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Authors

Thompson, Sarah

Treyvaud, Karli

Pascoe, Leona

et al.

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ORIGINAL ARTICLE

Trajectories of social outcomes in individuals born very preterm from childhood to adolescence

Sarah C. H. Thompson^{1,2}  | Karli Treyvaud³ | Leona Pascoe^{1,4} | Rheanna M. Mainzer^{5,6} | Thi-Nhu-Ngoc Nguyen² | Terrie E. Inder^{7,8} | Lex W. Doyle^{2,9,10} | Peter J. Anderson^{1,2,7,8} 

¹School of Psychological Sciences, Monash University, Clayton, Victoria, Australia

²Clinical Sciences, Murdoch Children's Research Institute, Parkville, Victoria, Australia

³School of Psychology and Public Health, La Trobe University, Bundoora, Victoria, Australia

⁴Centre for Community and Child Health, Murdoch Children's Research Institute, Parkville, Victoria, Australia

⁵Clinical Epidemiology and Biostatistics Unit, Murdoch Children's Research Institute, Parkville, Victoria, Australia

⁶Department of Paediatrics, University of Melbourne, Parkville, Victoria, Australia

⁷Center for Neonatal Research, Children's Hospital of Orange County, Orange County, California, USA

⁸Department of Pediatrics, School of Medicine, University of California Irvine, Orange County, California, USA

⁹Department of Obstetrics, Gynaecology and Newborn Health, University of Melbourne, Parkville, Victoria, Australia

¹⁰Newborn Research Centre, The Royal Women's Hospital and University of Melbourne, Parkville, Victoria, Australia

Correspondence

Peter J. Anderson, School of Psychological Sciences, Monash University, Room 537, 18 Innovation Walk, Wellington Road, Clayton, VIC 3800, Australia.

Email: peter.j.anderson@monash.edu

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Abstract

Aim: To compare trajectories of social functioning in peer problems and prosocial behavior from 5 to 13 years between individuals born very preterm (VPT) and full-term (FT).

Methods: Participants were from the Victorian Infant Brain Study (VIBeS) longitudinal cohort, consisting of 224 individuals born VPT and 77 born FT recruited at birth. Social functioning was measured using the parent-rated Strengths and Difficulties Questionnaire (SDQ) peer problems and prosocial behavior subscales at 5, 7, and 13 years' corrected age. Multilevel mixed effects models were fitted.

Results: Peer problems increased with age (adjusted mean difference per year=0.04, 95% confidence interval [CI]=0.01, 0.07, $p=0.02$), with higher peer problems in the VPT compared with the FT group (adjusted mean difference between groups=0.46, 95% CI=0.06, 0.86, $p=0.02$). Prosocial behavior increased from early to middle childhood and decreased approaching adolescence, but was similar between VPT and FT groups (adjusted mean difference between groups=-0.05, 95% CI=-0.50, 0.40, $p=0.82$).

Conclusion: Children born VPT are at greater risk for peer problems than FT peers and may benefit from receiving greater early social support.

Abbreviations: ASD, Autism Spectrum Disorder; FT, Full Term; SDQ, Strengths and Difficulties Questionnaire; VPT, Very Preterm.

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KEYWORDS

adolescence, childhood, development, prematurity, social functioning

1 | INTRODUCTION

Children born very preterm (VPT; <32 weeks' gestation) or very low birth weight (<1500g) display greater vulnerability to a range of neurodevelopmental difficulties compared with their full-term (FT) counterparts.¹⁻⁵ Social functioning is a key developmental outcome that is also affected, but less often reported. Social functioning refers to the ability to use social skills to adapt behavior and emotions to social contexts, facilitating interpersonal relationships.

Higher rates of social problems, which include greater interpersonal peer issues and reduced social skills, have been reported in children born VPT as young as 2 years through to adolescence compared with children born full-term (FT).⁶⁻¹¹ Some have reported additional sex differences, showing that VPT boys compared with FT boys experience greater bullying, while VPT girls compared with FT girls face greater social isolation.^{11,12} Findings are mixed for prosocial behavior, with most studies observing no differences between VPT and FT groups,^{9,13-17} while a select few report worse prosocial behavior in VPT children.^{1,15,18,19}

VPT children exhibit different developmental trajectories compared with FT children.^{12,20-22} Some studies have reported an increasing gap for social difficulties between VPT and FT groups into adolescence, e.g., for social withdrawal.^{4,12,23} Nadeau et al. observed that VPT individuals have heightened rates of social isolation compared with FT individuals that remain stable during childhood.¹² Hosozawa et al. found that social competence difficulties (combined peer problems and prosocial behavior) followed u-shaped trajectories from childhood to adolescence that were similar across VPT, moderate-late preterm, early-term, and FT groups, although the VPT group consistently exhibited the greatest difficulties at each timepoint.²⁰ Thus, to date, findings relating to longitudinal studies regarding the trajectories of social functioning in individuals born VPT during childhood have varied.

