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Opportunities in Middle Childhood: Multiple System Involvement During Middle Childhood and Early Adolescence in Northern Territory, Australia

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ABSTRACT

Middle childhood offers a crucial window to identify and support children at risk of adverse outcomes in adolescence. This retrospective cohort study examined how data from multiple systems could identify children with the greatest need for support during middle childhood and early adolescence. Using individual level linked records from health, education, child protection and justice system for children who were enrolled in Northern Territory government schools in Year 1, we studied the relationships between system involvement/school engagement in middle childhood (ages 5–9) and subsequent system involvement/service usage during early adolescence (ages 10–13). Latent class analysis identified five distinct groups with varying patterns of system involvement. Notably, one group (12.1%) exhibited frequent contact with multiple systems, high school mobility between remote and urban regions, and high educational risk, contributing disproportionately to service usage. Early system involvement during middle childhood often preceded escalating service needs in adolescence, with early multi-system contact emerging as a leading indicator of service use in later years. Our findings highlight the potential benefits of a 'systems thinking' approach, with coordinated cross-agency responses and enhanced early interventions to better support vulnerable children, especially those engaged with multiple systems.

1 | Introduction

Middle childhood is a period in which children develop their socio-emotional and academic competencies as they learn to co-operate with peers and form relationships with friends and other significant adults (Huston and Ripke 2006). It is a time when these competencies develop into consistent behavioural patterns that persist into adolescence and early adulthood (Feinstein and Bynner 2004; Kowaleski-Jones and Duncan 1999). As such, middle childhood is recognised as a critical developmental period that shapes experiences and outcomes in adolescence and adulthood.

Middle childhood is also increasingly recognised as providing a critical opportunity to identify and intercept behaviours and other risk factors likely to lead to serious adverse outcomes in adolescence. Experiences and behaviours in middle childhood have 'repeatedly been found to predict adolescent and adult status...more reliably than do early childhood indicators' (Collins 1984). Although the early childhood years establish the foundations for a child's development, long-term health and lifelong learning (Center on the Developing Child at Harvard University 2010; Moore 2006), the experiences in middle childhood can 'sustain, magnify, or reverse the advantages or disadvantages' that children acquire in

early childhood (Huston and Ripke 2006). For example, a study using the British Cohort Study found links between cognitive functioning measures at age 5 years and adult outcomes including criminality and depression (Feinstein and Bynner 2006). Most importantly, the study found 'many children with improvement between age 5 and 10 escaped the risk implied by poor early performance [at age 5]', highlighting the value of targeting school resources and personalised educational interventions during middle childhood (Feinstein and Bynner 2006).

Different from early childhood, when the family is the main influence on children, the middle childhood years represent a time in which the environment outside the home has an increasing influence (Huston and Ripke 2006). School, in particular, becomes a central source of experience for children in middle childhood. Research has found that effective schooling can mitigate the adverse impacts of multiple early disadvantages, between birth and age 5 years, by promoting better self-regulation and academic attainment (Sammons et al. 2013). While there is evidence of a link between socioeconomic disadvantage and poor school engagement (e.g., parents less involved with their children's education) (Li et al. 2020; Wang et al. 2019), a systematic review demonstrated that this association was impacted by a range of factors, including individual, classroom, family and community factors and interventions (Tuohy 2022).

In Australia, Aboriginal and Torres Strait Islander people (hereafter respectfully referred to as Aboriginal people) have suffered severe social and economic disadvantage over the two centuries since European colonisation (Paradies 2016; Zambas and Wright 2016). While all Australian children have access to health and early childhood education services (Molla and Nolan 2019; Taylor et al. 2022), the disadvantage of Aboriginal children is evident before they start school. For example, the Australian Early Development Census (AEDC), a census measuring early childhood development at school entry (Brinkman et al. 2009), shows that Aboriginal children were twice as likely as other Australian children (41.3% c/w 20.4%) to be identified as developmentally vulnerable at age five (Australian Government Department of Education and Training 2019). This gap is even greater in the Northern Territory (NT), a large, remote and sparsely populated area of northern and central Australia, where 68.3% of Aboriginal children were identified as developmentally vulnerable compared to 23.2% of non-Aboriginal children. Of critical significance is that half of this difference was explained by potentially modifiable early health and sociodemographic factors (Guthridge et al. 2016). Further evidence of the disadvantage of Aboriginal children is their high rate of contact with the child protection system (CPS). Among Aboriginal children born in 2009 or 2010, more than half (53%) had child protection notifications before age 5 years (He et al. 2019). This disadvantage persists beyond age 5. A survey of over 500 children aged 11–14 years living in remote communities of the NT found that on average 3.5 stressors were experienced by children in the previous month: one-third by exposure to suicidal behaviour in their family or among kin; almost half had been affected by illness; almost half reported recent exposure to family violence; one-third were exposed to police intervention directed at their home or a relative; and over one-third were exposed to heavy drinking by family members (Robinson et al. 2022). Disadvantage accumulated during early and middle childhood contributes to the over-representation of Aboriginal children in the youth justice system. In 2020–2021, Aboriginal children comprised 42% of all NT children but 96% of all youth justice detainees (Australian Institute of Health and Welfare 2022a, 2022b).

Previous studies, specific to the NT, have suggested that potential points for intervention may exist in middle childhood. A study of hospital admissions for self-harming behaviour found that among NT Aboriginal children, the relative risk of self-harm was greatest for children with a record of substantiated child maltreatment in both early and middle childhood (9-fold risk compared to those with no contact with services) and children with a record of substantiated maltreatment in middle childhood only (7-fold risk) (Leckning et al. 2021). A similar pattern was observed in the relationship between childhood maltreatment and subsequent youth offending, with the risk of youth offending higher among children with substantiated maltreatment in both early and middle childhood, and among youth with substantiated maltreatment in middle childhood (He et al. 2021). These findings highlight the opportunity that middle childhood presents for identifying young people at risk of adverse outcomes in adolescence, and for mitigating this risk through coordinated service provision across agencies. Such provision could include targeted interventions such as assessments, therapeutic support and family services, delivered through effective interagency collaboration (e.g., referral to specialist mental health services, involvement with family support programs, or implementation of culturally appropriate healing programs for Aboriginal children and families). The need for greater collaboration between government agencies in the NT has long been recognised. Previous inquiry reports and coronial inquests have documented failures in communication and co-operation between agencies, with recommendations for greater collaboration included in reports from the NT Inquiry into the Child Protection System (Bamblett et al. 2010), the Royal Commission into the Detention and Protection of Children in the NT (Royal Commission and Board of Inquiry into the Protection and Detention of Children in the Northern Territory 2017) and the Commonwealth Productivity Commission 'Expenditure on Children in the Northern Territory' review (Productivity Commission 2020).

