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Sporadic childhood Burkitt lymphoma incidence in the United States during 1992–2005

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Abstract

Background—The risk factors and co-factors for sporadic childhood BL are unknown. We investigated demographic and age-specific characteristics of childhood BL (0–14 years) in the U.S.

Procedure—BL age-standardized incidence rates (2000 U.S. standard population), were calculated using data obtained from 12 registries in the NCI's Surveillance, Epidemiology, and End Results program for cases diagnosed from 1992 through 2005. Incidence rate ratios and 95% confidence intervals (95% CI) were calculated by gender, age-group, race, ethnicity, calendar-year period, and registry.

Results—Of 296 cases identified, 56% were diagnosed in lymph nodes, 21% in abdominal organs, not including retroperitoneal lymph nodes, 14% were Burkitt cell leukemia, and 9% on face/head structures. The male-to-female case ratio was highest for facial/head tumors (25:1) and lowest for Burkitt cell leukemia (1.6:1). BL incidence rate was 2.5 (95% CI 2.3–2.8) cases per million person-years and was higher among boys than girls (3.9 vs. 1.1, $p<0.001$) and higher among Whites and Asians/Pacific Islanders than among Blacks (2.8 and 2.9 vs. 1.2, respectively, $p<0.001$). By ethnicity, BL incidence was higher among non-Hispanic Whites than Hispanic Whites (3.2 vs. 2.0, $p=0.002$). Age-specific incidence rate for BL peaked by age 3–5 years (3.4 cases per million), then stabilized or declined with increasing age, but it did not vary with calendar-year or registry area.

Conclusions—Our results indicate that early childhood exposures, male-sex, and White race may be risk factors for sporadic childhood BL in the United States.

Keywords

epidemiology; pediatric cancer; non-Hodgkin lymphoma; HIV/AIDS

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Introduction

Burkitt lymphoma (BL) is an aggressive B cell non-Hodgkin lymphoma (NHL) first described in African children fifty years ago [1]. It appears to be the commonest childhood cancer in equatorial Africa and Papua New Guinea [2] and, hence, it is considered endemic there. Elsewhere, it is considered to be sporadic [3]. Endemic and sporadic BL are indistinguishable by histology or by the obligate translocation between cellular (c)-*MYC* on chromosome 8q and immunoglobulin genes on chromosome 14q or, less frequently, on 2q or 22q [4]. Endemic BL is epidemiologically linked to Epstein-Barr virus (EBV) [5,6], and integrated or clonal EBV is detected in most (95%) endemic BL tumors [7]. Endemic BL is also linked to *Plasmodium falciparum* malaria [8–10], which may increase BL risk directly through polyclonal stimulation of B cells or indirectly by impairing immunologic control of EBV infection [11], thereby amplifying EBV's effects on BL risk.

The etiology of sporadic BL, which is the third most common histologically-specified childhood lymphoid malignancy among children of age less than 15 years after acute lymphoblastic leukemia (ALL) and Hodgkin lymphoma, and is the most common subtype of NHL in the United States [12], is obscure. In an analysis of a clinical series of sporadic BL cases, using data from the American Burkitt Lymphoma Registry (derived from voluntary physician referrals and cases identified from the literature) some 25 years ago, sporadic childhood BL was more common among Whites than racial minorities and among boys than girls [3]. However, potential biases acknowledged by the authors, including voluntary reporting of cases and the relatively small number of childhood cases (n=163) preclude generalization of those findings. EBV appears less important in sporadic BL because integrated or clonal EBV-DNA is detected in, at most, 20% of tumors [13]. Malaria is not relevant in sporadic BL. We, therefore, studied the age-, sex-, and racial-patterns of childhood BL in the United States using data from the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) program to gain insights into epidemiologic characteristics of sporadic BL.

