurkhya, & McCormick, 2004).

Methods

Participants

National Child Development Study (NCDS). The NCDS is a cohort of 17,415 children born in one week (3rd-9th March) in 1958 in England, Wales and Scotland (Fogelman, 1983; Power & Elliott, 2006). It includes assessments at birth, 7, 11, and 16 years and later time points. More information regarding the sample is available on the website: http://www.cls.ioe.ac.uk/.

In the current study, the assessments at 7 (N_{MLPT}= 497; N_{FT}=10,586), 11 (N_{MLPT}= 448; N_{FT}= 9,348) and 16 (N_{MLPT}= 354; N_{FT}= 7,737) years were utilised.

British Cohort Study 1970 (BCS70). The BCS70 comprises 17,198 births in England, Wales, Scotland and Northern Ireland between 5 and 11 April 1970 (Elliott & Shepherd, 2006), with the first sweep occurring at birth followed by a further nine sweeps to date until adulthood. In the current study, assessments at 5 (N_{MLPT}= 428; N_{FT}= 8,680), 10 (N_{MLPT}= 419; N_{FT}= 8,681) and 16 years (N_{MLPT}= 282; N_{FT}= 5,677) were utilised.

The Avon Longitudinal Study of Parents and Children (ALSPAC). ALSPAC is a UK birth cohort examining the determinants of development, health and disease. The study is described in detail elsewhere (Boyd et al., 2013; Fraser et al., 2013). ALSPAC recruited 14,541 pregnant women with expected delivery dates of 1st April 1991 to 31st December 1992. Of the initial pregnancies, there were 14,676 fetuses resulting in 14,062 live births; 13,988 children were alive at 1 year of age. Ethical approval was obtained from the ALSPAC Law and Ethics committee and the local research ethics committee. Informed consent for the use of data collected via questionnaires and clinics was obtained from participants following the recommendations of the ALSPAC Ethics and Law Committee at the time. From the first trimester of pregnancy, parents completed postal questionnaires about themselves and the study child. The study website contains details of all data available through a fully searchable dictionary (http://www.bris.ac.uk/alspac/ researchers/data-access/data-dictionary/). In the current study, assessments at 6 (N_{MLPT}= 378; N_{FT}= 7,631), 11 (N_{MLPT}= 303; N_{FT}= 6,124) and 16 years (N_{MLPT}= 240; N_{FT}= 4,725) were utilised.

Millennium Cohort Study (MCS). MCS is a national birth cohort of 18,818 children born between 1st September 2000 and 11th January 2002 in England, Wales, Scotland, and Northern Ireland (Connelly & Platt, 2014). More information is available at: http://www.cls.ioe.ac.uk/. Ethical approval and written informed consent were obtained

(London - Hampstead Research Ethics Committee, REC reference 14/LO/0868). In the current study, assessments at 7 (N_{MLPT}= 888; N_{FT}= 11,488), 11 (N_{MLPT}= 847; N_{FT}= 10,922) and 14 years (N_{MLPT}= 733; N_{FT}= 9,641) were utilized.

Assessments across cohorts were grouped into three points: early childhood (5-7 years), late childhood (10-11 years) and adolescence (14-16 years). Characteristics of the participants included in the study are shown in Table 1 (See Supplementary Table 1 for characteristics of the participants who dropped-out). The ethical approval for the current study was obtained from the Ethics Committee of the University of Warwick (96/17-18).

Measures

Moderate to Late Preterm Birth (MLPT): Gestational full weeks were recoded into a categorical variable as follows: 0: full-term (FT: 37th-41st completed weeks of gestation); and 1: moderate to late preterm (MLPT; 32nd-36th completed weeks of gestation).

Emotional Problems, Hyperactivity and Conduct Problems. At all measurement points, we used mother ratings of emotional problems, hyperactivity and conduct problems using the Rutter behaviour questions (Rutter, Tizard, & Whitmore, 1970) in NCDS (at 7, 11, 16 years) and BCS70 (at 5, 10, 16 years) and the Strengths & Difficulties Questionnaire (SDQ) (Goodman, 1997) in ALSPAC (at 6, 11, 16 years) and MCS (at 7, 11, 14 years). Although SDQ was developed based on the Rutter scale and the two scales are highly correlated (Stone, Otten, Engels, Vermulst, & Janssens, 2010), we wanted to make sure the scores are comparable across the scales. Thus, we only used the items which are very similar across the scales following the guidance from Centre for Longitudinal Studies regarding the harmonisation of mental health measures across UK cohorts (Supplementary Table 2). The harmonised answering scale ranged for all measures from one (*not true*) to three (*certainly true*).

With respect to emotional problems, we further used self-reports in adolescence in the cohorts where such data was available (BCS70, ALSPAC and MCS). Adolescents completed the 15-item psychological subscale of Malaise Inventory (Rutter et al., 1970) in BCS70, which measures the level of depression with a 3-point response scale (0= rarely or never, 1= some of the time, 2= most of the time) and has good reliability and validity (Rodgers, Pickles, Power, Collishaw, & Maughan, 1999). In ALSPAC and MCS, adolescents completed the short version of the Moods and Feelings Questionnaire (SMFQ) (Angold, Costello, Messer, & Pickles, 1995; Costello & Angold, 1988), which is a 13-item measure with good reliability and validity (Rhew et al., 2010; Turner, Joinson, Peters, Wiles, & Lewis, 2014). Self-reported emotional problems scales had high reliability in the current samples (BCS70: α= .82; ALSPAC: α= .91; MCS: α= .93).

Covariates. The following variables were included as covariates: sex (0 = male; 1 = female), ethnic group (0 = majority; 1 = minority), birth status (0 = singleton; 1 = multiple birth), parity (0 = first born child; 1 = second born or later), neurosensory impairment (0 = no; 1 = yes), obligatory education only or lower of either parent at participants' birth (0 = A level/vocational equivalent or higher education/university degree; 1 = obligatory education only or lower), foetal growth restriction, maternal age at birth, and smoking during pregnancy (0 = no; 1 = yes). Neurosensory impairments were either extracted from medical records or parent-reported and indicated by the presence of either (a) an IQ score for fluid reasoning of 3SDs below the mean identified between 5-11 years, (b) parent- or school-reported visual or hearing impairment, or (c) severe congenital malformations identified during the child's first year of life. As a measure of foetal growth, birth weight z-scores were computed via the model proposed by Hadlock (Hadlock, Harrist, & Martinez-Poyer, 1991).

