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Child and Parental factors in Childhood Cancer in Australia

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Research Article

Keywords: childhood cancer, stage at diagnosis, parental education, health equity, Australia, sociodemographic factors

Posted Date: May 26th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9803500/v1

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Additional Declarations: The authors declare no competing interests.

Abstract

Background

Despite universal healthcare and high overall survival rates for childhood cancer in Australia, a proportion of children are still diagnosed at an advanced or metastatic stage. Limited evidence exists on how parental sociodemographic factors influence advanced or metastatic stage at diagnosis in children. Understanding these associations is essential to identify at-risk groups and guide education and support for parents. Hence, this study examined child and parental factors associated with advanced or metastatic stage at diagnosis among Australian children.

Methods

A cross-sectional survey was conducted from January and September 2025 among parents of children aged 0–14 years diagnosed with cancer between 2014 and 2024. A convenience sampling approach was used, recruiting parents accessible through cancer support organisations and through a commercial online market research panel provider. The outcome was parent-reported stage at diagnosis which was dichotomised as advanced/metastatic versus localised. Child factors (age, sex, and cancer type) and parental factors (education, occupation, employment status, household income, country of birth, and region of residence) were examined using univariable and multivariable logistic regression analyses.

Results

There were 126 completed surveys, of these 94 were included in the analysis. There were 51.1% children who had been diagnosed at an advanced or metastatic stage. Girls had higher odds of being diagnosed at an advanced/metastatic stage compared with boys (aOR = 2.88, 95% CI: 1.01 to 8.31; p = 0.049). Children of overseas-born parents were less likely to present with advanced disease than children of Australian-born parents (aOR = 0.28, 95% CI: 0.81 to 0.99; p = 0.048). Parental education was associated with stage at diagnosis; children whose parents had no tertiary education were nearly four times more likely to be diagnosed at an advanced or metastatic stage compared with children of parents with tertiary qualifications (aOR = 5.53, 95% CI: 1.67 to 18.25; p = 0.005). Parental occupation, employment, income and region of residence were not statistically significant to stage of diagnosis.

Conclusions

In Australia, low parent education, parent born in Australia and female sex of the child are linked to diagnosis at advanced-stage childhood cancer. These factors likely affect how parents recognize symptoms and navigate the healthcare system. The findings highlight the need for parent-focused child

health education and parent-support pathways. Future studies should use larger samples to explore social and system-level causes of delayed diagnosis.

Introduction

In high-income countries, childhood cancer remains a leading cause of disease-related mortality among children and adolescents - despite major advances in diagnosis and treatment. Globally, an estimated 400,000 children and adolescents aged 0–19 years are diagnosed with cancer each year [1]. In high-income countries, survival now exceeds 80%, largely due to improvements in specialised paediatric oncology care, risk-adapted therapies, and supportive treatment [2]. However, outcomes continue to vary according to disease characteristics at presentation, particularly stage at diagnosis. Children diagnosed with advanced or metastatic disease generally experience poorer survival outcomes and require more intensive treatment than those diagnosed at earlier stages [1, 2].

Stage at diagnosis is a key clinical and epidemiological indicator in childhood cancer research, as it is closely associated with treatment pathways, prognosis, and survival outcomes, and serves as an important measure for evaluating early detection and health system performance [3, 4]. It reflects the extent of disease spread at the time of diagnosis and is strongly associated with prognosis across many paediatric malignancies [1, 2]. In addition to its prognostic importance, stage at diagnosis is often used as a proxy measure of diagnostic timeliness. Delays in recognising symptoms, seeking medical care, or obtaining referral to specialist services may allow disease progression before diagnosis, increasing the likelihood of advanced-stage presentation [5].

Globally, Australian childhood cancer 5-year survival, supported by specialised paediatric oncology services, comprehensive national cancer registration systems, and universal healthcare, was approximately 86% [6]. Population-based studies using data from the Australian Childhood Cancer Registry have provided important insights into the epidemiology and outcomes of childhood cancers [7]. Application of the Toronto Paediatric Cancer Stage Guidelines has enabled national analyses of stage distribution across major childhood cancer types in Australia [8, 9]. These studies show that while many children are diagnosed with localised or regional disease, a substantial proportion still present with advanced or metastatic cancer [6].

