

The Incidence of Positional Plagiocephaly: A Cohort Study



WHAT'S KNOWN ON THIS SUBJECT: The incidence of plagiocephaly varies widely and is based on anecdotal evidence of increase in the number of referrals to specialty clinics. Five studies have produced varying results, indicating that the incidence of plagiocephaly ranges from 3.1% to 61.0%.



WHAT THIS STUDY ADDS: This is the first study to estimate the incidence of positional plagiocephaly using 4 community-based data collection sites in infants ranging from 7 to 12 weeks of age. The estimated incidence of positional plagiocephaly was found to be 46.6%.

abstract

OBJECTIVE: The objective of this study was to estimate the incidence of positional plagiocephaly in infants 7 to 12 weeks of age who attend the 2-month well-child clinic in Calgary, Alberta, Canada.

METHODS: A prospective cohort design was used to recruit 440 healthy full-term infants (born at ≥ 37 weeks of gestation) who presented at 2-month well-child clinics for public health nursing services (eg, immunization) in the city of Calgary, Alberta. The study was completed in 4 community health centers (CHCs) from July to September 2010. The CHCs were selected based on their location, each CHC representing 1 quadrant of the city. Argenta's (2004) plagiocephaly assessment tool was used to identify the presence or absence of plagiocephaly.

RESULTS: Of the 440 infants assessed, 205 were observed to have some form of plagiocephaly. The incidence of plagiocephaly in infants at 7 to 12 weeks of age was estimated to be 46.6%. Of all infants with plagiocephaly, 63.2% were affected on the right side and 78.3% had a mild form.

CONCLUSIONS: To our knowledge, this is the first population-based study to investigate the incidence of positional plagiocephaly using 4 community-based data collection sites. Future studies are required to corroborate the findings of our study. Research is required to assess the incidence of plagiocephaly using Argenta's plagiocephaly assessment tool across more CHCs and to assess prevalence at different infant age groups. The utility of using Argenta's plagiocephaly assessment tool by public health nurses and/or family physicians needs to be established. *Pediatrics* 2013;132:298–304

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KEY WORDS

incidence, nonsynostotic plagiocephaly, positional plagiocephaly, deformational plagiocephaly

ABBREVIATIONS

CHC—community health center

SIDS—sudden infant death syndrome

Dr Mawji conceptualized and designed the study, drafted data collection instruments, collected data at the 4 sites, analyzed data, and drafted the initial manuscript; Dr Vollman conceptualized and designed the study, finalized data collection instruments, coordinated and supervised data collection at the 4 sites, and reviewed and revised the manuscript; Dr Hatfield conceptualized and designed the study, and reviewed and revised the manuscript; Dr McNeil finalized data collection instruments, supervised data analysis, and reviewed and revised the manuscript; Dr Sauvé supervised data analysis, and reviewed and revised the manuscript; and all authors approved the final manuscript as submitted.

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In 1992, the American Academy of Pediatrics released a statement recommending that healthy infants be placed in the supine position (ie, on their backs) to sleep.¹ Canada followed suit in February 1999, when the Canadian Foundation for the Study of Infant Deaths, the Canadian Paediatric Society, and the Canadian Institute for Child Health released a joint statement titled "Reducing the Risk of Sudden Infant Death Syndrome (SIDS) in Canada." The current version of the statement recommends that all healthy infants be placed supine to sleep.² Evidence supports the supine sleep position to reduce the incidence of SIDS; indeed, SIDS mortality in Canada decreased from 144 deaths (26% of all postneonatal deaths) in 1999 to 76 deaths (18% of all postneonatal deaths) in 2004.³ However, although the benefit of supine sleeping is reduced infant mortality, it is not without consequence. The supine sleep position has been thought to contribute to an increase in positional plagiocephaly across Canada.^{4,5} Plagiocephaly is defined as a deformation of the skull producing the appearance of an oblique (asymmetric) head.⁶ Deformational plagiocephaly refers to the external molding forces that are associated with parents' or caregivers' positioning of infants during sleep and other activities.^{7,8}