Statistical Analysis

Statistical analyses were performed with Stata version 15. Differences between MLPT and FT-born individuals in emotional problems, hyperactivity and conduct problems within cohort in early and late childhood and adolescence were tested using multivariate linear regressions with the survey command (svy), which includes the sample-specific weights to account for the survey design of MCS, which over-sampled areas of higher proportions of ethnic minorities and child poverty. Standard analytic procedures and sampling weights, developed for use with MCS (Plewis, 2007), accounted for this and ensured results were nationally representative. All utilised outcome variables were standardised according to the scores of FT children (z-scores). All analyses were adjusted for sex, ethnic group, multiple birth, parity, neurosensory impairment, parental education at birth, foetal growth restriction, maternal age, and smoking during pregnancy (Supplementary Table 3).

Power analysis. Based on the sample sizes, observed statistical power to detect a small difference between MLPT and FT of d=0.20 was calculated with Gpower (version 3.1.9.4) (Faul, Erdfelder, Lang, & Buchner, 2007), which revealed statistical power greater than 0.85 for all of the analyses (Supplementary Table 4).

Sensitivity Analyses. Three sensitivity analyses were conducted to test whether the findings were robust to changes in the analytic plan: 1) Separate analyses for those born late preterm (LPT; 34-36 weeks of gestation) to understand if the findings would differ; 2) Multiple imputations (20 imputations) were carried out using chained equations separately in the four cohorts and all main analyses were repeated using the imputed data to understand whether sample attrition has changed the results; 3) Analyses with the full Rutter and SDQ sub-scales (i.e. not only selecting items which were the same across cohorts) to understand whether harmonization changed the results.

Results

Emotional problems in MLPT born children and adolescents

In early childhood, there were no significant differences between MLPT and FT born children in all cohorts (Figure 1, Table 2). In late childhood and in adolescence, the MLPT group had significantly higher scores on mother-rated emotional problems in comparison to the FT group in the most recent cohort (β= .147, 95% CI: .023; .271; and β= .158, 95% CI: .048; .267, respectively) but not in the earlier cohorts. However, there were no significant differences between the MLPT and FT groups in self-reported emotional problems from 1970 to 2000-2002.

Hyperactivity in MLPT born children and adolescents

In early childhood, there were no significant differences between MLPT and FT born children in hyperactivity scores in all cohorts (Figure 1, Table 2). In late childhood, MLPT born children had higher levels of hyperactivity than FT born children in the two most recent cohorts (β= .208, 95% CI: .081; .334 and β= .158, 95% CI: .054; .261, respectively). In adolescence, MLPT group had higher scores of hyperactivity than the FT group only in the most recent cohort (β= .199, 95% CI: .073; .325).

Conduct problems in MLPT born children and adolescents

In early childhood, the MLPT and FT groups were not significantly different in conduct problems in any of the cohorts (Figure 1, Table 2). In late childhood, the MLPT group had significantly higher conduct problems in the earliest (β= .119, 95% CI: .023; .215) and most recent cohort (β= .136, 95% CI: .016; .255). On the other hand, in adolescence, the MLPT group had significantly lower scores in conduct problems in comparison to the FT group in the cohort born in 1991-1992 (β= -.143, 95% CI: -.283; -.003).

Sensitivity Analyses

Sensitivity analysis comparing the LPT group separately with the term born group showed consistent findings with the main analyses for emotional problems and hyperactivity, however there was no significant difference between the two groups in conduct problems in any of the assessment points across all cohorts (Supplementary Table 5). Furthermore, sensitivity analysis using imputed dataset revealed consistent results with main analyses (Supplementary Table 6). When the full-scales were used, findings regarding late childhood and adolescence remained consistent, and higher scores of emotional problems and hyperactivity were found in early childhood in the two most recent cohorts (ALSPAC and MCS, Supplementary Table 7).

Discussion

This study of 4 cohorts born between the late 1950s and the early 2000s in the UK showed that the difference between MLPT and FT born individuals in emotional problems and hyperactivity has increased in recent cohorts in comparison to cohorts born in 1958 and 1970. This was found in mother reports in late childhood and adolescence, whereas no significant differences were found in self-reported emotional problems in adolescence. In contrast, no consistent trend between 1958 and 2000-2002 was found for maternal reports of conduct problems.

Our finding of an increase in mother-reported emotional problems and hyperactivity in the UK during late childhood and adolescence in MLPT individuals born between the late 1950s and the early 2000s is contrary to our expectation of a decrease in these problems over the years given the advances in the prenatal and neonatal care (Dunn, 2007) and the decrease in the association between birth weight and cognitive abilities over the years in the UK (Goisis, Ozcan, & Myrskyla, 2017). However, this finding is in line with the previous studies showing higher emotional problems and hyperactivity levels in MLPT born children in comparison to FT born children in the recent cohorts (Faleschini, Matte-Gagné, Côté,

Tremblay, & Boivin, 2020; Potijk et al., 2012). Furthermore, this finding is in line with studies showing that the quality of neurodevelopmental outcomes has not improved over time in VPT born children despite improvements in neonatal care and higher survival rates (Cheong, Spittle, Burnett, Anderson, & Doyle, 2020; Marlow et al., 2021). Our unique study adds to the existing literature given that this was not investigated for emotional and behavioural problems in children and adolescents before and in particular, not for MLPT born children and adolescents.