This study aimed to describe trajectories of social functioning in peer problems and prosocial behavior from 5 to 13 years in VPT and FT children. We hypothesized that VPT children would display poorer social functioning compared with FT children that would worsen into adolescence, particularly in the peer problems domain.

2 | PATIENTS AND METHODS

2.1 | Participants

Participants were from the Victorian Infant Brain Study (ViBeS) longitudinal cohort, initially comprising 224 individuals born <30 weeks' gestation or with a birthweight <1250g. They were recruited shortly after birth between July 2001 and December 2003 from the Royal

Key notes

- Children born very preterm (VPT) display increased social difficulties compared with full-term (FT) peers; however, how social functioning develops throughout childhood for individuals born VPT is unclear.
- Peer problems were persistently higher among children born VPT relative to FT peers, but prosocial behavior was similar between groups.
- It is important to monitor social functioning in children born VPT who may benefit from receiving early social support.

Women's Hospital, Melbourne. A comparison group of 77 individuals born FT (37-41 weeks' gestation) was recruited, of whom 46 were recruited at birth from the Royal Women's Hospital and 31 recruited at 2 years of age from Maternal and Child Health Centres in Victoria. One individual born FT was later excluded due to experiencing neonatal complications. Participants were assessed at 2 (219 VPT; 74 FT), 5 (194 VPT; 68 FT), 7 (197 VPT; 69 FT), and 13 (79 VPT; 61 FT) years' corrected age (Figure 1). Ethical approval was obtained from the Human Research and Ethics Committees of the Royal Women's Hospital and Royal Children's Hospital, Melbourne.

2.2 | Procedures

Follow-up assessments were administered at 2, 5, 7, and 13 years of age, corrected for prematurity, with informed consent obtained from primary caregivers at each follow-up. Parents of participants completed demographic, emotional, behavioral, and social functioning questionnaires at 5, 7, and 13 years.

2.3 | Measures

2.3.1 | Social functioning

Social functioning was measured with the peer problems and prosocial behavior subscales from the Strengths and Difficulties Questionnaire (SDQ)²⁴ at ages 5, 7 and 13 years. The SDQ is a 25-item parent-rated questionnaire designed to screen behavioral, emotional, and social functioning in children and adolescents. The peer problems subscale includes items such as 'has at least one good friend' and 'picked on or bullied by other children', while the prosocial behavior subscale includes items such as 'often volunteers to

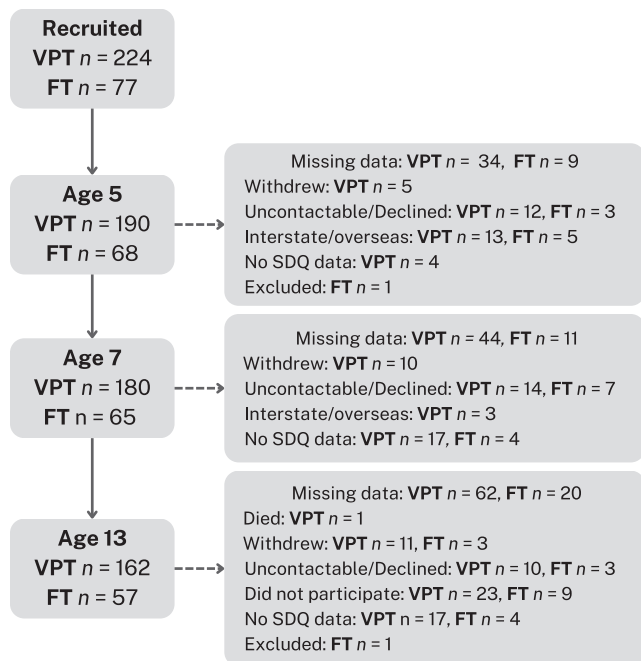


FIGURE 1 Participant flowchart of those with data at each time point where SDQ was measured. FT, Full term; SDQ, Strengths and Difficulties Questionnaire; VPT, Very preterm.