Infants with plagiocephaly present with unilateral occipital flattening where 1 side of the occiput is flattened, and contralateral occipital bulging where the other side of the occiput is rounded.⁹ Infants with more severe plagiocephaly may also have asymmetric faces that might include (1) forehead protrusion ipsilateral (same side) to the occipital flattening, (2) forehead flattening ipsilateral to the occipital rounding, (3) ear displacement where the ear on the side of the occipital flattening is located anteriorly and below when compared with the location of the other ear, and

(4) chin deviation where the chin points in direction to the side opposite of the occipital flattening.^{9,10} Plagiocephaly is of significant concern because if it is not diagnosed and treated early, the associated changes in the described facial features can be permanent.¹¹ This permanent change in facial features may have adverse psychosocial implications for the child that may put him or her at increased risk for teasing and bullying during school years. The helmet approach to treating positional plagiocephaly has been proven effective and is well documented.^{12–24} However, little research has been undertaken to determine the incidence of positional plagiocephaly. Clinicians working at Head Shape Clinics in Canada have reported anecdotally more infants attending these specialty clinics.^{4,5,25} No surveillance system exists at present in Canada to capture data on plagiocephaly. To our knowledge, this is the first population-based study investigating the incidence of positional plagiocephaly using 4 community-based data collection sites. The objective of this study was to estimate the incidence of positional plagiocephaly in infants 7 to 12 weeks of age who attended a 2-month public health well-child immunization clinic in Calgary, Alberta, Canada. More than 95% of infants in Calgary attend these clinics to receive their childhood immunizations, along with an infant and family assessment conducted by a registered nurse.

METHODS

We used a prospective cohort design in this study. Healthy full-term infants (born at ≥ 37 weeks of gestation) ranging from 7 to 12 weeks of age who presented at well-child clinics in the city of Calgary, Alberta, were included in the study. Access was given in 4 community health centers (CHCs) from July to September 2010 to complete the

data collection. The 4 CHCs were selected based on their location, each CHC representing 1 quadrant of the city. Selecting 1 CHC from each quadrant of the city increased the likelihood that the results would be representative of the larger population in the city of Calgary. A sample size of 384 was considered adequate to detect population incidence using a confidence interval of 0.95, $P = .5$, and the margin of error (e) = 0.05.²⁶ Ethical approval was received from the Conjoint Health Research Ethics Board from the University of Calgary on June 3, 2010.

Argenta's plagiocephaly assessment tool²⁷ was used to estimate the incidence of positional plagiocephaly. According to Argenta's tool,²⁷ abnormalities that are clinically visible are classified according to whether they are present or absent. No anthropometric measurements are taken and minimal abnormalities that require precise measurements are not considered clinically relevant. Argenta²⁷ provides guidelines for assessing plagiocephaly based on 4 positions of observational examination that result in the identification of 1 of 5 types of plagiocephaly. With the infant in the first examination position, the clinician observes the forehead and face anteriorly to ascertain if any asymmetries are present. The second position for examination is to view the infant's head directly from above. The index fingers of the examiner are placed in each external auditory canal to allow evaluation of forehead asymmetry, posterior cranial asymmetry, and malposition of the ears. Viewing from directly above allows also for identification of abnormal bulging of the temporal fossa. In the third observational position, the clinician stands behind the infant's posterior skull to confirm ear position and posterior asymmetry, and widening of the posterior skull. The fourth examination position is a direct lateral

view. This position allows the clinician to ascertain any degree of abnormal vertical growth of the skull, which may be observed in more severe forms of plagiocephaly wherein the restrained brain makes an effort to decompress. After receiving informed consent, assessments were completed by the primary author (A. M.) or a trained registered nurse research assistant while the parent(s)/guardian(s) held the infant. To ensure reliability, both the primary author and research assistant spent 8 or more hours conducting plagiocephaly assessments with clinicians at the Head Shape Clinic. For the first week of the study, assessments were conducted together to ensure that the same classification, according to the 5 types of plagiocephaly in Argentina's plagiocephaly assessment tool,²⁷ was obtained. They convened also halfway through and near the end of data collection to ensure their plagiocephaly assessments were conducted in a consistent fashion. In addition to the type of plagiocephaly recorded on the data collection tool, the severity of plagiocephaly observed in terms of mild, moderate, or severe was recorded. The side of the head on which the plagiocephaly was observed and whether the infants identified with plagiocephaly also demonstrated accompanying features of brachycephaly were recorded.