This study aims to demonstrate the potential for multi-agency collaboration and targeted early intervention approaches in addressing the needs of vulnerable children. To achieve this, we utilise individual-level linked records for NT children's involvement with education, health and child protection and youth justice systems. While definitions of middle childhood and adolescence vary across cultures, and some definitions of adolescence (e.g., 10–19 or 10–24 years) (Sawyer et al. 2018) overlap with the upper end of middle childhood (e.g., 10 or 12 years) (Collins 1984), we define middle childhood as ages 5–9 and early adolescence as ages 10–13 in our study. Latent class analysis is used to identify different groups of children based on system involvement during middle childhood. We then model the association between these groups and their subsequent risk of system involvement/service usage during

early adolescence. Finally, we quantify the contribution of each group to total service usage over the periods of middle childhood and early adolescence. By illuminating how the risks of system involvement and service use in early adolescence differ based on middle childhood patterns of system involvement, we demonstrate the potential benefits of coordination and information-sharing between agencies.

2 | Methods

2.1 | Study Design and Study Population

This was a retrospective population-based cohort study of children who were enrolled in NT government schools in Year 1 (aged 5–7 years) in 2011 (and so turned 14 before 31/12/2019). Children who died between ages 10 and 14 years or who moved interstate (identified from enrolment records) from Year 1 to age 14 were excluded.

2.2 | Data Sources

This study used data from the Child and Youth Development Research Partnership (CYDRP)'s comprehensive repository of de-identified, linked administrative datasets. The repository's establishment and linkage methodology have been previously documented (Su et al. 2020). Our analysis incorporated linked records from 11 datasets spanning education, health, child protection and justice systems.

2.2.1 | Educational and Mortality Data

The study cohort was established using the NT government school enrolment dataset, cross-referenced with mortality records to exclude children who died before age 14. School enrolment records also provided data on student mobility, while the school attendance dataset supplied attendance figures. Demographic information was sourced from the student information dataset. Geographic classification was determined by children's first Year 1 school enrolment in 2011, with those in Darwin, Palmerston, Katherine, Nhulunbuy, Alice Springs and Tennant Creek classified as 'urban-residing', and all others as 'remote-residing'. The National Assessment Program for Literacy and Numeracy (NAPLAN) dataset, encompassing both government and non-government NT schools, provided Year 3 Reading test outcomes.

2.2.2 | Health

Multiple health datasets were used. The NT Perinatal Data Register, a statutory collection of demographic and birth information, identified NT-born children and provided parity data for this subset. Children absent from this register were classified as born interstate/overseas. Hospital inpatient records documented admissions across all NT public hospitals, including mental health-related stays. The Emergency Department dataset captured all hospital emergency department presentations, whilst the mental health outpatient dataset detailed all mental health consultations.

2.2.3 | Child Protection

The Department of Children and Families' child protection dataset provided comprehensive records of child protection notifications, including dates, types, sources and reported concerns. These records also include investigation outcomes, substantiation status, harm types and out-of-home care placement details.

2.2.4 | Justice

Police records from 2014 onwards were accessed through the Police Real Time Online Information Management System (PROMIS), documenting alleged offences for children aged 10–13, including family and domestic violence incidents.

2.2.5 | Demographic Variable Derivation

Aboriginal status was determined using an algorithmic approach that prioritised datasets based on data quality. Health datasets were given primary consideration, followed by child protection, education and youth justice records (Silburn 2018). This hierarchy was established through systematic evaluation against inpatient hospital data, which demonstrated 98% consistency in Aboriginal status recording during a 2011 audit (Foley et al. 2012). This methodology aligns with best practice guidelines for linked datasets (Australian Institute of Health and Welfare and Australian Bureau of Statistics 2012). Sex classification followed the same approach.

2.3 | Analysis

Four components of analysis were conducted.

The first component describes the study cohort and presents summary statistics on the key indicators for service level use.

The second component of the analysis used latent class analysis to identify different groups of children based on their levels of contact with government agencies during middle childhood. The indicator variables used for latent class analysis (LCA) were selected from education, health and child protection datasets. Correlations between variables were examined to ensure highly correlated variables were excluded. Demographic variables (such as Aboriginal status, sex, remoteness and place of birth) were not used in the LCA to determine class membership. The optimum number of classes was selected using model fit statistics, which were log-likelihood (LL), Bayesian Information Criteria (BIC), Akaike Information Criteria (AIC), Lo–Mendell Rubin adjusted likelihood ratio (LMR-A) test, and entropy as well as the interpretability of the selected model.

The third component examined the association between the different groups (derived from the LCA) and various system involvements/service usages during early adolescence. The analysis encompassed: (a) mental health service events; (b) emergency department visits; (c) hospital admissions; (d) child protection

notifications; (e) child protection investigations; (f) child protection substantiations; (g) family and domestic violence exposure; and (h) youth offences (from police data).

System involvement/service usage was measured through two epidemiological measures: prevalence rates (per 100 persons) for client numbers and incidence rates (per 1000 person-years) for episodes. Prevalence ratios were used to compare differences in prevalence, and incidence rate ratios were used to compare differences in incidence rates. Prevalence ratios were derived using modified Poisson regression, and incidence rate ratios were derived using negative binomial regression (with robust variance).

The fourth component of the analysis estimated the contribution of each group to client numbers and episodes of mental health service events, emergency department visits, hospital admissions, child protection, and youth justice contacts.