help others' and 'shares readily with other children'. Both subscales comprise 5-items, each measured using a 3-point Likert scale (0 = not true, 1 = somewhat true, 2 = certainly true), which are summed to produce a subscale score ranging from 0 to 10. Higher scores on the peer problems subscale indicate more problematic behavior, and for this study we classified 'at-risk' as scores ≥ 3 (British categorisation: normal = 0–2, borderline = 3, abnormal = 4–10). Higher scores on the prosocial behavior subscale indicate higher positive adaptive social behaviors, and for this study we classified 'at-risk' as scores ≤ 5 (normal = 6–10, borderline = 5, abnormal = 0–4).²⁵

2.3.2 | Perinatal data

Perinatal data including sex, gestational age, birth weight, multiple births (singleton/multiple), neonatal brain injury, neonatal infection, and bronchopulmonary dysplasia were collected from hospital records. Family social risk was evaluated at age 2 years, using an index that included family structure, maternal age, primary carer education, primary income earner occupation and employment status, and primary language spoken at home.²⁶ Scores were dichotomised around the median, with ≥ 2 reflecting higher social risk compared with lower social risk (< 2).²⁶

2.4 | Statistical analyses

Data were analysed using Stata version 17.0. Mean trajectories of peer problems and prosocial behavior from 5 to 13 years in individuals

born VPT and FT were described using multilevel mixed effects models that included fixed effects for birth group, age (as a continuous variable), sex and social risk, and random effects for individuals (slopes and intercepts). Individual trajectories over time for both outcomes were plotted and examined to inform model form (linear or quadratic term for age). Formal hypothesis testing was performed for the linear and quadratic terms for age to see whether these improved model specifications and for the inclusion of an interaction between birth group and age. For outcomes where there was little evidence for an interaction between group and age, results are reported from the model without the interaction term included. Results are presented as graphs of the marginal mean trajectories in outcomes as a function of age and group, with 95% confidence intervals (CIs).

Secondary analyses were undertaken examining differences in social functioning between birth groups in males and females. Additional analyses were also undertaken to examine differences in birth groups after excluding children with neurosensory impairments (moderate–severe cerebral palsy, blindness, or deafness) assessed at age 2, cognitive impairment (those with a full-scale IQ < 70 assessed according to the Wechsler Abbreviated Scale of Intelligence (WASI))²⁷ or a diagnosis of autism spectrum disorder (ASD) on the developmental and wellbeing assessment (DAWBA)^{26,28} assessed at age 7 ($n = 23$).

3 | RESULTS

The number of participants with parent-reported SDQ data available at each age is shown in [Figure 1](#). [Table 1](#) summarises the characteristics of those included in the analysis, i.e. who had SDQ data for at least one timepoint (282 total; 207 VPT and 75 FT). As expected, the VPT group had a higher rate of neonatal complications and multiple births than the FT group. Over half of the VPT group showed elevated social risk, compared with less than a third of the FT group. Parents of children in the VPT group tended to report more peer problems than the FT group at ages 5, 7, and 13 years, while similar prosocial behaviors were reported by parents in both groups. The percentage of participants in the 'at-risk' range for peer problems was higher for the VPT group at each timepoint than the FT group. The percentage of participants in the 'at-risk' range for prosocial behavior was similar at each time point for the two groups.

[Table S2](#) outlines the sample characteristics of those included and excluded from the analysis (i.e., with and without SDQ data) in the VPT group, which had missing data for 17 participants. There was only 1 FT participant with missing data (male, gestational age = 40 wks, birthweight = 2752 kg). VPT participants had slightly elevated rates of neonatal complications and were of higher social risk than VPT non-participants.

3.1 | Trajectories of social functioning

A linear model was specified for describing the mean trajectory of peer problems, while a model that included a quadratic term for age

TABLE 1 Sample characteristics for those with SDQ data for at least one time point.