RESULTS

During the data collection time frame, 1712 infants were eligible to participate in the study. To account for potential attrition, the plan was to consecutively recruit 461 infants. Because there were 2 individuals collecting data and 4 data collection sites, the data collectors rotated through the 4 sites. We approached the first 486 parents/guardians who attended the 2-month well-child clinics on data collection days at the 4 data collection sites. Of the 486 (28.4% of

eligible) parents/guardians of infants who were approached to participate in the study, 440 infants (25.7% of those eligible and 90.5% of those approached) were included in the study. Although only healthy infants were included, the authors did not use computed tomography scans to rule out cases of synostotic plagiocephaly. The mean age of the infants was 2.25 months. Of the 440 infants, 261 were boys and 179 were girls. Table 1 presents socioeconomic indicators of the populations served by the 4 clinics. The incidence of plagiocephaly was estimated to be 46.6% (Table 2). In Table 3, the type of plagiocephaly and the corresponding side of the infant's head on which the plagiocephaly was observed is presented. Of all infants identified as having plagiocephaly, 63.2% were affected on the right side. All infants were assessed subjectively for severity of positional plagiocephaly: mild, moderate, or severe. Of all infants

identified as having plagiocephaly, 78.3% had a mild form (Table 4). As presented in Table 5, of all infants observed to have plagiocephaly, 3.9% also showed the characteristic symmetrically flattened occiput associated with brachycephaly.

DISCUSSION

The incidence of plagiocephaly in infants who ranged from 7 to 12 weeks of age was estimated to be 46.6%. Most infants who presented with positional plagiocephaly were identified to have Type 1, a mild form of the condition. A larger proportion of infants with plagiocephaly were affected on the right side than the left. In our study, right-sided flattening was present in 63.8% of plagiocephaly cases, whereas 36.2% were observed to have left-sided flattening. The right-sided preference may result from events toward the latter period of pregnancy. During this period,

TABLE 1 Socioeconomic Indicators of Populations Served by Data Collection Sites

Socioeconomic Indicator (Based on 2006 Data) ^a	Clinic 1	Clinic 2	Clinic 3	Clinic 4
Families with income <\$50 000/y, %	19	16–30	13–23	30–33
Families with income ≥100 000/y, %	54	30–50	39–48	21–22
Average income, \$	136 799	96 328–131 108	107 800–118 052	73 330–73 572
Female lone parent families, %	9	7–14	8–12	12–16
Living in owned dwellings, %	64	62–91	77–94	74–83
Living in rented dwellings, %	36	9–38	6–23	17–25
Average value of dwelling, \$	619 071	335 386–421 319	353 578–382 448	273 602–279 448
With university degree, %	56	33–55	32–56	19–22
Recent immigrants (arriving in the past 5 y), %	21	19–25	17–31	21–29
Do not speak either official language, %	1	1–3	1	4–6

Ranges represent the various zones served by the various clinics

^a Source: Predy GN, Lightfoot P, Edwards J, et al. *How Healthy Are We? 2010 Report of the Senior Medical Officer of Health*. Edmonton, Alberta: Population and Public Health, Alberta Health Services; February 2011.