A national population-based study reported that approximately 71% of children with solid tumours were diagnosed with localised or regional disease, although stage distribution varied widely by cancer type [8]. Metastatic disease at diagnosis was relatively common in cancers such as neuroblastoma and certain sarcomas, whereas tumours such as Wilms tumour were more frequently detected at earlier stages [8]. Importantly, survival outcomes differed markedly according to stage, with significantly poorer survival among children presenting with metastatic disease [8]. Similar analyses of childhood blood cancers demonstrated that stage at diagnosis could be assigned for the majority of cases in the national registry and that disease extent at diagnosis was associated with survival differences, particularly for non-Hodgkin lymphoma [9]. More recent analyses have further shown that although childhood cancer

survival has improved over time in Australia, children diagnosed with advanced disease continue to experience substantially worse outcomes [10].

Despite these advances in national surveillance in Australia, the determinants of advanced stage at diagnosis remain poorly understood. Evidence from high-income countries, including Australia, suggests that socioeconomic, parental education, health literacy, and geographic factors could influence symptom recognition, healthcare-seeking behaviour, and navigation of health systems [7, 11]. These factors may affect both the patient interval (time from symptom onset to first healthcare consultation) and the diagnostic interval (time from first presentation to diagnosis), thereby influencing disease stage at detection.

In Australia, structural inequalities related to geographic remoteness, socioeconomic disadvantage, and cultural and linguistic diversity may contribute to variation in access to timely diagnosis and care [12]. Families living in rural and remote areas may face reduced access to primary healthcare, diagnostic imaging, and specialist paediatric services, as well as greater travel burdens associated with care [12]. However, while these factors are recognised contributors to broader health inequities in Australia, their role in shaping the stage at diagnosis for childhood cancer remains insufficiently explored. Existing Australian studies have largely focused on describing stage distribution and stage-specific survival rather than examining the social and demographic determinants of advanced-stage presentation [8–11]. Limited evidence exists on how characteristics such as child sex, parental education, parental country of birth, socioeconomic, and geographic factors may influence the likelihood of presenting with advanced or metastatic disease. Addressing these gaps is important for informing strategies aimed at improving equity in childhood cancer outcomes in Australia.

Methods

Sample Size

Given the rarity of childhood cancer and the constraints of the survey population, a formal sample size calculation was not performed prior to data collection. The target sample was determined based on feasibility and the number of parents accessible through participating organisations (Redkite, The Childhood Cancer, and Pureprofile) Redkite is a national charity that provides practical, emotional, and financial support to children and young people with cancer and their families [13]. The Childhood Cancer Association provides counselling, accommodation, education support, and family services to children with cancer and their families [14]. Pureprofile is an online insights company that conducts market research and consumer profiling using established participant panels [15]A total of 126 parents completed the survey, of which 94 responses were included in the analysis after excluding children for whom conventional tumour staging is not applicable (e.g., leukaemia).

Despite the modest sample size, combining advanced and metastatic stages into a single outcome category increased statistical power to detect meaningful associations between stage at diagnosis and

parental sociodemographic factors. Univariable and multivariable logistic regression analyses were used to estimate associations, acknowledging that the limited sample may reduce the precision of effect estimates and the ability to detect smaller associations. This study is therefore considered exploratory and hypothesis-generating, providing important preliminary evidence for future larger studies.

Ethics Approval

Ethics approval

for this study was obtained from Western Sydney University Human Research Ethics Committee (HREC). The study was conducted in collaboration with Redkite, The Childhood Cancer, and Pureprofile, which provides emotional, financial, and practical support to children with cancer and their families across Australia.

All participants were recruited through Redkite, The Childhood Cancer, and Pureprofile. The Childhood Cancer, and Pureprofile's support programs. All survey data were completed by the adult parents or legal guardians of the participating children. Informed consent to participate was obtained from the adult parents or legal guardians of all participants, including those under the age of 16 years, prior to data collection. Participation was voluntary, and participants were informed of their right to withdraw at any time without consequence.

All data were de-identified prior to analysis to ensure confidentiality and privacy. Data were securely stored in password-protected systems accessible only to the research team. No identifiable information was included in any publications or reports arising from this study.