Characteristics	Participants with SDQ data	
	VPT (n = 207)	FT (n = 75)
Female, n (%)	100.0 (48.0%)	39.0 (52.0%)
Gestational age (weeks), M (SD)	27.5 (1.9)	39.2 (1.3)
Birth weight (grams), M (SD)	968.3 (217.9)	3313.4 (514.6)
Multiple birth, n (%)	88.0 (42.5%)	4.0 (5.4%)
Severe brain injury ^a , n (%)	15.0 (7.2%)	-
Neonatal infection ^b , n (%)	72.0 (34.8%)	-
Bronchopulmonary dysplasia ^c , n (%)	70.0 (33.82%)	-
Higher social risk at 2 years, n (%)	111.0 (53.6%)	23.0 (30.7%)
Single parent household	27.0 (11.1%)	4.0 (5.3%)
Maternal age at birth <21 years	11.0 (5.3%)	2.0 (2.6%)
Primary income earner unemployed	34.0 (16.4%)	4.0 (5.3%)
Primary income earner unskilled occupation	57.0 (27.5%)	14.0 (18.7%)
Language other than English spoken at home	22.0 (10.6%)	6.0 (8.0%)
Primary carer highest education level completed less than Year 12	25.0 (12.1%)	1.0 (1.3%)
Age at assessment, M (SD) range		
Age 5	5.4 (0.4) 4.5–5.8	5.0 (0.2) 4.7–6.3
Age 7	7.5 (0.3) 6.6–8.4	7.7 (0.3) 6.8–8.4
Age 13	13.3 (0.4) 11.8–14.9	13.2 (0.5) 12–14.3
Peer problems, M (SD), % at-risk ^d		
Age 5	1.8 (1.9), 44.4%	1.0 (1.4), 21.3%
Age 7	1.8 (1.8), 47.8%	1.3 (1.3), 32.0%
Age 13	2.0 (2.0), 58.0%	1.3 (1.5), 37.3%
Prosocial behavior, M (SD), % at-risk ^d		
Age 5	8.0 (2.0), 12.1%	8.0 (2.1), 13.3%
Age 7	8.4 (1.8), 8.2%	8.7 (1.6), 5.3%
Age 13	8.4 (1.9), 8.7%	8.4 (1.8), 9.3%

Abbreviations: M, mean; n, number; SD, standard deviation; SDQ, Strengths and Difficulties Questionnaire.

^aSevere brain injury = presence of either grade III/IV intraventricular haemorrhage or cystic periventricular leukomalacia as detected by neonatal cranial ultrasound.

^bNeonatal infection = confirmed sepsis or necrotising enterocolitis.

^cBronchopulmonary dysplasia = oxygen dependency at 36 weeks' postmenstrual age.

^dPercentage at-risk (borderline and abnormal) categorised according to British SDQ norms (4–17).²⁵

was specified for describing the mean trajectory of prosocial behavior (Figure S1A,B, Table S1).

3.1.1 | Peer problems

Peer problems were greater in individuals born VPT compared with those born FT (adjusted mean difference = 0.46, 95% confidence interval (CI) = 0.06, 0.86, $p = 0.02$; Figure 2A), and increased with age (adjusted mean difference per year = 0.04, 95% CI = 0.01, 0.07, $p = 0.02$). Overall, the model was significant despite the overlapping confidence intervals illustrated in Figure 2A. There was little evidence that the effect of birth group on peer problems varied by age (adjusted mean difference = 0.01, 95% CI = -0.06, 0.08, $p = 0.80$).

There was little evidence of an effect of birth group on peer problems for males (adjusted mean difference = 0.28, 95% CI = -0.33, 0.88, $p = 0.37$; Figure 3A). Peer problems were greater in females born VPT compared with those born FT (adjusted mean difference = 0.60, 95% CI = 0.07, 1.11, $p = 0.03$; Figure 3B). Mean peer problems increased at a similar rate for males (adjusted mean difference = 0.02, 95% CI = -0.02, 0.06, $p = 0.27$) and females (adjusted mean difference = 0.05, 95% CI = 0.01, 0.09, $p = 0.02$) over time, although mean peer problems were slightly greater in males than females between groups.

Results of secondary analyses excluding children with a neurosensory impairment, cognitive impairment, or an ASD diagnosis found mean peer problems in individuals born VPT were higher compared with those born FT; however, confidence intervals were