Since the 1970s the incidence of emotional problems and hyperactivity in childhood and adolescence has increased on a population level in the UK (Collishaw, 2015; Collishaw, Maughan, Goodman, & Pickles, 2004). It has been suggested that this increase in emotional problems and hyperactivity in the general population could be due to societal changes in recent years such as a greater emphasis on academic performance and pressure to perform (Livingstone & Smith, 2014; Sweeting, West, Young, & Der, 2010; Twenge et al., 2010). It is possible that MLPT children are more vulnerable to the increased pressure to perform at school as they have more difficulties with academic performance, particularly maths (Wolke et al., 2015). In addition, MLPT born children represent a clinically distinct population since many of them are delivered for maternal medical complications during pregnancy (e.g., early delivery due to preeclampsia via cesarean section or induction of labour), which are consequently linked with increased rates of behavioural and emotional problems in children (Curran et al., 2016; Lahti-Pulkkinen et al., 2020; Silva, Colvin, Hagemann, & Bower, 2014). Potential mechanisms for such associations include changes in placental and immune system, and hypothalamic-pituitary-adrenal axis functioning during pregnancy that may lead to fetal programming (Maher et al., 2018). Thus, there may be clinical reasons for the increase in emotional problems and hyperactivity in the recent years.

Alternatively, our findings could be explained by the increased awareness of mothers about the influence of preterm birth on the development of emotional and behavioural problems, which may be reflected in their ratings during recent years (Guralnick, 2012). Thus, our findings might actually reflect maternal perception of vulnerability of their MLPT born children and adolescents rather than actual differences in their behaviour. While being speculative, this interpretation is consistent with our finding that there are no significant differences between MLPT and FT groups in self-reported emotional problems in adolescence. The low agreement in reports of emotional and behavioural problems between parent and child reports has also been shown previously in community studies (Achenbach, Krukowski, Dumenci, & Ivanova, 2005) and in preterm samples (Baumann, Bartmann, & Wolke, 2016; Eves et al., 2020). Moreover, this finding of no difference between MLPT and FT born adolescents in self-reported emotional problems is consistent with Festinger's theory of social comparison (Festinger, 1954), which suggests that individuals compare themselves with those they socialize most often, that is their peers in the case of adolescents. On the other hand, mothers of MLPT born adolescents are more likely to compare their adolescents to the whole birth cohort (i.e., all adolescents), which could be associated with using a different comparison level and with reporting more emotional problems than adolescents themselves (Eves et al., 2020).

Perception of child vulnerability among mothers of preterm children could be due to preterm birth being an emotionally challenging event as it is often unexpected and associated with a higher risk of medical complications and neonatal difficulties (Horwitz et al., 2015). It has been suggested that mothers might continue to perceive their premature born child as vulnerable beyond the infancy period, which could result in overprotective parenting (Horwitz et al., 2015). Although there is evidence that maternal sensitive parenting is not influenced by preterm birth (Bilgin & Wolke, 2015), overprotective and controlling parenting

behaviours in mothers of MLPT born children have been recently documented (Toscano, Soares, & Mesman, 2020) and were found to be linked with hyperactivity-impulsivity levels from 4 to 8 years of age (Faleschini, Matte-Gagné, Luu, et al., 2020). Nevertheless, it is unclear if the influence of overprotective parenting in mothers of MLPT born children on hyperactivity-impulsivity levels has a longer-lasting influence into late childhood and adolescence.

Our findings regarding mother-reported conduct problems were less consistent than those relating to mother-reported emotional problems and hyperactivity. MLPT born adolescents had lower scores in conduct problems in comparison to FT born adolescents in the ALSPAC cohort, which is in line with 'preterm behavioural and personality phenotype' which suggests that those born preterm are socially withdrawn and disinclined towards risk taking (Johnson & Wolke, 2013; Montagna & Nosarti, 2016). In contrast, our findings in late childhood showed higher levels of conduct problems in the MLPT group in comparison to the FT group in 1958 cohort and in the 2000-2002 cohort. This finding is inconsistent with the preterm behavioural phenotype and should be explored in future research.

Despite the fact that MLPT children experience fewer neonatal complications and have a more mature brain size than VPT children, they are still born immature in comparison to FT children (Walsh et al., 2014). Considering the increasing number of MLPT birth survivors (Chawanpaiboon et al., 2019), our findings suggest that the teachers should be made aware of this risk and the particular increase in emotional problems and hyperactivity in late childhood and adolescence following MLPT birth in the recent years (Johnson, Gilmore, Gallimore, Jaekel, & Wolke, 2015). Behavioural and emotional sequelae associated with MLPT birth is particularly important for employment and educational achievement during adulthood (Bilgin, Mendonca, & Wolke, 2018), thus, identification of problems during the

school years would be helpful in improving the long-term negative consequences on behavioural and emotional development.

The current study has several strengths including large cohort studies with participants who were born between the late 1950s and the early 2000s, measurement of the outcomes at three assessment points from childhood to adolescence and adjustment for several covariates. Moreover, we explored the consistency of our findings through several sensitivity analyses. Nevertheless, there are also limitations of the current study. First, the drop-out rate was high, which is a common problem in longitudinal studies, where those at risk of medical and social problems are likely to drop-out (Dieter Wolke et al., 2009). Nonetheless, the findings of the analysis with imputed data revealed a similar pattern of results, which suggests that the study attrition may not have influenced our findings. Second, mother reports were based on different scales in the older and recent cohorts (Rutter Scale and SDQ). Nonetheless, the SDQ was developed based on the Rutter Scale and they show high correlation (Goodman, 1997; Stone et al., 2010). In addition, we used only the most similar items from these two questionnaires. This approach of harmonization of questionnaires was previously used to document trends in mental health across the UK cohorts (Collishaw et al., 2004). Third, self-report measures of emotional problems were available only in three cohorts, where the scales were different between the oldest and the two newest cohorts. Last, the reliability scores of the harmonized scales were lower in comparison to the full sub-scales, particularly in hyperactivity and conduct problems. However, sensitivity analyses using the complete scales revealed similar findings.

In conclusion, mother-reported emotional problems and hyperactivity are increased in MLPT born children during late childhood and adolescence in the most recent cohort born in 2001-2002. On the other hand, the level of emotional problems reported by adolescents themselves were similar in the two groups in all cohorts with self-report data. Future research

should investigate the reasons associated with increasing mother-reported emotional problems and hyperactivity in MLPT children in the recent years and whether increased academic demands played a role. Overall, the current findings highlight the importance of raising the awareness of teachers about the association between MLPT birth and behavioural and emotional problems in late childhood and adolescence to prevent the long-term negative outcomes associated with the sequalae of MLPT birth.