The study adhered to all relevant ethical guidelines for research involving vulnerable populations, particularly children and families affected by cancer, ensuring that participant wellbeing and confidentiality were maintained throughout the research process.

Data Collection and Study Participants

Data were collected through an online survey administered via Qualtrics between January and September 2025. Participants were recruited through Redkite.

The survey invitation was distributed by the participating organisations, via email, to approximately 1,000 parents and caregivers registered with the organisation whose children had been diagnosed with cancer. Participation was voluntary, and respondents completed the questionnaire anonymously online. Eligible participants were parents or primary caregivers of children diagnosed with cancer who were able to complete the survey in English.

The questionnaire collected information on child characteristics, including age, sex, cancer type, and stage at diagnosis, as well as parental sociodemographic characteristics such as country of birth,

education level, occupation, employment status, household income, and region of residence. Stage at diagnosis was dichotomised as localised or advanced/metastatic to reflect clinically meaningful differences in disease extent, prognosis, and treatment intensity across childhood cancers. When parents are closely involved in their child's care, have been informed about the diagnosis and when survey questions use clear broad staging categories, parent-reported stage at diagnosis in childhood cancer has been considered reasonably reliable [16].

A total of 126 parents completed the survey, corresponding to an approximate response rate of 12.6%. For the present analysis, responses were restricted to children diagnosed with cancers for which tumour staging is clinically applicable. Consequently, 32 responses were excluded because the child had been diagnosed with leukaemia, for which conventional tumour staging systems are not typically used. The final sample included 94 parents of children diagnosed with solid tumours or other cancers with applicable staging classifications.

Study Design and Participants

A cross-sectional study design was used to examine the association between stage at diagnosis of childhood cancer and child characteristics (age, sex and cancer type) as well as parental sociodemographic factors (education, occupation, employment status, household income, country of birth, and region of residence). A convenience sample of parents of children aged 0–14 years who were diagnosed with cancer between January 2014 and December 2024 was recruited in Australia.

Participants were recruited over a seven-month period through three organisations: Redkite, The Childhood Cancer, and Pureprofile. Redkite is a national charity that provides practical, emotional, and financial support to children and young people with cancer and their families [13]. The Childhood Cancer Association provides counselling, accommodation, education support, and family services to children with cancer and their families [14]. Pureprofile is an online insights company that conducts market research and consumer profiling using established participant panels [15].

Convenience sampling was used to recruit readily available participants for the survey. This approach allowed for relatively rapid and cost-effective data collection; however, it may limit the representativeness of the sample and the generalisability of findings due to potential selection bias. Eligible participants were parents residing in Australia who were able to complete the survey in English.

Outcome Variable and Potential Confounding Factors

The primary outcome variable for this study was **s**tage at diagnosis of childhood cancer, classified as localised or advanced/metastatic disease. Due to small sample size and the rarity of childhood cancers, advanced and metastatic stages were combined into a single category. This approach increased statistical power and enabled a more meaningful comparison between children diagnosed with early-stage disease and those presenting with more advanced disease at diagnosis.

Several child- and parent-level variables were considered as potential confounding factors. Child characteristics included age, sex, and cancer type, as these factors may influence both disease progression and the likelihood of early detection. Parent sociodemographic characteristics were also included as potential confounders based on evidence from previous studies examining diagnostic pathways and health inequalities in childhood cancer. These variables included parental country of birth, education level, occupation, employment status, household income, and region of residence and were obtained from previous literature [8, 9]. The survey questionnaire was developed for this study based on a review of the relevant literature (see Supplementary File 1). These factors may influence symptom recognition, healthcare-seeking behaviour, and access to diagnostic services, and therefore could affect the stage at which childhood cancer is diagnosed [7, 9].

Statistical analysis

Descriptive statistics were used to summarise the characteristics of the study population. Categorical variables were presented as frequencies and percentages to describe the distribution of child characteristics (age, sex, cancer type) and parental sociodemographic factors (country of birth, education, occupation, employment status, household income, and region of residence).