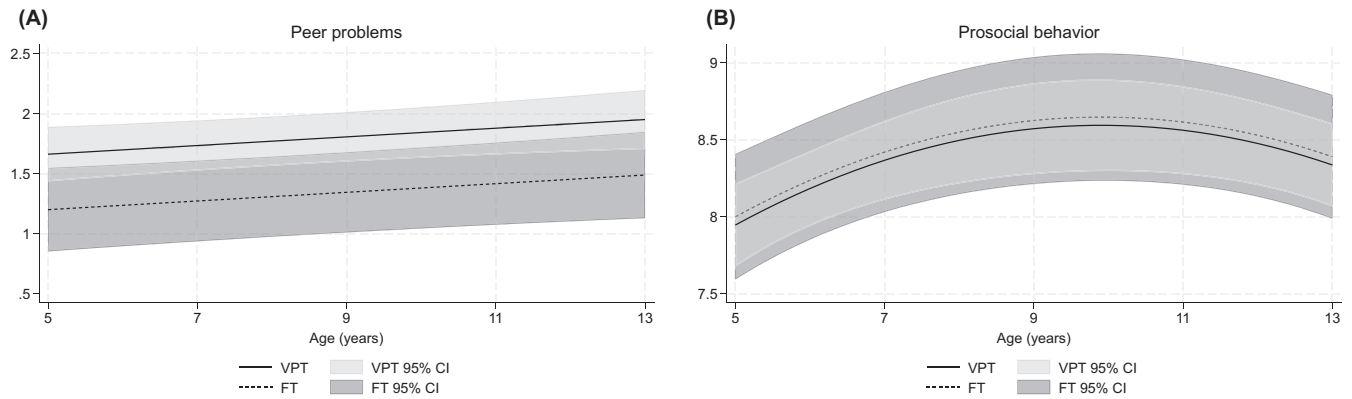


FIGURE 2 Mean trajectories in (A) peer problems and (B) prosocial behavior for individuals born very preterm (VPT) and full-term (FT) between age 5 and 13 years, presented with 95% confidence intervals (CIs) while controlling for sex and social risk.

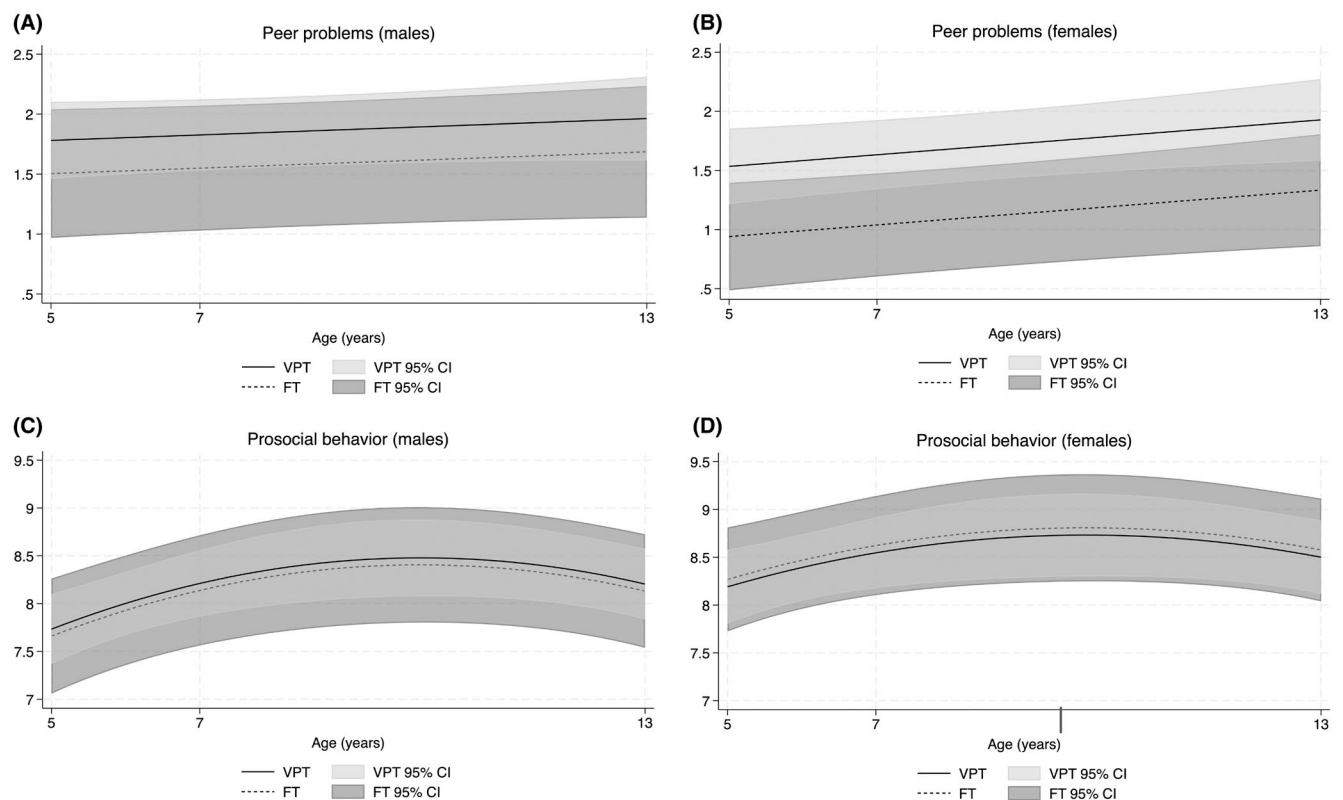


FIGURE 3 Mean trajectories in peer problems and prosocial behavior for (A,C) males and (B,D) females born very preterm (VPT) and full-term (FT) between age 5 and 13 years, presented with 95% confidence intervals (CIs) while controlling for social risk.