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References

Aarnoudse-Moens, C. S., Weisglas-Kuperus, N., van Goudoever, J. B., & Oosterlaan, J. (2009). Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics, 124*(2), 717-728. doi:10.1542/peds.2008-2816

Achenbach, T. M., Krukowski, R. A., Dumenci, L., & Ivanova, M. Y. (2005). Assessment of adult psychopathology: meta-analyses and implications of cross-informant correlations. *Psychological Bulletin, 131*(3), 361-382. doi:10.1037/0033-2909.131.3.361

Adams-Chapman, I. (2006). Neurodevelopmental outcome of the late preterm infant. *Clinics in Perinatology, 33*(4), 947-964; abstract xi. doi:10.1016/j.clp.2006.09.004

Angold, A., Costello, E. J., Messer, S. C., & Pickles, A. (1995). Development of a short questionnaire for use in epidemiological studies of depression in children and adolescents. *International Journal of Methods in Psychiatric Research, 5*(4), 237-249.

Baumann, N., Bartmann, P., & Wolke, D. (2016). Health-Related Quality of Life Into Adulthood After Very Preterm Birth. *Pediatrics, 137*(4). doi:10.1542/peds.2015-3148

Bhutta, A. T., Cleves, M. A., Casey, P. H., Cradock, M. M., & Anand, K. J. (2002). Cognitive and behavioral outcomes of school-aged children who were born preterm: a meta-analysis. *JAMA, 288*(6), 728-737. doi:10.1001/jama.288.6.728

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). doi:10.1542/peds.2017-3625

Bilgin, A., & Wolke, D. (2015). Maternal Sensitivity in Parenting Preterm Children: A Meta-analysis. *Pediatrics, 136*(1), e177-193. doi:10.1542/peds.2014-3570

Boundy, E. O., Dastjerdi, R., Spiegelman, D., Fawzi, W. W., Missmer, S. A., Lieberman, E., . . . Chan, G. J. (2016). Kangaroo mother care and neonatal outcomes: A meta-analysis. *Pediatrics, 137*(1), e20152238. doi:10.1542/peds.2015-2238

Boyd, A., Golding, J., Macleod, J., Lawlor, D. A., Fraser, A., Henderson, J., . . . Davey Smith, G. (2013). Cohort Profile: the 'children of the 90s'--the index offspring of the Avon Longitudinal Study of Parents and Children. *International Journal Epidemiology, 42*(1), 111-127. doi:10.1093/ije/dys064

Chawanpaiboon, S., Vogel, J. P., Moller, A.-B., Lumbiganon, P., Petzold, M., Hogan, D., . . . Gülmezoglu, A. M. (2019). Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. *The Lancet Global Health, 7*(1), e37-e46. doi:10.1016/S2214-109X(18)30451-0

Cheong, J. L., Spittle, A. J., Burnett, A. C., Anderson, P. J., & Doyle, L. W. (2020). Have outcomes following extremely preterm birth improved over time? *Seminars in Fetal & Neonatal Medicine, 25*(3), 101114. doi:10.1016/j.siny.2020.101114

Collishaw, S. (2015). Annual research review: Secular trends in child and adolescent mental health. *Journal of Child Psychology & Psychiatry, 56*(3), 370-393. doi:10.1111/jcpp.12372

Collishaw, S., Maughan, B., Goodman, R., & Pickles, A. (2004). Time trends in adolescent mental health. *Journal of Child Psychology & Psychiatry, 45*(8), 1350-1362. doi:10.1111/j.1469-7610.2004.00842.x

Connelly, R., & Platt, L. (2014). Cohort profile: UK Millennium Cohort Study (MCS). *International Journal of Epidemiology, 43*(6), 1719-1725. doi:10.1093/ije/dyu001

Costello, E. J., & Angold, A. (1988). Scales to assess child and adolescent depression: checklists, screens, and nets. *Journal of the American Academy of Child and Adolescent Psychiatry, 27*(6), 726-737. doi:10.1097/00004583-198811000-00011

Curran, E. A., Cryan, J. F., Kenny, L. C., Dinan, T. G., Kearney, P. M., & Khashan, A. S. (2016). Obstetrical Mode of Delivery and Childhood Behavior and Psychological Development in a British Cohort. *Journal of Autism and Developmental Disorders, 46*(2), 603-614. doi:10.1007/s10803-015-2616-1

de Jong, M., Verhoeven, M., & van Baar, A. L. (2012). School outcome, cognitive functioning, and behaviour problems in moderate and late preterm children and adults: a review. *Seminars in Fetal & Neonatal Medicine, 17*(3), 163-169. doi:10.1016/j.siny.2012.02.003

Dunn, P. M. (2007). The birth of perinatal medicine in the United Kingdom. *Seminars in Fetal & Neonatal Medicine, 12*(3), 227-238. doi:10.1016/j.siny.2007.02.001

Eg, J., Bilenberg, N., Costello, E. J., & Wesselhoeft, R. (2018). Self- and parent-reported depressive symptoms rated by the mood and feelings questionnaire. *Psychiatry Research, 268*, 419-425. doi:10.1016/j.psychres.2018.07.016

Elliott, J., & Shepherd, P. (2006). Cohort profile: 1970 British Birth Cohort (BCS70). *International Journal of Epidemiology, 35*(4), 836-843. doi:10.1093/ije/dyl174

Eves, R., von Mühlenen, A., Mendonça, M., Johnson, S., O'Reilly, H., Bartmann, P., . . . Wolke, D. (2020). The Role of Executive and General Cognitive Functioning in the Attention Problems of Very and Extremely Preterm Adults. *Journal of Developmental & Behavioral Pediatrics, 41*(6), 461-469. doi:10.1097/dbp.0000000000000806

Faleschini, S., Matte-Gagné, C., Côté, S., Tremblay, R. E., & Boivin, M. (2020). Trajectories of behavioral problems among moderate-late preterm children from 4 to 10 years: A prospective population-based study. *Early Human Development, 143*, 104964. doi:10.1016/j.earlhumdev.2020.104964

Faleschini, S., Matte-Gagné, C., Luu, T. M., Côté, S., Tremblay, R. E., & Boivin, M. (2020). Trajectories of Overprotective Parenting and Hyperactivity-Impulsivity and

Inattention Among Moderate-Late Preterm Children: A Population-Based Study. *Journal of Abnormal Child Psychology, 48*(12), 1555-1568. doi:10.1007/s10802-020-00704-w

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175-191.