Methods

Study population

We analyzed BL data (SEER site recode=NHL or leukemia and International Classification of Diseases for Oncology, Third Edition (ICD-O-3)[14] morphology code 9687 or 9826) for children diagnosed at ages 0–14 years during 1992–2005 using data from the SEER 13 Registries Databases (www.seer.cancer.gov, released April 2008, based on the November 2007 submission). SEER 13 Registries Databases have high-quality, unbiased, population-based cancer data from 6 states (Hawaii, Iowa, New Mexico, Alaska, Connecticut, and Utah) and 7 metropolitan or rural area cancer registries (San Francisco-Oakland, Detroit, Seattle (Puget Sound), Atlanta, San Jose-Monterey, Los Angeles, and rural Georgia), covering approximately 14% of the U.S. general population. Because only one case was diagnosed in the Alaskan Cancer Registry, this registry was excluded from analysis. Although BL data from 1973–1991 are available for nine SEER registries, analysis was restricted to the period 1992–2005 because more extensive racial and ethnicity data were available since 1992.

Statistical methods

BL incidence rates (cases per million person-years), age-adjusted by the direct method (2000 U.S. standard population), were calculated for five 3-year age-groups (0–2, 3–5, 6–8, 9–11, 12–14 years), race (White, Black, Asian/Pacific Islander), ethnicity (non-Hispanic or Hispanic White), calendar-year period (1992–1996, 1997–2001, 2002–2005), and primary anatomic site. Primary sites were grouped into mutually exclusive categories of lymph node, abdominal, Burkitt cell leukemia (bone marrow infiltration), and face or head, based on ICD-O-3

topographical codes[14]. Only two cases arose in the central nervous system, so these were arbitrarily grouped with Burkitt cell leukemia. Incidence rate ratios across categories and 95% confidence intervals (95% CI) were calculated using the Tiwari method [15]. Two-sided *p*-values <0.05 were considered statistically significant. Consistent with SEER policy not to present unstable rates, incidence rates were not presented for categories with less than 16 cases. Because there were less than 16 cases for certain anatomic sites among females, we explored gender patterns at anatomic site for three 5-year age groups (0–4, 5–9, 10–14 years) by calculating case-ratios by gender.

Results

Demographic and clinical characteristics of BL

Overall, 296 cases of BL (average 21 per year) were diagnosed among children ages 0–14 years old during 1992–2005, accounting for approximately 30% of childhood NHL (excluding leukemia). Most (79%) cases were male and 81% were White. Most cases (27%) were diagnosed in children aged 3–5 years, followed by children aged 6–8 years (25%), and only 6% occurred in children aged 0–2 years (Table I). The mean age at diagnosis was 7.8 years (standard deviation [SD] 3.7), and it was not different for females and males (6.7 vs. 7.3 years, *p*=0.7) or for Blacks and Whites (5.5 vs. 7.5 years, *p*=0.2). However, the mean age was higher for non-Hispanic Whites than Hispanic Whites (7.7 vs. 5.9 years, *p*=0.04).

BL tumors most frequently arose in the lymph nodes (56%), the abdomen (21%, primarily in the small or large intestine), and bone marrow (14%, also called Burkitt cell leukemia); nine percent arose on the face or head (primarily in the oral cavity or the oropharynx). For nodal BL, the majority (42%) involved lymph nodes draining multiple sites or unspecified lymph nodes (20%), but among lymph nodes draining specified regions, about half (20%) involved lymph nodes draining the face, head or neck and half (18%) involved lymph nodes draining intra-abdominal or retroperitoneal organs.

Overall, BL predominated among boys (M:F case-ratio 3.7:1), but the case-ratio varied by primary anatomical site (Table II). The M:F case-ratio was highest for face or head tumors (25:1, based on only one case in a female) and lowest for Burkitt cell leukemia (1.6:1). The M:F case-ratios for nodal and abdominal tumors were similar to the overall ratio.

As a proportion of BL cases involving specified anatomic sites, leukemic BL was more common in younger children (21% among 0–4 year olds vs. 10% among 10–14 year olds), while abdominal BL was common in older children (14% among 0–4 year olds vs. 25% among 10–14 year olds). The proportion of cases presenting as nodal and facial/head BL did not vary greatly with age. However, the proportions presenting at these different anatomic sites were not statistically different.