wide (adjusted mean difference=0.46, 95% confidence interval (CI)=0.06, 0.86; $p=0.02$; Figure 4A). There was little evidence that the effect of birth group on peer problems varied by age (interaction $p=0.87$).

3.1.2 | Prosocial behavior

Prosocial behavior was similar between the VPT and FT groups (adjusted mean difference=-0.05, 95% CI=-0.50, 0.40, $p=0.82$; Figure 2B). Mean prosocial behavior increased from early to middle

childhood and then stabilised before decreasing when approaching adolescence. There was little evidence to suggest that the effect of birth group on prosocial behavior varied by age (adjusted mean difference=-0.001, 95% CI=-0.07, 0.07, $p=0.97$).

There was little evidence to suggest that the effect of birth group on prosocial behavior varied by sex for both males (adjusted mean difference=0.07, 95% CI=-0.59, 0.73, $p=0.83$; Figure 3C) and females (adjusted mean difference=-0.08, 95% CI=-0.68, 0.53, $p=0.80$; Figure 3D). Prosocial behavior was similar between males and females over time, which increased from early to middle childhood and then stabilised before decreasing when approaching

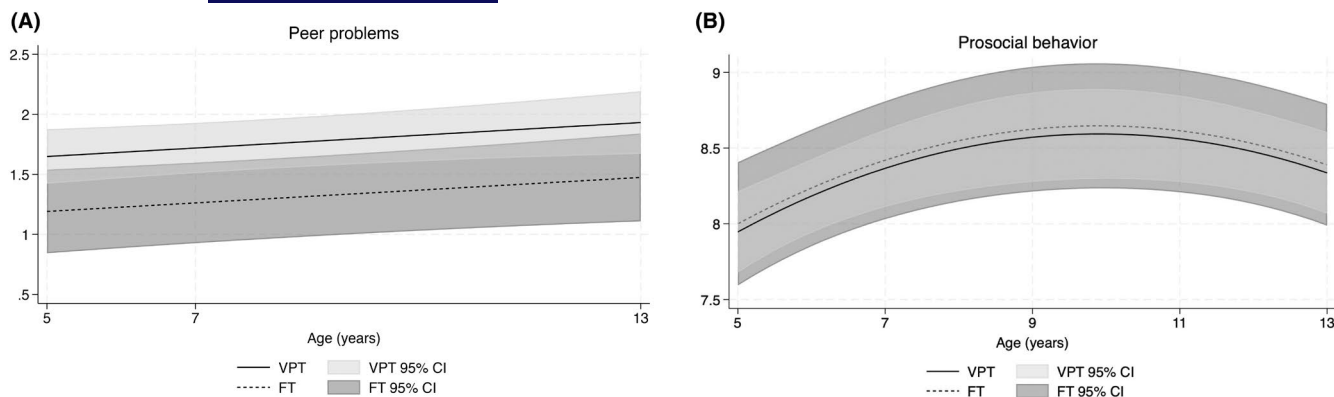


FIGURE 4 Mean trajectories in (A) peer problems and (B) prosocial behavior for individuals born very preterm (VPT) and full-term (FT) between age 5 and 13 years excluding individuals with neurosensory impairment, cognitive impairment, or a diagnosis of Autism spectrum disorder (ASD), presented with 95% confidence intervals (CIs) while controlling for sex and social risk.

adolescence, although mean prosocial behavior was slightly greater in females than males.

Results of secondary analyses excluding children with a neurosensory impairment, cognitive impairment, or an ASD diagnosis found little evidence for differences in prosocial behavior in those born VPT compared with those born FT (adjusted mean difference = -0.05 , 95% CI = -0.50 , 0.40 ; $p = 0.82$; Figure 4B). Mean prosocial behavior increased from early to middle childhood and then stabilised before decreasing when approaching adolescence. There was little evidence to suggest that the effect of birth group on prosocial behavior varied by age (interaction $p = 0.80$).