TABLE 2 Distribution of Positional Plagiocephaly According to Type Across Data Collection Sites

Plagiocephaly Type	Clinic 1	Clinic 2	Clinic 3	Clinic 4	Total
Type 1	3	34	51	31	119
Type 2	3	7	13	15	38
Type 3	3	8	17	15	43
Type 4	0	0	2	0	2
Types 1 plus 5 (vertical growth)	0	0	1	0	1
Types 1 plus 3 (frontal asymmetry)	0	0	1	0	1
Subtotal	9	49	85	61	204
No Plagiocephaly	14	81	94	47	236
Total	23	130	179	108	440

TABLE 3 Side of Head on Which Positional Plagiocephaly Was Observed According to Type

Plagiocephaly Type	Side of Head That Plagiocephaly Was Observed		Total
	Left	Right	
Type 1			
Frequency	40	77	117
Percent	19.8	37.7	57.5
Type 2			
Frequency	13	25	38
Percent	6.4	12.3	18.7
Type 3			
Frequency	17	26	43
Percent	8.3	12.7	21.0
Type 4			
Frequency	2	0	2
Percent	1.0	0.0	1.0
Types 1 plus 3			
Frequency	1	0	1
Percent	0.5	0.0	0.5
Types 1 plus 5			
Frequency	0	1	1
Percent	0.0	0.5	0.5
Total			
Frequency	73	129	202
Percent	36.0	63.2	99.2
Missing			2

TABLE 4 Distribution of Observed Positional Plagiocephaly According to Severity and Type

Plagiocephaly Type	Severity of Plagiocephaly That Was Observed			Total
	Mild	Moderate	Severe	
Type 1				
Frequency	104	12	2	118
Percent	51.5	5.9	1.0	58.4
Type 2				
Frequency	29	8	1	38
Percent	14.4	4.0	0.5	18.9
Type 3				
Frequency	23	16	3	42
Percent	11.4	7.9	1.5	20.8
Type 4				
Frequency	0	2	0	2
Percent	0.0	1.0	0.0	1.0
Types 1 plus 3				
Frequency	1	0	0	1
Percent	0.5	0.0	0.0	0.5
Types 1 plus 5				
Frequency	1	0	0	1
Percent	0.5	0.0	0.0	0.5
Total				
Frequency	158	38	6	202
Percent	78.3	18.8	3.0	100.1
Missing				2

the fetus turns and engages the birth canal, usually head down. Most often, the vertex of the head lies within the birth canal with a left occipital anterior presentation.²⁰ In this position, the infant's right occiput is compressed against the maternal pelvis and the left forehead against the lumbosacral spine.^{20,28} This position may initiate a process that may be perpetuated by postnatal supine sleep positioning, resulting in the preference to right-sided head turning and allowing for a position of comfort to be established.²⁰ It is this position of comfort that contributes to the compressive force on the right occiput, resulting in positional plagiocephaly. Other studies have also reported that occipital cranial flattening is more frequently observed on the right side.^{20,28,29}

Five population-based incidence studies were found in the literature.^{28,30–33} Littlefield et al³⁰ estimated the incidence of plagiocephaly to be 15.2%. Peitsch et al²⁸ and Hutchison et al³³ reported a similar incidence, at 13.1% and 16.0%, respectively. Rubio et al³¹ reported the incidence of plagiocephaly to be much lower, at 3.1%, whereas Stellwagen et al³² reported a much higher rate, at 61.0%. Three groups of authors reported that their studies took place at a single center.^{28,30,31} Stellwagen et al³² indicated simply that their study was hospital-based. What distinguishes our study from past work is that it was designed to ensure a broad representation of participants. Furthermore, 3 of the 4 studies^{28,32,33} had sample sizes smaller than that of our study ($n = 183$; $n = 102$; $n = 200$, respectively).

Three of the comparison studies were undertaken during the newborn physical examination before discharge from the hospital, ≤ 72 hours after birth.^{28,31,32} The objectives of the studies by Peitsch et al,²⁸ Rubio et al,³¹ and Stellwagen et al³² were different from our study in that they were designed to evaluate