Cross-sectional age-standardized and age-specific BL incidence

The overall BL incidence rate was 2.5 (95% CI 2.3–2.8) cases per million person-years and was higher among boys than girls (3.9 vs. 1.1, respectively; *p*<0.001; male: female (M:F) rate ratio 3.5:1; Table I). BL incidence rates increased rapidly with age from 0.7 cases per million person-years among children of age 0–2 years to 3.4 among those of age 3–5 years and then stabilized or declined slightly among older children. BL incidence rates were higher among males than females in all age groups (Figure 1). By race, BL incidence was higher among Whites and Asians/Pacific Islanders than among Blacks (2.8 and 2.9, vs. 1.2, respectively, both *p*<0.001). By ethnicity, BL incidence was higher among non-Hispanic White than among Hispanic White (3.2 vs. 2.0, *p*=0.002). Overall BL incidence rates did not vary significantly by calendar-year or by registry.

Discussion

Our results suggest that sporadic childhood BL in the United States is characterized by early age onset (3–5 years) and by predominance in boys (79%) and in Whites (81%). BL incidence was highest among non-Hispanic Whites and Asians/Pacific Islanders, intermediate in Hispanic Whites, and lowest among Blacks, in agreement with findings from the American Burkitt Lymphoma Registry some 25 years ago [3]. Incomplete case ascertainment, bias, and small sample size were limitations of that study, but they are unlikely to be important in the current study, which was based on high-quality, unbiased, population-based data from SEER cancer registries.

Our finding of higher risk of sporadic BL among non-Hispanic Whites than Hispanic Whites or Blacks is in accord with earlier studies [3,16], but is unexplained. Similar racial patterns have been reported for most lymphoid malignancies, including non-BL NHL subtypes, pediatric Hodgkin lymphoma, and acute lymphocytic leukemia (ALL) [2,17,18], suggesting they are due to shared risk factors among lymphoid malignancies, such as socioeconomic status, which has been positively associated with ALL in some [19,20] but not all studies [21]. Socioeconomic status is postulated to modulate the risk for lymphoid malignancy by influencing the age of exposure to common childhood infections, including EBV [22]. Specifically, early age at exposure, such as occurs in socially disadvantaged children, is thought to modulate early immune function, which is considered protective for lymphoid malignancy. Conversely, later age exposure to infections, as may occur in socially advantaged groups [23], is thought to result in delayed or anomalous immune maturation leads and aberrant immune responses to infections, and is considered a risk factor for lymphoid malignancy. Because children in socially disadvantaged minorities are exposed to and infected by EBV at a younger age than in socially advantaged Whites [22], the reduced risk for sporadic BL among Blacks and Hispanic-Whites may reflect protective effects of early EBV infection. Our finding of rapidly accelerating BL incidence among very young children, most of them White, challenges the notion, based mostly on studies conducted among African children [6], that early childhood EBV infection is a risk factor for childhood BL.

The incidence rate of sporadic childhood BL in the United States was 10-fold lower than the incidence of endemic BL that we recently reported in northern Uganda (2.5 vs 25 cases per million) [24]. Nonetheless, we noted some similarities in the age and clinical presentation patterns of U.S. and Ugandan BL [24]. In both, the risk peaked rapidly in mid-childhood and then declined, albeit more gradually in sporadic BL. This pattern suggests a fundamental similarity in the acute increase in BL risk in relation to diverse age-specific exposure to cofactors, whose effects wane as children mature. In Africa, EBV and malaria are considered the likely co-factors [25], but they are not relevant in sporadic BL in the United States, where children with sporadic BL often have not been exposed to EBV, and malaria is not even a theoretical possibility. In both sporadic and endemic BL, face and/or head presentations of BL were especially frequent in males than females. Our finding of male predominance of BL mirrors the reported general pattern of male predominance for lymphoid malignancies and other, but not all, cancers [16]. The basis for male predominance is unclear, but it prompted us to wonder whether genes on sex chromosomes that modulate developmental milestones [26] contribute. Some of us have previously speculated [24] that, possibly, earlier age at and/or faster rate of deciduous teeth, a developmental stage controlled by genes on the Y-chromosome [26], could explain the male preponderance of face or head BL in Uganda [24].

Some contrasts were evident. Sporadic BL arose more often in lymph nodes and bone marrow (leukemic BL), but these sites are rarely involved in endemic BL [24]. Misclassification of site is possible, but probably would not differ by gender. Thus, anatomic sites involved in BL probably suggest clues about portals of exposure to potential causal infectious agents. While

BL is easily identified by histological appearance [27] and BL leukemia would be readily identified by a routine blood examination, diagnostic misclassification of BL and diffuse large B cell lymphoma is also a concern [28], but it would be random and would not cause the patterns we observed.