4 | DISCUSSION

This study examined trajectories of social functioning in peer problems and prosocial behavior from childhood to adolescence in VPT and FT born individuals. We found peer problems increased from early childhood to adolescence, although peer problems were consistently higher in the VPT group relative to FT controls at all ages. Prosocial behavior showed similar patterns for both groups, increasing in middle childhood before decreasing approaching adolescence.

Our finding of persistently higher peer problems in individuals born VPT compared with their FT peers is consistent with previous research.^{4,12,20,23} Approximately one half (44%–58%) of the VPT group fell within the ‘at-risk’ range for peer problems, reflecting a 1.5–2.1 times increase in risk compared with the FT group. The increase in peer problems with age regardless of birth group, aligns with past developmental studies.^{4,23} Linsell et al. reported a similar upward trajectory until 16 years, wherein those born VPT showed consistently greater problems.⁴ Johns et al. similarly noted an increase in peer problems until age 12, followed by a decrease in both groups thereafter.²³ Reyes et al. found peer problems remained consistently ‘low’ or ‘high’ from childhood to early adulthood, with VPT status associated with higher problems.²² Research using

relational measures has reported more variable patterns of social functioning over time. Some have reported inverse u-shaped or dynamic patterns for both groups, similarly indicating adolescence to be a period of marked social difficulties, particularly for those born VPT.^{20,22} In contrast, others have noted stability for children born FT but increased problems with victimisation for those born VPT.¹² Heterogeneity in study findings may be related to factors including variability in follow-up age, different informants, gestational age of the VPT cohort, and outcome measurements. Despite mixed findings on how social behavior and relationships change across childhood, studies using teacher- and parent-rated peer relationship measures provide evidence that overall VPT children and adolescents display greater social problems compared with their FT peers which persist and sometimes worsen with time.^{4,6,8,10,23,29,30} This could have long-lasting implications for a range of outcomes including mental health, academic and occupational achievement, and their overall quality of life.

We found little difference in prosocial behavior between groups from ages 5 to 13 years. The overall trajectory of prosocial behavior showed a marked increase from age 5 to 7 that preceded a period of stability in middle childhood, followed by a decrease. A relatively small proportion of children across both birth groups were classified in the ‘at-risk’ range for prosocial behavior compared with peer problems, with a 4%–8% decrease in ‘at-risk’ scores from ages 5 to 7 followed by a 0.5%–4% increase from ages 7 to 12. This inverse ‘u-shaped’ trajectory aligns with previous developmental literature, which has reported an increase in prosocial behaviors between 6 and 11 years and a decrease approaching 16 years.⁴ Young children typically demonstrate more positive and engaging interpersonal behaviors when adapting to school and fostering new relationships, whereas in later childhood, more self- and peer-focused behaviors emerge during the transition to high school. Dissimilarly, other studies have reported an increase in mean prosocial behaviors for both groups until age 16.²³ Most studies have similarly observed little difference in prosocial behavior between birth groups.^{9,13–17,31} In the few studies that reported poorer prosocial behavior in VPT children compared with FT peers, these differences were related to lower

gestational age (<28 weeks) and/or neurodevelopmental delays, including intellectual disabilities.^{1,15,18,19} Differences in social behavior primarily pertain to social withdrawal, where individuals born VPT have displayed persistently higher,¹² or worsening issues with age compared to those born FT.²³ Our finding of little evidence for group differences may reflect the relatively low number of children with moderate–severe neurodevelopmental impairments or the measure of social behavior used.

Our finding of greater peer problems among VPT compared to FT born females should be interpreted cautiously due to limited power in the subgroup analysis. Sex differences in social behavior between VPT and FT born females have been noted in past research, evidenced by greater social isolation among VPT-born females compared to their FT peers.¹² Sex differences between groups have also been reported at particular time points, for instance, worse prosocial behavior and adaptive behavior in VPT females and worse maladaptive behavior in VPT males at age 8 but not age 12, relative to FT counterparts.⁹ Differences in study findings pertaining to sex may be attributed to sample sizes, measures, and timepoints, warranting further exploration.