Data management and descriptive analyses were conducted using Stata for Windows, Version 17. Latent class analysis was conducted using Mplus Version 8. The stata2mplus program was used for the transfer of data from Stata to Mplus.

2.4 | Ethical Approval and Adherence to AIATSIS Code of Ethics

The study was approved by the Human Research Ethics Committee of the NT Department of Health and the Menzies School of Health Research (HREC-2018-3261) and was supported by a First Nations Advisory Group, which includes independent Aboriginal community members. The First Nations Advisory Group endorses and supports the methodology, aims and objectives of this research and supports the progression of this research study. This group has been instrumental in guiding the research in CYDRP to ensure its alignment with community priorities and values and ensuring that the management and use of research data is adhered to the AIATSIS Code of Ethics and Indigenous Data Sovereignty principles (Australian Institute of Aboriginal and Torres Strait Islander Studies 2020). The research team includes an Aboriginal researcher, with a legal background, ensuring Indigenous perspectives were embedded in the study analysis and writing.

3 | Results

3.1 | Characteristics of the Study Cohort

This study aimed to explore the link between system involvement during middle childhood (i.e., ages 5–9) and subsequent system involvement/service usage during early adolescence (i.e., ages 10–13). Therefore, it did not include children who left NT before turning 14. After applying all exclusion criteria, the cohort consisted of 2270 children (Figure S1). These participants were presumed to stay in the NT from their first school year until the age of 14. Additional analysis showed that the proportion of Aboriginal and remote-living children in the cohort was similar to all Year 1 students enrolled in NT government schools (Tables S1 and S2). This similarity suggests that our study cohort is representative of the broader population of Year 1 government school students.

Table S3 details the study cohort's characteristics and their involvement with various government agencies, analysed for both Aboriginal and non-Aboriginal children. The data reveals distinct disparities between NT Aboriginal and non-Aboriginal children in demographic profiles and agency involvement levels. A significant 64.4% of Aboriginal children were enrolled in schools in remote areas, in contrast to 94.8% of non-Aboriginal children attending urban schools. Compared with non-Aboriginal children, Aboriginal children were more likely tobe born in the NT, experience greater school mobility, have lower school attendance, and have lower participation in NAPLAN Year 3 reading tests. Aboriginal children also had higher rates of hospital admissions, child protection reports, domestic violence exposure and youth justice contact.

3.2 | Patterns of System Involvement During Middle Childhood (i.e., Ages 5–9)

Latent class analysis was performed with one to eight latent classes (Table S4 and Figure S2). The Lo–Mendell Rubin Test indicated the five-class model was a preferred model over two-, three- or four-class models. Based on interpretability and parsimony, a five-class solution was selected, which produced a clear separation between different latent classes (entropy: 0.827). Each latent class (hereafter referred to Group) was named according to the dominant traits of the children within it, detailed in Table 1.

Group 1, 'High mobility, high educational risk; high CPS contact & high acute health care', accounts for 12.1% of the cohort. This group is characterised by a high school mobility and educational risk, extensive CPS interaction and significant health service usage between ages 5–9.

Almost two-thirds of Group 1 changed schools between Year 1 and Year 4, with the majority of moves being between remote and urban schools. About two-fifths of Group 1 had school attendance of 80%–100% from Year 1 to Year 4, and 70% participated in the NAPLAN Year 3 reading test. Among those who participated, 54% achieved at or above the National Minimum Standard (NMS) for reading at Year 3 level.

Group 1 exhibited notably high involvement with the CPS. All children in this group had experienced at least one child protection notification, with 85% having a substantiated notification and 16% placed in out-of-home care between the ages of 5 and 9 years old. This group demonstrated the highest rates of notifications, investigations, substantiations and out-of-home placements (Tables S5 and S6). Of particular concern were the exceptionally high rates of physical abuse (57.1%) and reported exposure to domestic and family violence (45.8%) during ages 5–9 (Tables S1–S13). The prevalence of notifications for Group 1 was high across various reporting sources, including police (62.2%), school personnel (43.3%) and health professionals (36.0%) (Table S7). It is worth noting that of the 1164 notifications for all children in Group 1 who had notifications during ages 5–9, 28.9% were not investigated as they did not meet the required threshold (Table S8).

TABLE 1 | Level of involvement of groups of children during middle childhood (age 5–9 years) with education, child protection and health system (in terms of probabilities for indicators) and demographic characteristics (expressed in terms of proportions for covariate).

Indicators	1: High mobility, high educational risk; high CPS contact and high acute health care (12.1%; $n = 275$)	2: High mobility, high educational risk; moderate CPS contact and high acute health care (13.3%; $n = 303$)	3: High mobility, high educational risk; low CPS contact and low acute health care (14.8%; $n = 335$)	4: Moderate mobility, low educational risk; low CPS contact and high acute health care (15.3%; $n = 347$)	5: Low mobility, low educational risk; low CPS contact and low acute health care (44.5%; $n = 1010$)
Education					
School mobility					
Not changed school	0.35	0.35	0.41	0.68	0.84
Urban to urban	0.17	0.02	0.02	0.25	0.14
Remote to remote	0.14	0.32	0.40	0.01	0.00
Remote to urban (vice versa)	0.34	0.32	0.17	0.07	0.02
School attendance					
80%–100%	0.41	0.03	0.15	0.92	0.97
50%–79%	0.41	0.65	0.49	0.09	0.03
< 50%	0.18	0.32	0.36	0.00	0.00
NAPLAN Year 3 reading					
At/Above NMS	0.38	0.20	0.16	0.78	0.80
Below NMS	0.32	0.35	0.45	0.12	0.08
Not participating	0.17	0.29	0.25	0.02	0.02
Not found in NT NAPLAN	0.13	0.16	0.15	0.08	0.10
Child Protection					
CP notification(s)					
0	0.00	0.58	0.75	0.71	0.89
1 only	0.18	0.19	0.17	0.18	0.07
≥2	0.82	0.23	0.08	0.11	0.04

(Continues)

TABLE 1 | (Continued)