A two-sample test of proportions was conducted to compare the proportions of cancer stage at diagnosis in children between this study and national estimates over the past decade. Bivariable analyses were conducted to examine the association between each independent variable and stage at diagnosis (localised versus advanced/metastatic). Associations between categorical variables were assessed using the chi-square test or Fisher's exact test, where appropriate, given the relatively small sample size.

Univariable logistic regression analyses were conducted to examine the unadjusted associations between advanced or metastatic stage at diagnosis and child characteristics (age, sex, and cancer type), as well as parental sociodemographic factors (country of birth, education, occupation, employment status, household income, and region of residence). Associations were reported as unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) and multivariable logistic regression analysis was performed to examine the association between parental sociodemographic factors and the likelihood **of** advanced or metastatic stage at diagnosis, while adjusting for potential confounding variables. Child characteristics, including age, sex, and cancer type, were included in the model as potential confounders based on prior literature and their potential influence on stage at diagnosis. Results from the regression models were reported as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was set at $p < 0.05$. All analyses were conducted using SPSS version 30.

Results

Characteristics of participants

Table 1
Child and parent-reported study characteristics of children with cancer diagnosed (n = 94).

Variables	Categories	n (%)
Age of the child	0 to 9 Years	47 (50.0%)
	10 to 14 Years	47 (50.0%)
Sex	Boy	61 (64.9%)
	Girl	33 (35.1%)
Cancer type	Lymphomas	17 (18.1%)
	Solid tumours including Central Nervous System tumours	77 (81.9%)
Stage	Localised	46 (48.9%)
	Advanced or metastatic	48 (51.1%)
Parent Country of Birth	Australia	60 (63.8%)
	Other	34 (36.2%)
Ethnicity	Australian	60 (63.8%)
	Other	34 (36.2%)
Education	Tertiary education	63 (67.0%)
	No tertiary education	31 (33.0%)
Occupation	Professional/nonmanual	68 (72.3%)
	Manual/trade	26 (27.7%)
Employment Status	Employed	80 (85.1%)
	Unemployed	14 (14.9%)
Income	Above $80,000	44 (46.8%)
	Below $80,000	50 (53.2%)
Region	City	58 (61.7%)
	Rural/Regional	36 (38.3%)

Demographic characteristics of parents

Sixty parents (63.8%) reported their country of birth as Australia, with 34 (36.2%) born overseas (see Table 1). This mirrored the reporting for ethnicity, 60 (63.8%) of parents identified as ‘Australian’ and 34 (36.2%) parents identified as ‘other’. Educational attainment was tertiary for 63 parents (67.0%) and non-tertiary for 31 (33.0%). Employment status indicated that 80 parents (85.1%) were employed and 14 (14.9%) were unemployed; 68 (72.3%) worked in professional or nonmanual roles, and 26 (27.7%) in

manual or trade occupations. Annual household income exceeded $80,000 for 44 families (46.8%) and was below $80,000 for 50 (53.2%). Geographically, 58 families (61.7%) resided in metropolitan areas and 36 (38.3%) in rural or regional locations.

Clinical characteristics of children

Data were available for 94 children and their parents. Age was evenly distributed: 47 children (50.0%) were aged 0–9 years and 47 (50.0%) were aged 10–14 years, supporting balanced examination across developmental stages. In this sample, most children were boys (*n* = 61, 64.9%) and 33 (35.1%) were girls. The most common cancer type was solid tumours including central nervous system (CNS) tumours (*n* = 77, 81.9%), followed by lymphomas 17 (18.1%).

Figure 1 compares the proportions of cancer stages at diagnosis in children between this study and national data. The proportion of localised disease was higher at the national level [17] than in this study, with a difference of 17 percentage points (95% CI: 2%–32%; p = 0.030). In contrast, the proportion of advanced or metastatic disease was higher in our study compared to the national estimate, with a difference of 19 percentage points (95% CI: 4%–34%; p = 0.012). However, the confidence intervals are relatively wide, likely reflecting the small sample size associated with rare diseases such as childhood cancer.

Table 2
Advanced or metastatic stage at diagnosis of childhood cancer: Prevalence, unadjusted odds ratios (OR) and adjusted odds ratios (aOR).