Our findings suggest that individuals born VPT display similar developmentally appropriate positive adaptive behaviors for social interaction compared with their FT peers. These behaviors are distinct from peer relationships at school and do not reflect closeness with family, siblings, or other adults. Past studies have shown greater closeness between VPT adolescents and parents compared with FT dyads and greater peer discord for VPT adolescents from lower socioeconomic backgrounds.³² Increased peer problems among VPT children may be related to characteristics associated with VPT birth, such as underlying cognitive or developmental challenges. Studies have linked poorer general cognitive abilities and poorer peer relationships,^{10,22} which may potentially contribute to misunderstandings between VPT children and their peers. Temperament may also explain discrepancies between social functioning outcomes. Personality studies of VPT adults indicate greater shyness and worry and less social engagement and risk-taking behavior compared with those born FT.^{33,34} These attributes suggest those born VPT may be more reserved, due to a potential preference to be alone or sensitivity to others' reactions, which could contribute to greater peer difficulties.

The longitudinal investigation of social functioning within a prospective cohort is a strength of our study. This design enabled us to examine social functioning trajectories during a crucial period of social skill development and social transition. The inclusion of a term-born group enabled the comparison of birth group differences and assisted with generalisability of findings. However, our study has some limitations. Attrition and missing data may have introduced a potential risk for bias, where individuals with greater social problems may have dropped out of the study, meaning group trajectories may appear more similar than they really are. In addition, only 2 social functioning domains could be examined within the scope of the existing dataset; thus, future research into social functioning should consider a more comprehensive approach. While our

discrete follow-up assessments allowed some variability in assessment age, we were unable to precisely capture social functioning between assessments. Assessment of social functioning in later adolescence and later adulthood will be important to determine long-term trajectories incorporating later developmental transitions. The inclusion of data from multiple sources (teachers and/or children) would be preferable to understand social functioning from different perspectives. However, in a longitudinal context, young children are unlikely to accurately perceive their own social functioning, and classroom teachers generally do not remain consistent from year to year. Parent reports provide important insights over time, which enable advocacy and engagement with early intervention, if necessary. Lastly, elucidating factors relating to social functioning over time is essential for understanding risk factors associated with poor long-term social outcomes.

This study corroborates past research demonstrating VPT children are at greater, ongoing risk of poor peer relationships. While peer problems increase with age from early childhood to adolescence, individuals born VPT display persistently greater problems relative to FT controls. Supportive peer relationships promote optimal emotional and behavioural development, establish a positive self-concept, and provide greater social support.^{35,36} Social functioning is important to assess and monitor across development for children born VPT, given significant implications for identity, connectedness, school performance, career development, and general wellbeing.^{37–39} These findings have implications for parents, schools, and clinicians, suggesting that children born VPT could benefit from early social support to establish and foster improved peer relationships, such as through peer mentoring or structured play.⁴⁰

Given little evidence for differences in prosocial behavior between VPT and FT children in this study, prosocial behavior may reflect an area of relative strength in VPT individuals that could be harnessed in interventions to support overall social functioning. Furthermore, a systems approach involving parents, educators, and healthcare providers would be ideal to tailor supports towards the individual's strengths and weaknesses, as informed by different perspectives.⁴¹ Considering the multifaceted nature of social functioning, the benefits of providing early intervention for social issues may also extend to improving long-term outcomes in other domains affected for VPT individuals, such as cognitive development, academic achievement, and mental health.

AUTHOR CONTRIBUTIONS

Sarah C. H. Thompson: Conceptualization; methodology; funding acquisition; writing – original draft; writing – review and editing; formal analysis. **Karli Treyvaud:** Conceptualization; methodology; investigation; supervision; funding acquisition; writing – review and editing; data curation; formal analysis. **Leona Pascoe:** Methodology; conceptualization; investigation; supervision; data curation; formal analysis; writing – review and editing. **Rheanna M. Mainzer:** Methodology; data curation; formal analysis; resources; writing – review and editing; visualization; supervision; software. **Thi-Nhu-Ngoc**

Nguyen: Investigation; data curation; writing – review and editing. **Terrie Inder:** Methodology; conceptualization; investigation; supervision; funding acquisition; writing – review and editing; data curation. **Lex W. Doyle:** Conceptualization; methodology; resources; writing – review and editing; supervision; funding acquisition. **Peter J. Anderson:** Conceptualization; methodology; investigation; data curation; supervision; funding acquisition; writing – review and editing; resources; project administration.

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CONFLICT OF INTEREST STATEMENT

The other authors have no conflicts of interest to disclose.

ETHICS STATEMENT

Ethical approval was obtained from the Human Research and Ethics Committees of the Royal Women's Hospital and Royal Children's Hospital, Melbourne.

ORCID

Sarah C. H. Thompson  <https://orcid.org/0000-0001-5898-2690>

Peter J. Anderson  <https://orcid.org/0000-0001-7430-868X>

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