plagiocephaly immediately after birth. van Vlimmeren et al,³⁴ in a longitudinal study, found that of the 23 infants who were identified with plagiocephaly at birth, 14 reverted to normal by 7 weeks of age. In addition, 75 of 380 infants in the van Vlimmeren et al³⁴ study who were not identified with plagiocephaly at birth, presented with the condition at 7 weeks of age. As a result of this evidence, Bialocerowski et al³⁵ assert, in their systematic review, that the term “positional plagiocephaly” should be used to describe infants older than 6 weeks of age with altered skull shape.³³ Therefore, the incidence calculations provided by Peitsch et al,²⁸ Rubio et al,³¹ and Stellwagen et al³² may not be valid for population-level measures for the incidence of positional plagiocephaly.^{28,31,32} Littlefield et al³⁰ sampled infants 10 months and younger who attended routine well-child clinics. It would therefore appear that the study by Littlefield et al³⁰ is a study of prevalence and not of incidence. Incidence is defined as the number of new health-related events in a defined population within a specified period of time.³⁶ Given the information provided regarding evolving head shapes in the first few weeks of life and the correct use of the term positional plagiocephaly to describe infants with altered skull shape who are older than 6 weeks of age,^{34,35} it can be proposed that any incidence study for positional plagiocephaly that begins when the infants are younger than 6 to 7 weeks would not be a good measure of incidence at the population level.

In their study of prevalence of plagiocephaly and brachycephaly in the first 2 years of life, Hutchison et al³³ report that the incidence of positional plagiocephaly at 6 weeks of age is 16%. Differences between the incidence found in the study by Hutchison et al and that of our study may be attributable to sample size and data collection sites.

TABLE 5 Distribution of Infants With Positional Plagiocephaly Also Demonstrating Signs of Brachycephaly According to Type of Plagiocephaly

Plagiocephaly Type	Brachycephaly Observed		Total
	Yes	No	
Type 1			
Frequency	6	113	119
Percent	2.9	55.4	58.3
Type 2			
Frequency	1	37	38
Percent	0.5	18.1	18.6
Type 3			
Frequency	1	42	43
Percent	0.5	20.6	21.1
Type 4			
Frequency	0	2	2
Percent	0.0	1.0	1.0
Types 1 plus 3			
Frequency	0	1	1
Percent	0.0	0.5	0.5
Types 1 plus 5			
Frequency	0	1	1
Percent	0.0	0.5	0.5
Total			
Frequency	8	196	204
Percent	3.9	96.1	100.0

Although our study used a large sample size ($n = 440$) and 4 community-based data collection sites, Hutchison et al³³ used a significantly smaller sample size ($n = 200$) and 1 data collection site, which may not accurately reflect a population-level measure.

In comparison with the 5 incidence studies found in the literature,^{28,30–33} our study provides a measure of positional plagiocephaly at a more appropriate infant age by which to calculate the incidence of positional plagiocephaly in Calgary. The 2-month well-child clinic visit would be the first time that positional plagiocephaly could be identified by a public health nurse. However, the ideal age for calculating incidence of plagiocephaly is when an infant is 7 to 8 weeks of age. Currently, there is no evidence to support that the head shapes of infants with plagiocephaly at 7 to 8 weeks spontaneously revert to normal at 9 to 12 weeks. As a result, infants who attend their first

well-child clinic between the ages of 9 and 12 weeks, and have plagiocephaly, are also likely to have had some form of the condition at 7 to 8 weeks of age. Therefore, the inclusion criterion related to infant age is fitting.

The high incidence of positional plagiocephaly indicates that intervention in the form of parental education about how to prevent the development of positional plagiocephaly is warranted before infants arrive at the 2-month well-child clinic. Two factors affecting the treatment plan are age at diagnosis and severity of the deformity.³⁷ However, Argenta²⁷ does not provide guidelines for treatment based on the 5-point plagiocephaly assessment scale.

One limitation of the study was that specific data were not collected to calculate the κ statistic, the degree of nonrandom agreement between the assessments,³⁴ completed by the 2 data collectors. Spermon et al³⁸ studied the reliability of Argenta's tool²⁷ among 9 health care professionals (pediatricians, physiotherapists, and manual therapists) who had no previous experience conducting head shape assessments. The 9 health care professionals examined 20 patients, and κ scores were used to measure agreement for classification type as well as specific clinical features. There was a moderate overall interrater agreement for classifying deformational plagiocephaly ($\kappa = 0.54$). The total agreement for the specific clinical features of deformational plagiocephaly among the practitioners differed slightly with κ scores ranging from 0.45 to 0.57. Spermon et al³⁸ found the κ coefficient for the first 4 clinical features of deformational plagiocephaly (occipital flattening, ear malposition, frontal bossing, and facial asymmetry) to range from 0.6 to 0.85, indicating substantial intrarater agreement. Although specific data were not collected to calculate the κ statistic in our study, 2 individuals completed the

assessments, serving as a major strength of the study in terms of maintaining consistency in how the assessments were conducted. Both individuals rotated through all data collection sites, thus minimizing cross-site differences in assessment.