Predictor Variable	Pr	OR (95% CI)	p value	AOR (95% CI)	p value
Child characteristics					
Age in categories					
0–9 years	42.6	1.00		1.00	
10 to 14 Years	59.6	1.98 (0.87–4.52)	0.100	2.05 (0.68–6.13)	0.198
Gender					
Boy	42.6*	1.00		1.00	
Girl	66.7	2.69 (1.11–6.51)	0.028	2.88 (1.01–8.31)	0.049
Cancer type					
Lymphomas	52.9	1.00		1.00	
Solid tumours including CNS tumours	50.7	0.91 (0.31–2.61)	0.864	0.46 (0.12–1.77)	0.261
Parent sociodemographic characteristics					
Parent country of birth					
Australia-born	56.7	1.00		1.00	
Overseas born	41.2	0.53 (0.22–1.25)	0.151	0.28 (0.81–0.99)	0.048
Parent Level of Education					
Tertiary education	38.1***	1.00		1.00	
Non-tertiary education	77.4	5.57 (2.08–14.89)	0.001	5.53 (1.67–18.25)	0.005
Parent Occupation					
Professional	45.6	1.00		1.00	
Manual/trade	65.4	2.25 (0.88–5.76)	0.090	2.53 (0.68–9.37)	0.164
Parent Employment status					
Employed	45.0**	1.00		1.00	

Predictor Variable	Pr	OR (95% CI)	p value	AOR (95% CI)	p value
Unemployed	85.7	7.33 (1.54–34.91)	0.012	4.85 (0.87–27.05)	0.071
Parent Income level					
Above $80,000	47.7	1.00		1.00	
Below $80,000	54.0	1.28 (0.57–2.89)	0.544	0.44 (0.13–1.45)	0.18
Region of residence					
City	41.4*	1.00		1.00	
Rural/Regional	66.7	2.83 (1.19–6.74)	0.019	1.72 (0.61–4.79)	0.298

* p < 0.05; **p < 0.01; ***p < 0.001 by chi-squared test. Pr = Prevalence, CI: Confidence intervals; OR= odds ratios; AOR= adjusted odds ratios.

Unadjusted Analysis

Unadjusted logistic regression analysis was conducted to examine the associations between sociodemographic characteristics and stage at diagnosis of childhood cancer (localised vs advanced/metastatic). Sex was significantly associated with stage at diagnosis (OR = 2.69, 95% CI: 1.11–6.51; *p* = 0.028), indicating that girls had higher odds of being diagnosed at an advanced or metastatic stage compared with boys (Table 2).

Parental education was also significantly associated with stage at diagnosis (OR = 5.57, 95% CI: 2.08–14.89; *p* = 0.001), with children whose parents had no tertiary education more likely to present with advanced or metastatic disease than those whose parents had tertiary education. Similarly, parental employment status showed a significant association (OR = 7.33, 95% CI: 1.54–34.91; *p* = 0.012), indicating that children of unemployed parents had higher odds of advanced or metastatic diagnosis compared with those whose parents were employed. Region of residence was also a significant predictor (OR = 2.83, 95% CI: 1.19–6.74; *p* = 0.019), suggesting that children residing in rural or regional areas were more likely to be diagnosed at an advanced or metastatic stage than those living in urban areas.

Multivariable Analysis

Multivariable logistic regression analysis was conducted to examine the associations between sociodemographic characteristics and stage at diagnosis (localised vs advanced/metastatic) among Australian children with cancer (Table 2).

Sex was significantly associated with stage at diagnosis (AOR = 2.88, 95% CI: 1.01–8.31; *p* = 0.049), indicating that girls had higher odds of being diagnosed at an advanced or metastatic stage compared with boys. Parent country of birth was also statistically significant (AOR = 0.28, 95% CI: 0.08–0.99; *p* = 0.048), suggesting that children of overseas-born parents were less likely to be diagnosed at an advanced or metastatic stage compared with those whose parents were born in Australia. Age of the child was not statistically significant (AOR = 2.05, 95% CI: 0.68–6.13; p = 0.198). Children aged 10–14 years had approximately twice the odds of being diagnosed at an advanced or metastatic stage compared with those aged 0–9 years. Cancer type was also not significantly associated with stage at diagnosis (AOR = 0.46, 95% CI: 0.12–1.77; p = 0.261).