A major strength of our study is our use of population-based, geographically, racially and ethnically diverse high-quality cancer registry data. However, the limitations include possible distortion of incidence rates by the HIV/AIDS epidemic [29]. Children with HIV/AIDS experience a dramatically elevated risk for BL (some 650-fold increase compared to the incidence in the general population) in the two year-period from AIDS-diagnosis[29]. However, this result was based on 9 cases linked to 4954 children with AIDS diagnosed from 1978–1996. The absolute contribution of AIDS-BL to sporadic BL is likely small, consistent with the relatively small size of the pediatric AIDS epidemic in the United States [30]. In support, only 2 (2%) of 97 BL cases diagnosed in Connecticut and Los Angeles cancer registries during 1993 through 2005 were linked to a child with AIDS in the U.S. HIV/AIDS Cancer Match study (unpublished data). Our finding that childhood BL incidence was stable over 14 years and across registries agrees with findings by others that long-term NHL rates in similarly aged children have been stable [31], and contrasts with the dramatic increase of NHL by calendar-year and in certain registry regions among middle-aged males in the U.S. during the AIDS era [32]. The higher incidence of sporadic BL in White children mirrors findings from earlier studies [3,16] and the general pattern observed in other lymphoid malignancies [2,18], and is unlikely to be due to the AIDS epidemic because the majority of children with AIDS in this period were Black[29]. We lacked access to blood or tumor tissue samples from the children diagnosed with BL and thus could not examine HIV serology, EBV serology, or EBV tumor status. However, such studies, done by race, gender, age and tumor location, might lead to insights as to the role of EBV and HIV in sporadic BL.

To summarize, we have updated the descriptive epidemiology of sporadic childhood BL in the United States, last studied more than 25 years ago. Sporadic BL predominated among males and among non-Hispanic Whites in U.S. children, suggesting that male sex and factors correlated with race may be risk factors for sporadic BL.

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References

1. Burkitt D. A sarcoma involving the jaws in African children. *Br J Surg* 1958;46(197):218–223. [PubMed: 13628987]
2. Stiller CA, Parkin DM. International variations in the incidence of childhood lymphomas. *Paediatr Perinat Epidemiol* 1990;4(3):303–324. [PubMed: 2374749]
3. Levine PH, Kamaraju LS, Connelly RR, et al. The American Burkitt's Lymphoma Registry: eight years' experience. *Cancer* 1982;49(5):1016–1022. [PubMed: 7059918]
4. Brady G, MacArthur GJ, Farrell PJ. Epstein-Barr virus and Burkitt lymphoma. *J Clin Pathol* 2007;60(12):1397–1402. [PubMed: 18042696]
5. Thorley-Lawson DA, Gross A. Persistence of the Epstein-Barr virus and the origins of associated lymphomas. *N Engl J Med* 2004;350(13):1328–1337. [PubMed: 15044644]
6. de-The G, Geser A, Day NE, et al. Epidemiological evidence for causal relationship between Epstein-Barr virus and Burkitt's lymphoma from Ugandan prospective study. *Nature* 1978;274(5673):756–761. [PubMed: 210392]
7. Rochford R, Cannon MJ, Moormann AM. Endemic Burkitt's lymphoma: a polymicrobial disease? *Nat Rev Microbiol* 2005;3(2):182–187. [PubMed: 15685227]