Festinger, L. (1954). A theory of social comparison processes. *Human Relations, 7*, 117-140. doi:10.1177/001872675400700202

Fitzallen, G. C., Sagar, Y. K., Taylor, H. G., & Bora, S. (2021). Anxiety and Depressive Disorders in Children Born Preterm: A Meta-Analysis. *Journal of Developmental & Behavioral Pediatrics* doi:10.1097/dbp.0000000000000898

Fogelman, K. (1983). *Growing Up in Great Britain: Papers from the National Child Development Study*: Macmillan.

Fraser, A., Macdonald-Wallis, C., Tilling, K., Boyd, A., Golding, J., Davey Smith, G., . . . Lawlor, D. A. (2013). Cohort Profile: the Avon Longitudinal Study of Parents and Children: ALSPAC mothers cohort. *International Journal of Epidemiology, 42*(1), 97-110. doi:10.1093/ije/dys066

Goisis, A., Ozcan, B., & Myrskyla, M. (2017). Decline in the negative association between low birth weight and cognitive ability. *PNAS, 114*(1), 84-88. doi:10.1073/pnas.1605544114

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: a research note. *Journal of Child Psychology & Psychiatry, 38*(5), 581-586. doi:10.1111/j.1469-7610.1997.tb01545.x

Gray, R. F., Indurkhya, A., & McCormick, M. C. (2004). Prevalence, stability, and predictors of clinically significant behavior problems in low birth weight children at 3, 5, and 8 years of age. *Pediatrics, 114*(3), 736-743. doi:10.1542/peds.2003-1150-L

Guralnick, M. J. (2012). Preventive interventions for preterm children: effectiveness and developmental mechanisms. *Journal of Developmental & Behavioral Pediatrics, 33*(4), 352-364. doi:10.1097/DBP.0b013e31824eaa3c

Gurka, M. J., LoCasale-Crouch, J., & Blackman, J. A. (2010). Long-term cognition, achievement, socioemotional, and behavioral development of healthy late-preterm infants. *Archives of Pediatrics & Adolescent Medicine, 164*(6), 525-532. doi:10.1001/archpediatrics.2010.83

Hadlock, F. P., Harrist, R. B., & Martinez-Poyer, J. (1991). In utero analysis of fetal growth: a sonographic weight standard. *Radiology, 181*(1), 129-133. doi:10.1148/radiology.181.1.1887021

Horwitz, S. M., Storfer-Isser, A., Kerker, B. D., Lilo, E., Leibovitz, A., St John, N., & Shaw, R. J. (2015). A model for the development of mothers' perceived vulnerability of preterm infants. *Journal of Developmental & Behavioral Pediatrics, 36*(5), 371-380. doi:10.1097/dbp.0000000000000173

Huddy, C. L., Johnson, A., & Hope, P. L. (2001). Educational and behavioural problems in babies of 32-35 weeks gestation. *Archives of Disease in Childhood. Fetal and Neonatal Edition, 85*(1), F23-F28. doi:10.1136/fn.85.1.f23

Johnson, S., Evans, T. A., Draper, E. S., Field, D. J., Manktelow, B. N., Marlow, N., . . . Boyle, E. M. (2015). Neurodevelopmental outcomes following late and moderate prematurity: a population-based cohort study. *Archives of Disease in Childhood. Fetal and Neonatal Edition, 100*(4), F301-308. doi:10.1136/archdischild-2014-307684

Johnson, S., Gilmore, C., Gallimore, I., Jaekel, J., & Wolke, D. (2015). The long-term consequences of preterm birth: what do teachers know? *Developmental Medicine & Child Neurology*, *57*(6), 571-577. doi:10.1111/dmcn.12683

Johnson, S., & Wolke, D. (2013). Behavioural outcomes and psychopathology during adolescence. *Early Human Development*, *89*(4), 199-207. doi:10.1016/j.earlhumdev.2013.01.014

Lahti-Pulkkinen, M., Girchenko, P., Tuovinen, S., Sammallahti, S., Reynolds, R. M., Lahti, J., . . . Räikkönen, K. (2020). Maternal Hypertensive Pregnancy Disorders and Mental Disorders in Children. *Hypertension*, *75*(6), 1429-1438. doi:10.1161/hypertensionaha.119.14140

Livingstone, S., & Smith, P. K. (2014). Annual research review: Harms experienced by child users of online and mobile technologies: the nature, prevalence and management of sexual and aggressive risks in the digital age. *Journal of Child Psychology & Psychiatry, 55*(6), 635-654. doi:10.1111/jcpp.12197

Maher, G. M., O'Keeffe, G. W., Kearney, P. M., Kenny, L. C., Dinan, T. G., Mattsson, M., & Khashan, A. S. (2018). Association of hypertensive disorders of pregnancy with risk of neurodevelopmental disorders in offspring: A systematic review and meta-analysis. *JAMA Psychiatry*, *75*(8), 809–819. https://doi.org/10.1001/jamapsychiatry.2018.0854

March of Dimes, P., Save the Children, WHO. (2012). *Born Too Soon: The Global Action Report on Preterm Birth*. Retrieved from Geneva.