Parental education remained a strong predictor (AOR = 5.53, 95% CI: 1.67–18.25; *p* = 0.005), with children whose parents had no tertiary education having substantially higher odds of advanced or metastatic disease at diagnosis compared with those whose parents had tertiary qualifications. Parental occupation was not statistically significant (AOR = 2.53, 95% CI: 0.68–9.37; p = 0.164), although children of parents in manual occupations had higher, but non-significant, odds of advanced or metastatic stage at diagnosis compared with those whose parents were in professional roles. Parental employment status also did not reach statistical significance (AOR = 4.85, 95% CI: 0.87–27.05; p = 0.071). Household income was not significantly associated with stage at diagnosis (AOR = 0.44, 95% CI: 0.13–1.45; p = 0.180), with lower-income families showing reduced, but non-significant, odds of advanced disease compared with higher-income families. Region of residence was not statistically significant, although children living in rural or regional areas showed higher, but non-significant, odds of advanced or metastatic stage at diagnosis compared with those residing in metropolitan areas.

Discussion

This cross-sectional study examined factors associated with advanced or metastatic stage at diagnosis among Australian children aged 0–14 years with cancer. Despite boys comprising over two-thirds of the study population, girls had higher odds of being diagnosed at an advanced or metastatic stage compared with boys, suggesting potential sex-related differences in the progression of disease. Parental factors were also significantly associated with stage at diagnosis. Children of overseas-born parents were less likely to present with advanced or metastatic disease than those whose parents were born in Australia, and children whose parents had no tertiary education were nearly four times more likely to be diagnosed at an advanced or metastatic stage compared with children of parents with tertiary qualifications. These findings highlight that, even in a high-income country such as Australia with universal healthcare, child and parental sociodemographic characteristics can influence the timeliness of cancer diagnosis.

The association between low parental education and advanced-stage diagnosis aligns with international evidence demonstrating that parental education is a strong determinant of early recognition, health literacy, and healthcare navigation. Educational attainment may serve as a proxy for parental ability to identify early warning signs, seek care promptly, and advocate effectively within the health system [18].

In this study, children of parents without tertiary education were nearly four times more likely to present with advanced-stage disease, consistent with the global literature suggesting that lower educational resources contribute to delays in presentation and diagnosis [1, 2]. Notably, while the observed odds ratio was relatively large, this may partly reflect the modest sample size and potential residual confounding; studies with larger, population-based cohorts typically report smaller, yet consistent, associations. Nevertheless, the direction of the effect is consistent with the broader evidence base, supporting the plausibility of parental education as a key determinant of timely childhood cancer diagnosis.

Children of overseas-born parents had lower odds of advanced-stage diagnosis compared with children of Australian-born parents. Migrant and culturally and linguistically diverse (CALD) populations are often considered at higher risk of delayed diagnosis and inequities in cancer care [8], this study suggests that, in some contexts, overseas-born parents may engage in heightened vigilance, prompt healthcare-seeking behaviour, or better utilisation of supportive services such as Redkite and The Childhood Cancer [13, 14]. The healthy migrant effect may also partially explain this observation, reflecting selective migration of families with better health awareness or higher motivation to seek care [19]. However, given the small sample size, the possibility of residual confounding, and the exploratory nature of the study, this finding should be interpreted cautiously. Further qualitative and mixed-methods research is warranted to explore the mechanisms underlying this pattern and to understand how cultural, behavioural, and system-level factors interact to influence diagnostic timing.

There was an observed sex difference in stage at diagnosis, with girls being more likely to present with advanced disease. The finding underlying mechanisms are not fully understood, though differences in symptom recognition, parental concern, or clinical presentation may play a role. Prior studies in childhood cancer populations are limited, but some evidence suggests that gendered patterns in healthcare utilisation and parental perception of illness can influence time to presentation and stage at diagnosis [5, 8, 11]. In this study, the wide confidence intervals around the estimate indicate some uncertainty, and the true population effect may be smaller. These results highlight the need for further research on sex-specific determinants of diagnostic delay in children with cancer.