Indicators	1: High mobility, high educational risk; high CPS contact and high acute health care (12.1%; $n = 275$)	2: High mobility, high educational risk; moderate CPS contact and high acute health care (13.3%; $n = 303$)	3: High mobility, high educational risk; low CPS contact and low acute health care (14.8%; $n = 335$)	4: Moderate mobility, low educational risk; low CPS contact and high acute health care (15.3%; $n = 347$)	5: Low mobility, low educational risk; low CPS contact and low acute health care (44.5%; $n = 1010$)
Substantiation(s)	0.85	0.00	0.00	0.00	0.00
Out-of-home care placement(s)	0.16	0.00	0.00	0.00	0.00
Health					
Mental health services event	0.10	0.03	0.01	0.09	0.04
Emergency department visit(s)					
0	0.33	0.00	0.92	0.00	0.56
1 only	0.21	0.38	0.08	0.20	0.27
≥2	0.46	0.62	0.01	0.80	0.17
Inpatient hospital admission(s)					
0	0.56	0.18	0.85	0.32	0.95
1 only	0.24	0.41	0.12	0.41	0.04
≥2	0.20	0.42	0.03	0.27	0.01
Covariates					
Aboriginal	85.1	97.4	97.6	37.2	17.7
Male	49.1	55.1	51.0	57.6	48.2
Born interstate/ overseas	9.1	4.3	20.9	26.2	33.5
Remote (i.e., age 10)	46.5	81.2	90.7	13.0	8.4

Abbreviations: NAPLAN, National Assessment Program for Literacy and Numeracy; NMS, National Minimum Standard.

In terms of acute healthcare usage, 67% of Group 1 visited the emergency department (ED) at least once, 44% had hospital admissions and 10% had mental health events. Out of all five groups, they had the highest rates of mental health issues, ED visits and hospitalisations, with nearly half experiencing multiple ED visits and a fifth experiencing multiple hospitalisations.

Group 2, 'High mobility, high educational risk; moderate CPS contact & high acute health care', accounts for 13.3% of the cohort. This group had a high rate of school mobility, a low level of school engagement, a moderate level of CPS contact and a high use of healthcare services. Group 2 stands out for its low level of school engagement and high use of healthcare services.

This group shares Group 1's high school mobility (65%) and educational risk but has moderate CPS interaction and extensive healthcare usage. Notably, Group 2 has the lowest school attendance (only 3% had attendance rates of 80% or higher) and NAPLAN Year 3 reading test participation (55%). Among those who participated in the NAPLAN reading test, 36% achieved at or above the NMS.

After Group 1, Group 2 had the second highest prevalence and incidence rates for child protection notifications and investigations from ages 5 to 9. Group 2 follows Group 1 in child protection notification and investigation rates from ages 5 to 9. While 42% had notifications, none were substantiated or led to out-of-home care. About half of the 253 notifications for notified children in Group 2 were not investigated as they did not meet the threshold (Table S8); this result was also similar for Group 3–5 children (and thus not mentioned again for the other groups).

Acute healthcare usage in Group 2 is significant: all visited the emergency department at least once, 82% were hospitalised and 3% used mental health services over the ages of 5–9. Group 2 had the highest rate of ED visits among all groups.

Group 3, 'High mobility, high educational risk; low CPS contact & low acute health care', accounts for 14.8% of the cohort. Notably, this group had minimal interactions with services, including schools. They exhibited high school mobility and low engagement with schools, CPS, and healthcare. Only 25% had a CPS notification, with no substantiated cases or out-of-home care. School changes occurred for 59% of the group. School attendance was at least 50% for 64% of the children, with 15% attending 80%–100% of the time. 60% participated in the NAPLAN Year 3 reading test, with 26% meeting or exceeding the NMS. Acute healthcare service usage was low: 8% visited the ED, 15% had hospital admissions, and 1% had mental health consultations.

Group 4, 'Moderate mobility, low educational risk; low CPS contact & high acute health care', accounts for 15.3% of the study cohort. This group had moderate school mobility, high school engagement, low CPS interaction and high healthcare usage. Nearly 30% had a CPS notification, with no substantiated cases or out-of-home care from ages 5 to 9. School mobility was less common than Group 1–3, with 32% changing schools. Group 4 also had high school engagement, with 92% attending 80%–100% of the time and 90% participating in the NAPLAN Year 3 reading test. Of those who participated in NAPLAN, 87% achieved at or above the NMS. Despite the low educational risk, this group had high acute healthcare usage, with all having ED visits, 68% with hospital admissions and 9% with mental health consultations.

Group 5, 'Low mobility, low educational risk; low CPS contact & low acute health care', was the largest group, accounting for 44.5% of children in the cohort. Characterised by low school mobility, high engagement, minimal CPS interaction and low acute healthcare usage. Only 11% had a CPS notification, with no substantiated cases or out-of-home care. School mobility was low, with 16% changing schools and engagement was high, with 97% attending 80%–100% of the time. 88% took the NAPLAN Year 3 reading test, and 91% of those who participated achieved at or above the NMS. Acute healthcare usage was relatively low, with 5% having hospital admissions, 44% visiting the ED and 4% receiving mental health consultations between ages 5–9.

3.3 | Demographic Characteristics of Children Associated With Each Latent Class

Table 1 also presents the characteristics of children in each latent class, demonstrating the over-representation of Aboriginal children in Group 1 (85.1%), Group 2 (97.4%) and Group 3 (97.6%) and under-representation in Group 5 (17.7%). For Aboriginal children, 20.1% were in Group 1, 25.3% in Group 2, 28.1% in Group 3, with fewer in Group 4 (11.1%) and Group 5 (15.4%). Non-Aboriginal children's distribution was 3.7%, 0.7%, 0.7%, 19.7% and 75.1% across Groups 1 to 5, respectively.

School mobility patterns also varied between groups, with the majority of children in Groups 2 and 3 attending remote schools (81.2% and 90.7%, respectively), while most children in Groups 4 and 5 attended urban schools (87.0% and 91.6%, respectively). Over half of Group 1 attended urban schools (53.5%). Compared to the first two classes, Groups 3 to 5 were more likely to be born outside the NT.