Marlow, N., Ni, Y., Lancaster, R., Suonpera, E., Bernardi, M., Fahy, A., . . . Johnson, S. (2021). No change in neurodevelopment at 11 years after extremely preterm birth. *Archives of Disease in Childhood. Fetal and Neonatal Edition*. doi:10.1136/archdischild-2020-320650

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. *Psychological Bulletin, 143*(4), 347-383. doi:10.1037/bul0000091

McGowan, J. E., Alderdice, F. A., Holmes, V. A., & Johnston, L. (2011). Early childhood development of late-preterm infants: a systematic review. *Pediatrics, 127*(6), 1111-1124. doi:10.1542/peds.2010-2257

Montagna, A., & Nosarti, C. (2016). Socio-Emotional Development Following Very Preterm Birth: Pathways to Psychopathology. *Frontiers in Psychology, 7*(80). doi:10.3389/fpsyg.2016.00080

Morse, S. B., Zheng, H., Tang, Y., & Roth, J. (2009). Early school-age outcomes of late preterm infants. *Pediatrics, 123*(4), e622-629. doi:10.1542/peds.2008-1405

Philip, A. G. (2012). Bronchopulmonary dysplasia: then and now. *Neonatology, 102*(1), 1-8. doi:10.1159/000336030

Plewis, I. (2007). *Millennium Cohort Study First Survey: Technical Report on Sampling* (4th ed.). London: Centre for Longitudinal Studies, Institute of Education, University of London.

Potijk, M. R., de Winter, A. F., Bos, A. F., Kerstjens, J. M., & Reijneveld, S. A. (2012). Higher rates of behavioural and emotional problems at preschool age in children born moderately preterm. *Archives of Disease in Childhood, 97*(2), 112-117. doi:10.1136/adc.2011.300131

Power, C., & Elliott, J. (2006). Cohort profile: 1958 British birth cohort (National Child Development Study). *Int J Epidemiol, 35*(1), 34-41. doi:10.1093/ije/dyi183

Project, E.-P. (2018). *European Perinatal Health Report.* Retrieved from www.europeristat.com

Rhew, I. C., Simpson, K., Tracy, M., Lymp, J., McCauley, E., Tsuang, D., & Stoep, A. V. (2010). Criterion validity of the Short Mood and Feelings Questionnaire and one- and two-item depression screens in young adolescents. *Child and Adolescent Psychiatry and Mental Health, 4*(1), 8. doi:10.1186/1753-2000-4-8

Rodgers, B., Pickles, A., Power, C., Collishaw, S., & Maughan, B. (1999). Validity of the Malaise Inventory in general population samples. *Social Psychiatry and Psychiatric Epidemiology, 34*(6), 333-341. doi:10.1007/s001270050153

Rogers, C. E., Lenze, S. N., & Luby, J. L. (2013). Late preterm birth, maternal depression, and risk of preschool psychiatric disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 52*(3), 309-318. doi:10.1016/j.jaac.2012.12.005

Rutter, M., Tizard, J., & Whitmore, K. (1970). *Education, Health and Behaviour*. London: Longman.

Shapiro-Mendoza, C. K., & Lackritz, E. M. (2012). Epidemiology of late and moderate preterm birth. *Seminars in Fetal and Neonatal Medicine, 17*(3), 120-125. doi:10.1016/j.siny.2012.01.007

Silva, D., Colvin, L., Hagemann, E., & Bower, C. (2014). Environmental risk factors by gender associated with attention-deficit/hyperactivity disorder. *Pediatrics, 133*(1), e14-22. doi:10.1542/peds.2013-1434

Stone, L. L., Otten, R., Engels, R. C. M. E., Vermulst, A. A., & Janssens, J. M. A. M. (2010). Psychometric properties of the parent and teacher versions of the strengths and difficulties questionnaire for 4- to 12-year-olds: a review. *Clinical Child and Family Psychology Review, 13*(3), 254-274. doi:10.1007/s10567-010-0071-2

Sweeting, H., West, P., Young, R., & Der, G. (2010). Can we explain increases in young people's psychological distress over time? *Social Science & Medicine, 71*(10), 1819-1830. doi:10.1016/j.socscimed.2010.08.012

Talge, N. M., Holzman, C., Wang, J., Lucia, V., Gardiner, J., & Breslau, N. (2010). Late-preterm birth and its association with cognitive and socioemotional outcomes at 6 years of age. *Pediatrics, 126*(6), 1124-1131. doi:10.1542/peds.2010-1536

Toscano, C., Soares, I., & Mesman, J. (2020). Controlling Parenting Behaviors in Parents of Children Born Preterm: A Meta-Analysis. *Journal of Developmental & Behavioral Pediatrics, 41*(3), 230-241. doi:10.1097/dbp.0000000000000762

Turner, N., Joinson, C., Peters, T. J., Wiles, N., & Lewis, G. (2014). Validity of the Short Mood and Feelings Questionnaire in late adolescence. *Psychological Assessment, 26*(3), 752-762. doi:10.1037/a0036572

Twenge, J. M., Gentile, B., DeWall, C. N., Ma, D., Lacefield, K., & Schurtz, D. R. (2010). Birth cohort increases in psychopathology among young Americans, 1938-2007: A cross-temporal meta-analysis of the MMPI. *Clinical Psychology Review, 30*(2), 145-154. doi:10.1016/j.cpr.2009.10.005

van Baar, A. L., Vermaas, J., Knots, E., de Kleine, M. J., & Soons, P. (2009). Functioning at school age of moderately preterm children born at 32 to 36 weeks' gestational age. *Pediatrics, 124*(1), 251-257. doi:10.1542/peds.2008-2315

Walsh, J. M., Doyle, L. W., Anderson, P. J., Lee, K. J., & Cheong, J. L. (2014). Moderate and late preterm birth: effect on brain size and maturation at term-equivalent age. *Radiology, 273*(1), 232-240. doi:10.1148/radiol.14132410

Westrupp, E. M., Mensah, F. K., Giallo, R., Cooklin, A., & Nicholson, J. M. (2012). Mental health in low-to-moderate risk preterm, low birth weight, and small for gestational age children at 4 to 5 years: the role of early maternal parenting. *Journal of the American Academy of Child and Adolescent Psychiatry, 51*(3), 313-323. doi:10.1016/j.jaac.2011.12.004