Other parental factors, including occupation, employment status, household income, and region of residence, were not statistically significant predictors of advanced-stage diagnosis in this cohort. However, non-significant findings should not be interpreted as evidence of no effect. For instance, children of parents in manual or trade occupations had approximately 2.5 times higher odds of advanced-stage diagnosis compared with children of parents in professional occupations, though this did not reach statistical significance. Such patterns suggest that socioeconomic and occupational factors influenced care-seeking behaviour, awareness of early symptoms, and access to diagnostic services, particularly in this smaller samples with limited statistical power. These observations align with prior international studies showing that socioeconomic disadvantage can contribute to delays in diagnosis and treatment initiation, even in high-income settings [20, 21].

The mechanisms linking stage at diagnosis to; parental education, socioeconomic position, and child sex; likely involve a combination of health literacy, care navigation, symptom recognition, and access to healthcare resources. Parents with higher education may be better able to interpret early symptoms, engage with healthcare providers, and navigate referral pathways efficiently, thereby facilitating earlier diagnosis. Conversely, parents with lower education may encounter barriers in recognising symptoms or accessing care promptly, even when universal healthcare systems exist, resulting in higher likelihood of advanced-stage presentation. These findings underscore the importance of viewing stage at diagnosis not only as a clinical outcome but also as a proxy for social determinants of health in paediatric oncology.

This study highlights actionable policy and practice implications. Interventions that strengthen parental health literacy and support system navigation could reduce disparities in stage at diagnosis. These may include plain-language educational resources, symptom-awareness campaigns that include infographics and videos as well as integration of care navigation services within paediatric oncology pathways. Targeted support for families with lower education or in socioeconomically disadvantaged settings will support early symptom recognition and action. These findings support the Australian Cancer Plan (2024) emphasis on equity-focused initiatives to reduce variations in access, experience, and outcomes across population groups [22].

Strengths and Limitations

This study contributes important exploratory evidence on the social determinants of childhood cancer stage at diagnosis in Australia. The use of multivariable logistic regression enabled adjustment for key child- and parent-level confounders, strengthening analytical validity of the study [23]. Parent-reported stage at diagnosis is considered reliable when parents are closely involved in care, as was the case in this study. Nevertheless, several limitations warrant consideration. The cross-sectional design made it impossible for causal inference, and the modest sample size may have inflated effect estimates and limited precision. Recruitment via support organisations and online platforms, restricted to English-speaking participants, may have underrepresent non-English-speaking families, limiting generalisability [24]. Residual confounding may remain from unmeasured variables - parental health literacy, clinical characteristics, healthcare provider factors. Additionally, children with leukaemia were excluded due to inapplicability of conventional tumour staging, which further reduced sample size. These findings should be interpreted with caution due to the relatively small sample size, as reflected in the wide confidence intervals. Differences between this study and national estimates may also be influenced by potential selection bias and limited representativeness. Furthermore, variations in data sources, staging classifications, and unmeasured confounding factors may have contributed to the observed discrepancies. Despite these limitations, the study provides valuable preliminary insights into the influence of parental education, child sex, and parental country of birth on advanced-stage diagnosis among Australian children with cancer. In conclusion, this study provides exploratory evidence that low parent education, parent born in Australia and female sex of the child are linked to diagnosis at advanced-stage diagnosis among Australian children with cancer. These findings suggest that health

literacy, care navigation, and sociocultural factors are important determinants of early detection. Parent focused interventions that support child-health literacy, health system navigation, and culturally appropriate child-health educational programs may help reduce inequities in timely diagnosis and improve childhood cancer outcomes across Australia. Future research using larger, population-based samples and mixed-methods approaches is needed to further elucidate these relationships and to inform evidence-based policy and practice interventions.

Declarations

Ethics approval and consent to participate

Ethics approval, in accordance with the Declaration of Helsinki, was obtained (ethics reference: H16116) from Human Research Ethics Committee of Western Sydney University. The Participant Information Sheet was included at the start of the survey. Written informed consent was obtained from all participants prior to participation in the study. Participants were provided with detailed information regarding the purpose of the research, study procedures, confidentiality, voluntary participation, and their right to withdraw at any time without consequence. All study procedures were conducted in accordance with the requirements of the approving Human Research Ethics Committee.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare no competing interests.