3.4 | The Link Between the Groups (Based on System Involvement During Middle Childhood) and Subsequent Risk of System Involvement/ Service Usage During Early Adolescence

Table 2 and Tables S9–S12 provide detailed statistics, including estimates of prevalence and incidence rates of involvement with the child protection, health and justice system during early adolescence (i.e., ages 10–13) from modified Poisson (prevalence rates) and negative binomial (incidence rates) regression models.

Generally, a declining trend is observed from Group 1 to Group 5 in terms of child protection notifications, investigations and substantiations, as well as domestic and family violence exposure and alleged offender prevalence (Table 2). Groups 1, 2 and 4 showed higher prevalence and incidence rates for mental health services events, emergency department visits and hospitalisations than Groups 3 and 5 (Table 2 and Table S9). Group 5 had the lowest overall prevalence of hospital admissions and the second lowest prevalence of outpatient mental health consultations and emergency department visits, following Group 3.

TABLE 2 | Prevalence (proportion [95% CI]) of statutory system involvement/service usage during early adolescence (i.e., ages 10–13), by latent class (i.e., group based on system involvement during middle childhood).

	1: High mobility, high educational risk; high CPS contact and high acute health care	2: High mobility, high educational risk; moderate CPS contact and high acute health care	3: High mobility, high educational risk; low CPS contact and low acute health care	4: Moderate mobility, low educational risk; low CPS contact and high acute health care	5: Low mobility, low educational risk; low CPS contact and low acute health care
	(12.1%; *n* = 275)	**(13.3%; *n* = 303)**	**(14.8%; *n* = 335)**	**(15.3%; *n* = 347)**	**(44.5%; *n* = 1010)**
Child protection					
Notifications	84.0 [79.2–87.9]	63.7 [58.1–68.9]	45.1 [39.8–50.4]	35.7 [30.9–40.9]	18.1 [15.9–20.6]
Investigations	68.4 [62.6–73.6]	40.3 [34.9–45.9]	22.7 [18.5–27.5]	17.6 [13.9–22.0]	9.2 [7.6–11.2]
Substantiations	41.1 [35.4–47.0]	11.6 [8.4–15.7]	6.3 [4.1–9.4]	5.5 [3.5–8.4]	2.5 [1.7–3.6]
Health					
Mental health services	13.8 [10.2–18.4]	5.0 [3.0–8.1]	1.5 [0.6–3.5]	9.5 [6.8–13.1]	4.2 [3.1–5.6]
Emergency department	61.8 [55.9–67.4]	56.8 [51.1–62.2]	28.1 [23.5–33.1]	58.5 [53.2–63.6]	37.0 [34.1–40.1]
Hospitalisation	38.2 [32.6–44.1]	36.6 [31.4–42.2]	21.5 [17.4–26.2]	22.8 [18.7–27.5]	9.7 [8.0–11.7]
Police					
DV/FV exposure	58.2 [52.3–63.9]	33.0 [27.9–38.5]	22.1 [18.0–26.9]	21.0 [17.1–25.6]	11.3 [9.5–13.4]
Alleged offender	27.3 [22.3–32.8]	19.5 [15.4–24.3]	11.3 [8.4–15.2]	4.6 [2.8–7.4]	2.6 [1.8–3.8]

Note: Each row represents a separate estimation, where the first column lists the dependent variable.
Abbreviation: DV/FV, domestic and family violence.

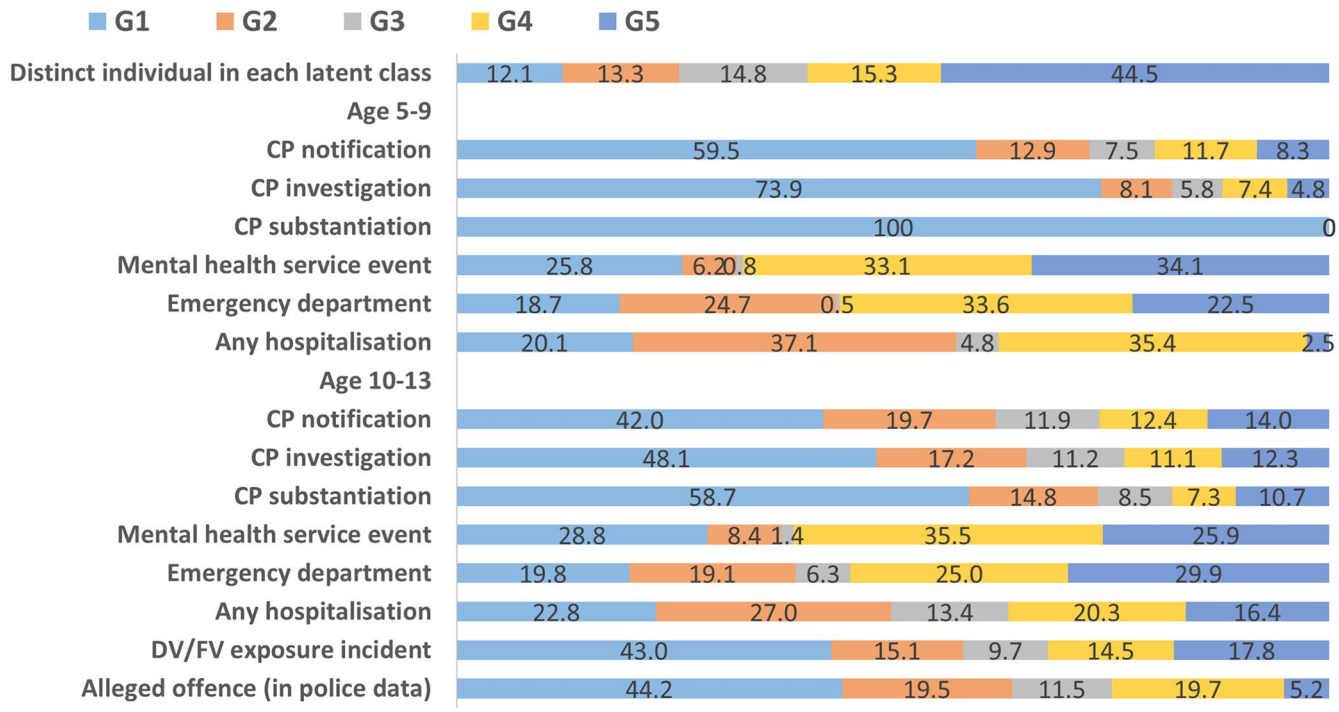

FIGURE 1 | The extent to which each latent class contributed to system involvement with health, child protection, and youth justice system (in terms of episode count). DV/FV, domestic and family violence; G, group.