8. Carpenter LM, Newton R, Casabonne D, et al. Antibodies against malaria and Epstein-Barr virus in childhood Burkitt lymphoma: a case-control study in Uganda. *Int J Cancer* 2008;122(6):1319–1323. [PubMed: 18000823]
9. Mitalima N, Molyneux E, Jaffe H, et al. Associations between Burkitt lymphoma among children in Malawi and infection with HIV, EBV and malaria: results from a case-control study. *PLoS ONE* 2008;3(6):e2505. [PubMed: 18560562]
10. Burkitt D. A children's cancer dependent on climatic factors. *Nature* 1962;194:232–234. [PubMed: 13874900]
11. Rasti N, Wahlgren M, Chen Q. Molecular aspects of malaria pathogenesis. *FEMS Immunol Med Microbiol* 2004;41(1):9–26. [PubMed: 15094163]
12. Ries, L.; Melbert, D.; Krapcho, M., et al. SEER Cancer Statistics Review, 1975–2005. National Cancer Institute; Bethesda, MD: http://seer.cancer.gov/csr/1975_2005/, based on November 2007 SEER data submission, posted to the SEER web site, 2008
13. Teitell MA, Lones MA, Perkins SL, et al. TCL1 expression and Epstein-Barr virus status in pediatric Burkitt lymphoma. *Am J Clin Pathol* 2005;124(4):569–575. [PubMed: 16146820]
14. Fritz, A.; Percy, C.; Jack, A., et al., editors. International Classification of Diseases for Oncology. Vol. 3. Geneva (Switzerland): World Health Organization; 2000.
15. Tiwari RC, Clegg LX, Zou Z. Efficient interval estimation for age-adjusted cancer rates. *Stat Methods Med Res* 2006;15(6):547–569. [PubMed: 17260923]
16. Li J, Thompson TD, Miller JW, et al. Cancer incidence among children and adolescents in the United States, 2001–2003. *Pediatrics* 2008;121(6):e1470–1477. [PubMed: 18519450]
17. Linet MS, Devesa SS. Descriptive epidemiology of childhood leukaemia. *Br J Cancer* 1991;63(3):424–429. [PubMed: 2003985]
18. Landgren O, Caporaso NE. New aspects in descriptive, etiologic, and molecular epidemiology of Hodgkin's lymphoma. *Hematol Oncol Clin North Am* 2007;21(5):825–840. [PubMed: 17908622]
19. Raaschou-Nielsen O, Obel J, Dalton S, et al. Socioeconomic status and risk of childhood leukaemia in Denmark. *Scand J Public Health* 2004;32(4):279–286. [PubMed: 15370768]
20. Little, J. Epidemiology of childhood cancer. Vol. 149. Lyon, France: IARC Scientific Publications; 1999. p. 15–19.
21. Smith A, Roman E, Simpson J, et al. Childhood leukaemia and socioeconomic status: fact or artefact? A report from the United Kingdom childhood cancer study (UKCCS). *Int J Epidemiol* 2006;35(6):1504–1513. [PubMed: 16945940]
22. Brodsky AL, Heath CW Jr. Infectious mononucleosis: epidemiologic patterns at United States colleges and universities. *Am J Epidemiol* 1972;96(2):87–93. [PubMed: 4340252]
23. Mueller N. An epidemiologist's view of the new molecular biology findings in Hodgkin's disease. *Ann Oncol* 1991;2 (Suppl 2):23–28. [PubMed: 1646623]
24. Ogwang MD, Bhatia K, Biggar RJ, et al. Incidence and geographic distribution of endemic Burkitt lymphoma in northern Uganda revisited. *Int J Cancer* 2008;123(11):2658–2663. [PubMed: 18767045]
25. Biggar RJ, Henle W, Fleisher G, et al. Primary Epstein-Barr virus infections in African infants. I. Decline of maternal antibodies and time of infection. *Int J Cancer* 1978;22(3):239–243. [PubMed: 212369]
26. Alvesalo L. Sex chromosomes and human growth. A dental approach *Hum Genet* 1997;101(1):1–5.
27. Steliarova-Foucher E, Stiller C, Lacour B, et al. International Classification of Childhood Cancer, third edition. *Cancer* 2005;103(7):1457–1467. [PubMed: 15712273]
28. Aldoss IT, Weisenburger DD, Fu K, et al. Adult Burkitt lymphoma: advances in diagnosis and treatment. *Oncology (Williston Park)* 2008;22(13):1508–1517. [PubMed: 19133605]
29. Biggar RJ, Frisch M. Estimating the Risk of Cancer in Children With AIDS. *JAMA* 2000;284(20):2593–2594. [PubMed: 11086360]
30. Epidemiology of HIV/AIDS--United States, 1981–2005. *MMWR Morb Mortal Wkly Rep* 2006;55(21):589–592. [PubMed: 16741494]
31. Weisenburger DD. Epidemiology of non-Hodgkin's lymphoma: recent findings regarding an emerging epidemic. *Ann Oncol* 1994;5 (Suppl 1):19–24. [PubMed: 8172811]