Funding

Dr Krishna Poudel has obtained a Postgraduate Research Scholarship from the Western Sydney University.

Authors' contributions

KP, DS, EG, KM, and DA contributed to the conceptualization and methodology of the study. KP and DA conducted the formal analysis, and KP was responsible for data curation. The original draft of the manuscript was prepared by KP and DS, with all authors (KP, DS, EG, KM, and DA) contributing to the review and editing process. Supervision was provided by EG, DS, KM, and DA. KP managed project administration.

Acknowledgements

We acknowledge Kingsley Agho, Professor of Biostatistics at Western Sydney University, for his valuable contributions to the data analysis and for critical revision of the manuscript. We would like to thank Redkite, Childhood Cancer and Pureprofile for their support to conduct this study.

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Figures

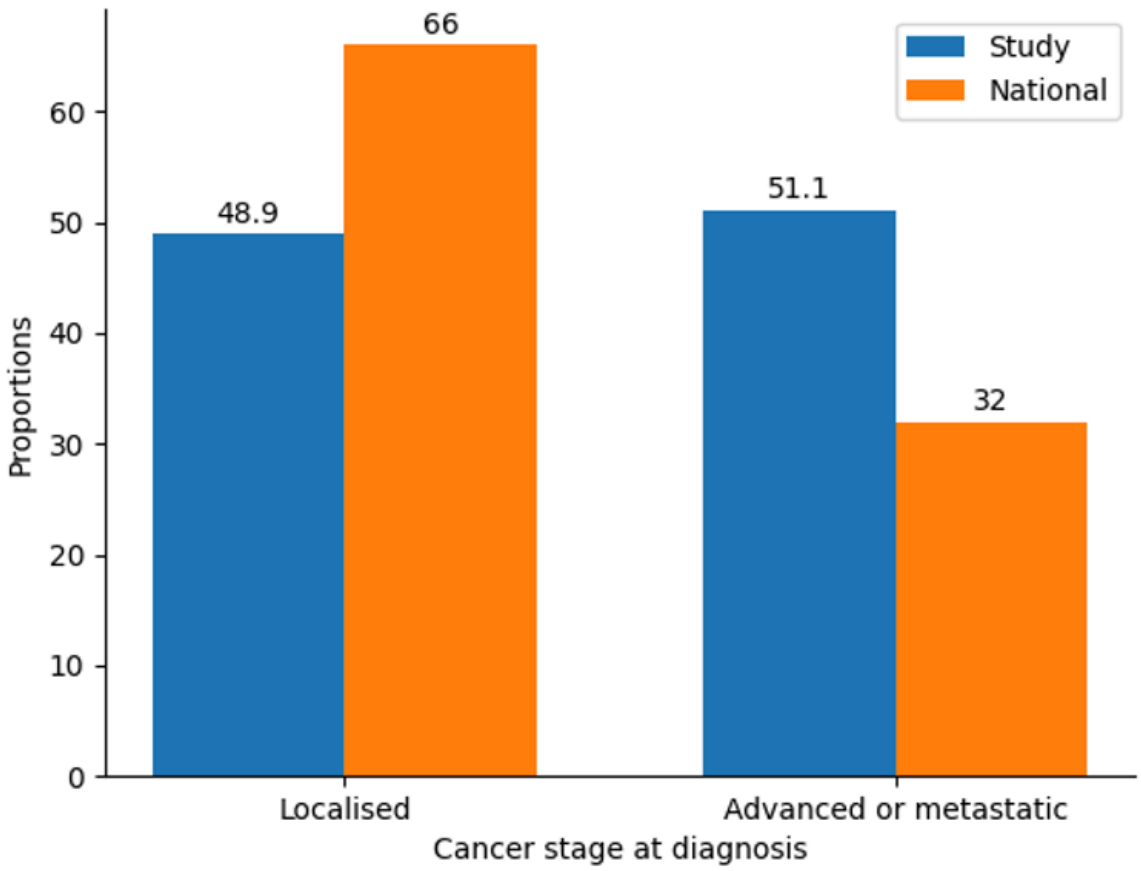


Figure 1

Proportions of the cancer stages at diagnosis in children between this study and national level.