A notable finding emerged when comparing health system involvement between Group 3 and Group 5. At the individual level, compared to Group 5, Group 3 individuals were less likely to have mental health service events (prevalence ratio: 0.36 [0.14–0.90]) and emergency department visits (prevalence ratio: 0.76 [0.63–0.92]) in adolescence, but were more likely to be hospitalised in adolescence (prevalence ratio: 2.22 [1.68–2.93]) (Table S11). Similar results were observed when expressed in terms of episodes: Group 3 had fewer episodes of mental health service events (incidence rate ratio: 0.16 [0.05–0.52]) and emergency department visits (incidence rate ratio: 0.63 [0.47–0.84]) in adolescence, but more episodes of hospital admissions in adolescence (incidence rate ratio: 2.46 [1.78–3.41]) compared to Group 5 (Table S12). These findings indicate that Group 5, who primarily resides in urban settings, has better access to mental health and emergency department services compared to Group 3, who primarily resides in remote regions (Table 2).

3.5 | Contribution of Service Usage in Middle Childhood and Early Adolescence Periods by Different Groups (Based on System Involvement During Middle Childhood)

Figure 1, Figure 2 and Table S13 show the extent to which each group contributed to the service usage within the health, child protection, and youth justice sectors. Figure 1a shows the proportion of total service episodes provided to each group of children for each service. Figure 1b shows the proportion of total clients from each group of children for each service. The upper part displays service usage when children were aged 5–9 years, while the lower part shows service usage when aged 10–13 years.

Despite comprising only 12% of the cohort, Group 1 accounted for the majority of CPS episodes and had the largest share of children involved with CPS when aged 5–9 and 10–13 years. For instance, when aged 10–13 years, Group 1 was responsible for almost half of all CPS investigations (48.1%) and nearly three-fifths of all substantiated CPS cases (58.7%). Regarding the proportion of individual children, at ages 5–9 years, 59.1% of children investigated by CPS and 100% of children with a substantiated notification were from Group 1.

Group 1's involvement in mental health services is also disproportionately high relative to their cohort size. Although constituting 12% of the cohort, this group account for a substantial portion of outpatient mental health consultations at age 5–9 (25.8%) and age 10–13 (28.8%).

Furthermore, when aged 10–13 years, Group 1 children were overrepresented in police-recorded domestic violence/family violence incidents, both in terms of incident episodes (43%) and individual children involved (30.7%). This group also accounted for the largest share of police-recorded alleged offences committed by individuals aged 10–13, representing 44.2% of all offence episodes and 35.0% of all individual children charged with an alleged offence.

Although Group 2 children comprised 13% of the study cohort, it was the group with the greatest contribution to the shares of hospital episodes from age 5 to 9 years (37.1%) and age 10–13 years (27.0%).

Despite Group 4 comprising fewer children than Group 5 (15% c/w 44%, respectively), these groups account for a similar percentage of outpatient mental health consultations for ages 5–9

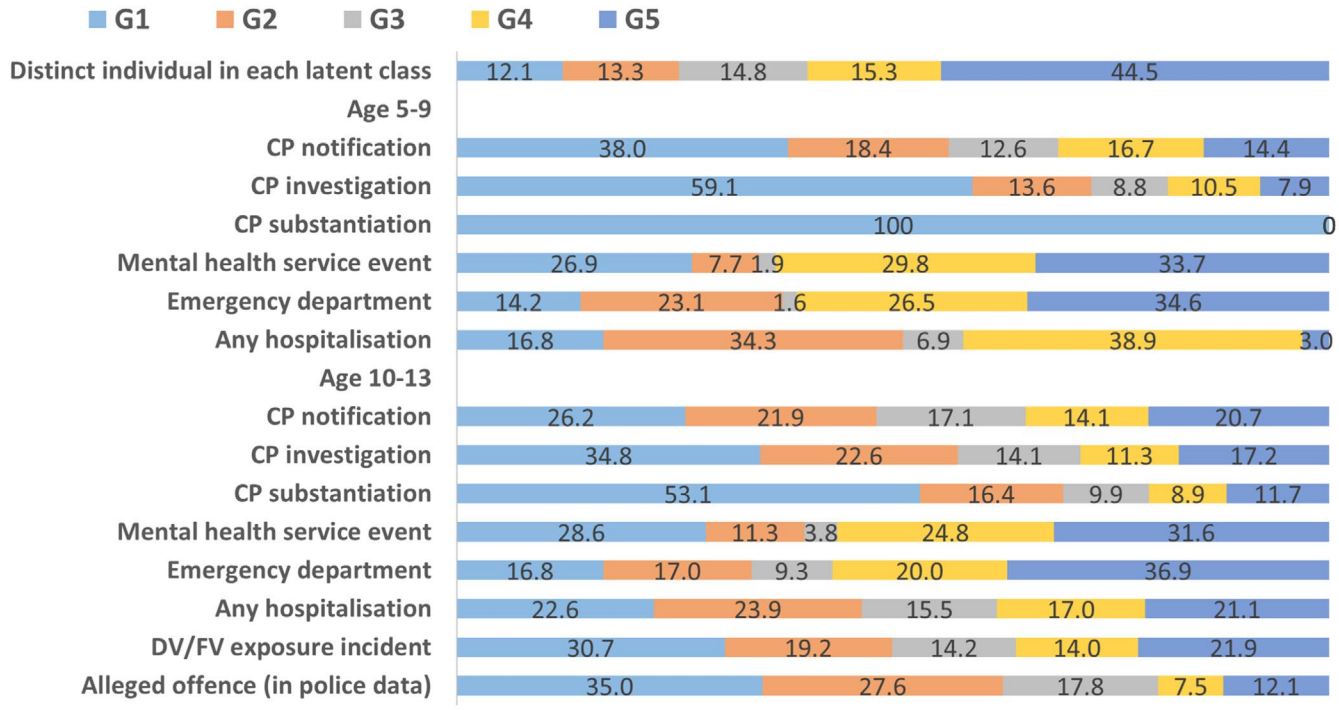

FIGURE 2 | The extent to which each latent class contributed to system involvement with health, child protection, and youth justice system (in terms of person count). DV/FV, domestic and family violence; G, group.