Wolke, D., Strauss, V. Y., Johnson, S., Gilmore, C., Marlow, N., & Jaekel, J. (2015). Universal gestational age effects on cognitive and basic mathematic processing: 2 cohorts in 2 countries. *The Journal of Pediatrics, 166*(6), 1410-1416.e1411-1412. doi:10.1016/j.jpeds.2015.02.065

Wolke, D., Waylen, A., Samara, M., Steer, C., Goodman, R., Ford, T., & Lamberts, K. (2009). Selective drop-out in longitudinal studies and non-biased prediction of behaviour disorders. *The British Journal of Psychiatry, 195*(3), 249-256. doi:10.1192/bjp.bp.108.053751

Woythaler, M. A., McCormick, M. C., & Smith, V. C. (2011). Late preterm infants have worse 24-month neurodevelopmental outcomes than term infants. *Pediatrics, 127*(3), e622-629. doi:10.1542/peds.2009-3598

Yates, R., Treyvaud, K., Doyle, L. W., Ure, A., Cheong, J. L. Y., Lee, K. J., . . . Anderson, P. J. (2020). Rates and Stability of Mental Health Disorders in Children Born Very Preterm at 7 and 13 Years. *Pediatrics, 145*(5), e20192699. doi:10.1542/peds.2019-2699

Table 1. Characteristics of Participants in Four Cohorts

	NCDS	BCS70	ALSPAC	MCS
			Early Childhood	
	N= 11083	N= 9108	N= 7739	N= 12376
MLPT: N (%)	497 (4.5%)	428 (4.7%)	378 (4.9%)	888 (7.2%)
Female: N (%)	5347 (48.2%)	4388 (48.2%)	3789 (48.9%)	6126 (49.5%)
First born: N (%)	3992 (36%)	3337 (36.6%)	3628 (46.9%)	5181 (41.9%)
Multiple birth: N (%)	285 (2.6%)	190 (2.09%)	170 (2.19%)	310 (2.5%)
Neurosensory impairment: N (%)	91 (0.8%)	28 (0.3%)	41 (0.5%)	275 (%)
Ethnic minority group: N (%)	161 (1.5%)	197 (2.2%)	285 (3.7%)	1736 (14%)
Parental education below tertiary: N (%)	7007 (63.2%)	4690 (51.5%)	2575 (33.3%)	2745 (22.2%)
Maternal Age: M (SD)	27.54 (5.88)	26.39 (5.5)	28.79 (4.42)	28.96 (6.01)
Smoking During Pregnancy: N (%)	4420 (39.9%)	4661 (51.2%)	1261 (16.3%)	2671 (21.6%)
			Late Childhood	
	N= 9796	N= 9100	N= 6427	N= 11769
MLPT: N (%)	448 (4.6%)	419 (4.6%)	303 (4.7%)	847 (7.2%)
Female: N (%)	4729 (48.3%)	4430 (48.7%)	3235 (50.3%)	5867 (49.9%)
First born: N (%)	3507 (35.8%)	3349 (36.8%)	3039 (47.3%)	4925 (41.8%)
Multiple birth: N (%)	247 (2.5%)	196 (2.2%)	126 (1.9%)	296 (2.5%)
Neurosensory impairment: N (%)	77 (0.8%)	24 (0.3%)	36 (0.6%)	269 (2.3%)
Ethnic minority group: N (%)	153 (1.6%)	264 (2.9%)	212 (3.3%)	1739 (14.8%)
Parental education below tertiary: N (%)	6163 (62.9%)	4671 (51.3%)	2057 (32%)	2650 (22.5%)
Maternal Age: M (SD)	27.53 (5.86)	26.28 (5.55)	28.98 (4.36)	28.94 (5.96)
Smoking During Pregnancy: N (%)	3901 (39.8%)	4679 (51.4%)	936 (14.6%)	2498 (21.2%)
			Adolescence	
	N= 8091	N= 5959	N= 4965	N= 10374
MLPT: N (%)	354 (4.4%)	282 (4.7%)	240 (4.8%)	733 (7.1%)
Female: N (%)	3931 (48.6%)	3036 (50.9%)	2588 (52.1%)	5179 (49.9%)
First born: N (%)	2960 (36.6%)	2310 (38.8%)	2435 (49%)	4357 (41.9%)
Multiple birth: N (%)	211 (2.61%)	120 (2.01%)	95 (1.91%)	245 (2.36%)
Neurosensory impairment: N (%)	57 (0.70%)	16 (0.27%)	34 (0.68%)	278 (2.68%)
Ethnic minority group: N (%)	111 (1.37%)	133 (2.23%)	168 (3.38%)	1703 (16.4%)
Parental education below tertiary: N (%)	5111 (63.2%)	2871 (48.2%)	1462 (29.5%)	2205 (21.3%)
Maternal Age: M (SD)	27.35 (5.83)	26.27 (5.59)	29.14 (4.41)	29.05 (5.95)
Smoking During Pregnancy: N (%)	3224 (39.8%)	2948 (49.5%)	646 (13%)	2084 (20.1%)

NCDS: National Child Development Study; BCS70: British Child Development Study; ALSPAC: Avon Longitudinal Study of Parents and Children; MCS: Millennium Cohort Study; MLPT: Moderate to Late Preterm

Table 2. Standardized difference estimates between MLPT and FT born individuals in emotional problems, hyperactivity and conduct problems