32. Eltom MA, Jemal A, Mbulaiteye SM, et al. Trends in Kaposi's sarcoma and non-Hodgkin's lymphoma incidence in the United States from 1973 through 1998. *J Natl Cancer Inst* 2002;94(16):1204–1210. [PubMed: 12189223]

Figure 1. Burkitt lymphoma incidence rates per million person-years among males (—) and females (---) by 3-year age groups, vertical bars indicate 95% confidence intervals for age-specific incidence rates

Table 1

Incidence and relative risk of childhood Burkitt lymphoma in the United States by selected demographic characteristics, 12 SEER registries*, 1992–2005

Characteristic	N	%	Incidence rate [†]	RR [±]	95% CI	p-value
Sex						
Female	63	21%	1.1	Ref.	1.0	
Male	233	79%	3.9	3.53	2.67–4.75	<0.001
Age group, years						
0–2	17	6%	0.7	Ref.	1.0	
3–5	81	27%	3.4	4.77	2.80–8.58	<0.001
6–8	75	25%	3.2	4.50	2.63–8.12	<0.001
9–11	62	21%	2.6	3.70	2.14–6.76	<0.001
12–14	61	21%	2.7	3.72	2.15–6.81	<0.001
Race [~]						
White	240	81%	2.8	Ref.	1.0	
Black	19	7%	1.2	0.42	0.25–0.67	<0.001
Asian/Pacific Islander	35	11%	2.9	1.03	0.70–1.48	0.92
Ethnicity						
White, non-Hispanic	184	77%	3.2	Ref.		
White, Hispanic	56	23%	2.0	0.62	0.45–0.84	<0.001
Calendar year						
1992–1996	96	32%	2.3	Ref.		
1997–2001	108	37%	2.6	1.09	0.82–1.45	0.58
2002–2005	92	31%	2.7	1.16	0.86–1.56	0.35
Registry						
All	296	100%		Ref.		
San Francisco-Oakland	25	9%	2.3	0.92	0.59–1.38	0.78
Connecticut	26	9%	2.7	1.07	0.68–1.58	0.81
Detroit (Metropolitan)	28	10%	2.2	0.89	0.58–1.31	0.63
Hawaii	9	3%	-	-	-	-
Iowa	24	8%	2.9	1.15	0.72–1.74	0.58
New Mexico	12	4%	-	-	-	-
Seattle (Puget Sound)	38	13%	3.3	1.32	0.92–1.86	0.13

Characteristic	N	%	Incidence rate [†]	RR [±]	95% CI	p-value
Utah	25	8%	3.1	1.23	0.79–1.86	0.36
Atlanta (Metropolitan)	23	8%	2.7	1.06	0.66–1.62	0.85
San Jose-Monterey	14	5%	-	-	-	-
Los Angeles	71	24%	2.3	0.90	0.68–1.16	0.44
Rural Georgia	1	0.3%	-	-	-	-
Tumor site						
Lymph node	167	56%	1.4	Ref.		
Abdomen	62	21%	0.5	0.37	0.27–0.50	<0.001
Burkitt cell leukemia [§]	41	14%	0.4	0.24	0.17–0.34	<0.001
Face/Head	26	9%	0.2	0.16	0.10–0.24	<0.001

* The Alaskan Native Registry (1 case) was excluded, and consistent with SEER policy, incidence rates are suppressed when cases are fewer than 16;

[†] Rate per million person-years, age-adjusted to the U.S. standard population (2000);

[±] Rate ratio (Relative risk, RR) based on unrounded rates;

[~] Race was not specified for two cases;

[§] Two cases with primary central nervous system were arbitrarily grouped with Burkitt cell leukemia

Table II

Childhood Burkitt lymphoma cases and male-to-female case ratios by tumor location, 12 SEER Registries, 1992–2005

Characteristic	Males	Females	Male/Female case ratio [*]
All cases	233	63	3.7
Lymph node	132	35	3.8
Abdomen	51	11	4.6
Burkitt cell leukemia	25	16	1.6
Face/head	25	1	25.0

* Male to female case-ratio used because SEER does not calculate rates based on fewer than 16 cases