(33.1% for Group 4 and 34.1% for Group 5). However, by ages 10–13, Group 4 surpasses Group 5, accounting for 35.5% of mental health consultations, compared to Group 5's 25.9%.

4 | Discussion

Our study explored the patterns of system involvement by children during middle childhood and subsequent involvement with mental health, acute health care, child protection and youth justice systems during early adolescence. We identified 5 groups of children in middle childhood, across which there was a decreasing gradient in the level of risks of contact with the different systems in adolescence from Group 1 to Group 5. Aboriginal children were overrepresented in Groups 1 to 3.

Almost one-tenth of children in our study (Group 1) had frequent contact with multiple systems at ages 5 to 9 and ages 10–13. This group accounted for a disproportionate share of service usage across various measures in different systems. More than half of these children were enrolled in urban schools in Year 1 and had a high level of school mobility (between remote and urban regions) and high educational risk.

Most children in Groups 2 and 3 were from remote areas, with the two groups distinguished by varying levels of contact with child protection, health and youth justice systems. Most children in Group 4 were enrolled in urban schools at Year 1, had moderate school mobility (between urban and urban regions) and high school engagement in primary years but had a high level of usage of mental health and acute health care services. Patterns of hospital service usage for Groups 2 and 4 suggest underlying medical issues are the main reasons for admission. While this may reflect poorer health, it may also reflect undiagnosed behavioural and psychosocial risks that underlie acute admissions for emergency services.

The profile of Group 5 reflects the common pattern of development for most urban children in the NT, with low levels of child protection and youth justice concerns, but with relatively heavier use of mental health care and emergency department services. This may reflect the emergence, in adolescence, of mental health issues and risky behaviours, but may also reflect better access and use of services by this predominantly urban group of children.

4.1 | Implication

This study demonstrates the value of using administrative data to describe and group children according to their vulnerability and needs as measured by their interaction with the CPS, schools and health services during middle childhood. Two crucial implications for policy and practice emerge from these empirical findings.

4.1.1 | 'Systems Thinking' to Support Children

Our findings demonstrate clear patterns of system involvement that persist from middle childhood into early adolescence. This finding highlights the critical need for a 'systems thinking' approach within and across NT departments and agencies sector to better support and respond to children's needs across child protection, education, health and youth justice systems, particularly during middle childhood. The identification of five distinct

groups, particularly Group 1 and 2 which showed consistently high service usage across multiple agencies in middle childhood, indicates that middle childhood serves as a crucial early warning system for future service needs in the early adolescence period.

The concept of 'systems thinking' is particularly relevant when examining these service usage patterns, as it focuses on understanding interconnected entities and their relationships (Trochim et al. 2006). This approach encourages a holistic view of how organisations and agencies interact (Carey et al. 2015; Newell et al. 2007), aiming to identify patterns and relationships within systems (De Savigny and Adam 2009). Such an understanding is crucial for addressing complex structural and social phenomena, such as those identified in our study. Our results reveal how engagement with one service often correlates with involvement in others—exemplified by Group 1's simultaneous high rates of CPS contact, healthcare utilisation and educational risk. This interconnectedness suggests that early identification of high-need children through one service could enable proactive support and/or intervention across other domains.

School mobility, particularly common among children with high needs and risks, exemplifies one such complex structural and social phenomena. Our analysis showed that Groups 1–3, characterised by high mobility, subsequently demonstrated higher rates of adverse outcomes at ages 10–13. This aligns with recent research showing significant differences in NT school mobility rates between Aboriginal (24.7%) and non-Aboriginal students (12.1%) (Su et al. 2023). This difference highlights the need for targeted support and enhanced inter-regional collaboration. Implementing a 'systems thinking' approach within the education sector has the potential to effectively address this issue. For example, by utilising data on patterns of mobility, education authorities can make informed decisions on enrolment management, staffing allocations and regional collaboration initiatives. This has the potential to better support students' educational needs (Su et al. 2023). For example, by better preparing students for anticipated mobility events, disruptions to their learning can be minimised (Su et al. 2023).

Beyond the application of 'systems thinking' within a single agency, our findings emphasise the broader importance of such approaches across multiple government agencies and non-government organisations to support vulnerable children. These approaches are crucial for identifying potential intervention points, assessing resource needs and developing strategies that enhance service accessibility across multiple sectors (Productivity Commission 2021). Examples include integrated service models, place-based strategies and programs aimed at improving social outcomes through primary prevention and early intervention, as well as secondary and tertiary prevention for those identified as being at risk (Productivity Commission 2021).

Through the lens of 'systems thinking,' enhanced data sharing across agencies can foster better coordinated and more responsive services. Improved coordination strengthens the capacity to identify and mitigate the effects on children exposed to various risk factors, including domestic and family violence. For example, the high rates of mental health service usage in Groups 1 and 4 during both middle childhood and early adolescence periods suggest opportunities for early intervention through coordinated healthcare and education responses. By viewing these interconnected systems holistically, agencies can better collaborate to provide timely, targeted support, ultimately improving outcomes across health, education, child protection and youth justice domains.

4.1.2 | The Importance of a Multi-Agency Approach and Early Intervention in Child Protection Services

A multi-agency approach in which data is shared and services are coordinated is likely to be one of the best means to detect and mitigate the impacts on children of exposure to domestic and family violence. Data limitations in our study restricted the availability of police information on exposure to domestic violence to children when aged 10–13, which is the age when significant proportions of children in Groups 1 through 4 were reported for exposure to domestic violence. It is likely that these children were also exposed at younger ages. CPS conducted investigations for most children in Group 1 when aged 5–9 years; however, most notifications for children in Groups 2–4 were not investigated.