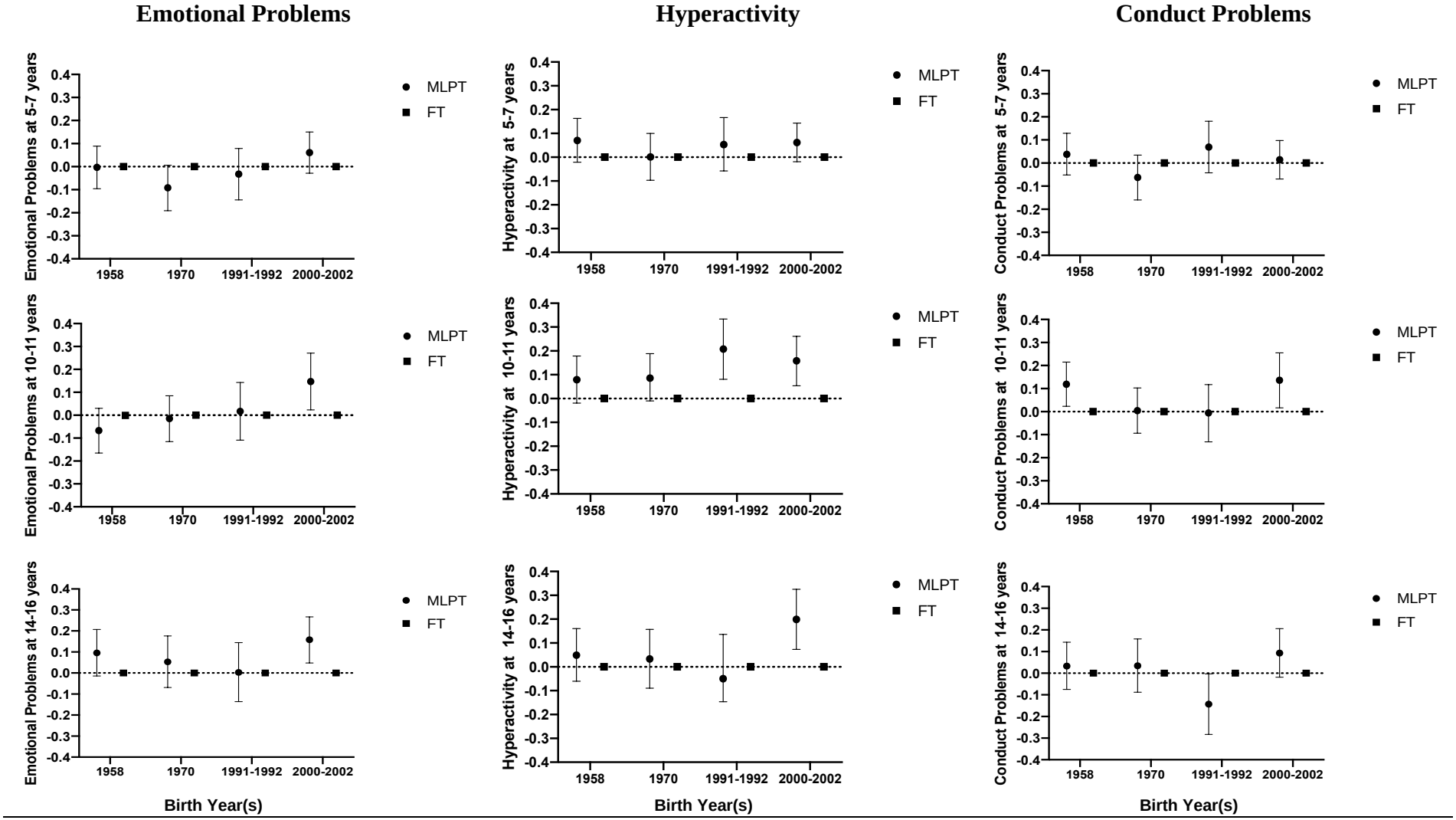
	NCDS β (SE), 95% CI	BCS70 β (SE), 95% CI	ALSPAC β (SE), 95% CI	MCS β (SE), 95% CI
Early Childhood (5-7 years)				
Emotional Problems	-.003 (.047), (-.096; .089)	-.092 (.050), (-.191; .006)	-.032 (.057), (-.144; .079)	.061 (.045), (-.028; .150)
Hyperactivity	.070 (.047), (-.021; .163)	.001 (.050), (-.097; .100)	.053 (.057), (-.058; .166)	.062 (.041), (-.019; .143)
Conduct Problems	.038 (.046), (-.052; .129)	-.062 (.049), (-.160; .034)	.069 (.057), (-.042; .181)	.014 (.042), (-.069; .098)
Late Childhood (10-11 years)				
Emotional Problems	-.067 (.050), (-.165; .030)	-.015 (.051), (-.116; .085)	.017 (.064), (-.109; .143)	**.147 (.063), (.023; .271)**
Hyperactivity	.079 (.050), (-.019; .178)	.086 (.050), (-.010; .188)	**.208 (.064), (.081; .334)**	**.158 (.052), (.054; .261)**
Conduct Problems	**.119 (.049), (.023; .215)**	.004 (.050), (-.094; .103)	-.006 (.063), (-.131; .118)	**.136 (.060), (.016; .255)**
Adolescence (14-16 years)				
Emotional Problems	.096 (.056), (-.014; .207)	.053 (.062), (-.069; .176)	.003 (.071), (-.136; .144)	**.158 (.055), (.048; .267)**
Self-Reported Emotional Problems*	-	-.039 (.081), (-.199; .120)	-.051 (.074), (-.196; .093)	.060 (.050), (-.038; .160)
Hyperactivity	.049 (.056), (-.060; .160)	.033 (.063), (-.090; .157)	-.005 (.072), (-.146; .136)	**.199 (.064), (.073; .325)**
Conduct Problems	.033 (.055), (-.075; .143)	.034 (.062), (-.088; .158)	**-.143 (.071), (-.283; -.003)**	.093 (.057), (-.018; .206)

NCDS: National Child Development Study; BCS70: British Child Development Study; ALSPAC: Avon Longitudinal Study of Parents and Children; MCS: Millennium Cohort Study; MLPT: Moderate to Late Preterm; FT: Full-Term

Adjusted for sex, multiple birth, parity, minority ethnicity, low parental education, neurosensory impairment, maternal age, foetal growth restriction, smoking during pregnancy

Boldface type indicates statistically significant differences.

Figure 1. Standardized beta coefficients showing change in mother-rated emotional problems, hyperactivity and conduct problems by gestational age (moderate to late preterm and full-term)



1958: National Child Development Study (NCDS); 1970: British Child Development Study (BCS70); 1991-1992: Avon Longitudinal Study of Parents and Children (ALSPAC); 2000-2002: Millennium Cohort Study (MCS); MLPT: Moderate to Late Preterm; FT: Full-Term