This suggests that investigations by CPS may only focus on children at the highest risk, potentially neglecting those at moderate risk. For instance, nearly half of the notifications for children aged 5–9 in Groups 2–4 were not investigated as they did not meet the required threshold. These overlooked notifications could represent missed opportunities for preventative measures that extend beyond the statutory obligations to identify and respond to maltreatment. For example, Group 2 has a moderate risk of exposure to DV/FV at 33.0% and youth offending at 19.5% (during ages 10–13). These cases likely could have benefited from early intervention.

All these findings suggest that beyond the statutory obligation for CPS to determine and respond to child maltreatment, the lack of follow-up of notifications may represent a missed opportunity to prevent and or intervene in situations of ongoing exposure to domestic violence, as well as prevent consequent behaviours, including youth offending. This observation echoes a finding of a public inquiry in 2010, which raised concerns about the CPS adopting a 'forensic approach that focuses more on the technicalities of whether harm occurred than on meeting the actual needs of families and children' (Bamblett et al. 2010). The Inquiry report recommended a public health approach that focused on early intervention, with referral pathways for at-risk families to access the necessary services and support, including for children with no notifications or notifications which were not substantiated.

A multi-agency approach would also facilitate the targeting of preventative measures requiring mental health support. Children in Groups 1–3 largely reside in remote locations, and their significant exposure to domestic and family violence suggests that a large proportion of children in remote regions did not have adequate access to mental health services. This likely represents a further missed opportunity for early preventative efforts. Early intervention efforts can also be supported

by moving from an outputs-based approach to one that targets real progress towards agreed shared outcomes. Achieving this will require integrating data collections across agencies and establishing the infrastructure to develop and deliver multi-agency programs that are child-centred. There is also a need to distinguish children with only passing contact with a service from those children who have received services in the education, child protection, youth justice and mental health systems (Jonson-Reid 2011). Due to data limitations, this study could not identify the services the children received when they were reported to the CPS or substantiated or investigated for maltreatment. This gap between system contacts and receipt of services warrants further investigation.

4.2 | Limitations

This study has several limitations. First, this study only includes government school students, representing almost three-quarters of all children in the NT. The future inclusion of non-government school data will provide a more comprehensive understanding of the population. Second, although the datasets provide extensive information on many services, there are some services from which information is not available. For instance, the study did not include primary health care services, including government and non-government clinics and general practice services. Access to this information would substantially increase our understanding of the unmet and met health needs of children in this study. Third, this study excluded one-fifth of the government school students enrolled at the age of 10 who moved out of the NT or transferred to interstate schools. Finally, the generalisability of this study may be limited by age-period-cohort effects. Specifically, period effects are changes that impact an entire population at a particular point in time, like natural disasters or policy changes, while cohort effects relate to being born in a particular year cohort (Hunter 2008). It is important to acknowledge significant events may have impacted outcomes for the cohort of children involved in the study.

5 | Conclusion

This study used linked administrative data to follow children's interactions with education, health, child protection and youth justice systems from middle childhood to adolescence. The results reveal distinct patterns of system involvement during middle childhood that strongly predict subsequent system involvement in early adolescence. These patterns demonstrate how early system involvement during middle childhood, particularly in child protection and healthcare services, often precedes continued or escalating service needs in early adolescence. For instance, as demonstrated in our study, children with high child protection contact in middle childhood showed substantially higher rates of youth justice involvement and continued child protection engagement in early adolescence.

Our findings underscore the importance of a 'systems thinking' approach, recognising the interconnectedness of these systems and the need for integrated, cross-agency responses. Our study identified five clear patterns of service involvement in middle childhood, with particular concern for children showing high levels of multi-system involvement. These patterns were characterised by varying combinations of school attendance, mobility between schools, child protection notifications and healthcare utilisation. Children exhibiting patterns of high service contact across multiple systems during middle childhood were more likely to require intensive service support in early adolescence, suggesting cumulative challenges that persist across developmental periods.

Understanding these system involvement patterns during middle childhood could inform coordinated, cross-agency prevention and support strategies, targeting critical intervention points to mitigate negative outcomes and reduce subsequent system involvement in early adolescence. Effective early interventions and family support, informed by a systems-level understanding of these patterns, could help reduce the disproportionate service demands from high-need groups, particularly meeting the needs of Aboriginal children who are overrepresented in high-contact patterns. These objectives align with Closing the Gap priorities for improving health, education and social outcomes for Aboriginal children in Australia (Coalition of Aboriginal and Torres Strait Islander Peak Organisations and Council of Australian Governments 2020).

Future research should expand data collection to encompass health, education and child protection contexts from birth, including primary healthcare contacts and early childhood education and family service participation, to better understand developmental trajectories influencing service engagement and service involvement. This broader understanding would help identify opportunities for targeted early intervention and family support across healthcare, early education and community services, potentially preventing the escalation of service needs in later childhood and adolescence.

Author Contributions

Vincent Yaofeng He: conceptualization, investigation, writing – original draft, writing – review and editing, visualization, validation, methodology, software, formal analysis, project administration, data curation. **Jenny Williams:** conceptualization, writing – review and editing, writing – original draft, investigation, methodology. **Steven Roche:** conceptualization, methodology, writing – review and editing, investigation. **Tamika Williams:** conceptualization, investigation, methodology, writing – review and editing. **Steven Guthridge:** conceptualization, funding acquisition, resources, supervision, investigation, methodology, writing – review and editing, project administration.

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Conflicts of Interest

Vincent He is currently an employee of the Northern Territory Government. His involvement in this study predates that employment, and the views contained herein do not reflect those of the Northern Territory Government. He initiated and completed the study during his employment at the Menzies School of Health Research until 14 April 2023; subsequently, he began his employment with the Northern Territory Government on 2 May 2023. All other authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.