Although support for data collection was garnered across 4 CHCs, there were difficulties in creating data collection schedules such that equal representation from all 4 sites could be obtained. Clinic 4 served a population that had a higher proportion of immigrants who had arrived in the past 5 years, when compared with Calgary as a whole (up to 29% vs 22%).³⁹ As a result, the population served by Clinic 4 may have a different regard for head shape than the dominant cultural group, as head molding is widely practiced by various cultural groups.⁴⁰ Most study participants were recruited from Clinics 2 and 3, which were located in more affluent neighborhoods. Although socioeconomic status was not collected as part of the study, lower levels of neighborhood income have been found to be a risk factor for poor birth outcomes in the Canadian context.⁴¹ The catchment area for Clinic 4 served a more disadvantaged population compared with Calgary as a whole. For example, populations served by Clinic 4 had lower average family incomes per year (\$73 330–\$73 572 vs \$105 277), higher percentage of female lone parent households (up to 16% vs 11%), and higher percentage of households in which English was not spoken (up to 30% vs 12%).³⁹ As a result, the distribution of study participants across the 4 data collection sites may have led to an underestimation of the true incidence of positional plagiocephaly. Hence, the way in which data were collected across sites may have affected the external validity of the study. The fact that data collection spanned only 3 months may also affect the external validity of the study.

CONCLUSIONS

To our knowledge, this is the first population-based study investigating the incidence of positional plagiocephaly using 4 community-based data collection sites. It is the first of its kind to estimate the incidence of positional plagiocephaly at the 2-month well-child clinic visit. The incidence of plagiocephaly in 7- to 12-week-old infants was estimated to be 46.6%. This high incidence indicates that parental education about how to prevent the development of positional plagiocephaly is warranted.

Future studies are required to corroborate the findings of our study and research is required to assess the incidence of plagiocephaly using Argenta's plagiocephaly assessment scale²⁷ across more CHC sites. A longitudinal study that could be completed at a variety of well-child clinic visits (2-month, 4-month, 6-month and 12-month visits) and locations would provide useful information about changes in incidence and prevalence over time, across various age ranges, and in diverse populations. In addition, the utility of

Argenta's plagiocephaly assessment tool²⁷ in well-child clinic visits needs to be established, given public health nurse capacity to engage in assessments within the context of clinic time constraints. The benefit of using Argenta's plagiocephaly assessment tool²⁷ by family physicians also needs to be ascertained. Finally, the advantages of using Argenta's plagiocephaly assessment tool²⁷ as a teaching tool for parents to track progress of the condition after repositioning strategies are implemented needs to be determined.

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USING MAGNETS TO DETECT MALARIA: *I see many patients who, after returning from a trip to a malaria endemic region of the world, inform me that they developed malaria and had been treated for it. Usually, I gently remind them that being treated for malaria and actually having malaria are quite distinct entities. The problem is that in many parts of the world, a simple, reliable, and fast means to diagnose malaria does not exist. Microscopy relies on access to a good microscope and a trained microscopist. Rapid diagnostic kits have similar sensitivity to microscopy and are relatively inexpensive but tend to expire quickly in heat. As reported in The New York Times (Health: June 10, 2013), however, a new and inexpensive way to diagnosis malaria may be on the horizon. Scientists have long known that the Plasmodium species degrade the hemoglobin in human blood but can neither use nor excrete the iron. The iron is stored in vacuoles as crystallized hemozoin. Researchers have taken advantage of this fact to detect Plasmodium in blood. A single drop of blood is diluted with water and placed in a magnetic field, and then a laser beam is shone through the drop. If the drop contains Plasmodium with their concomitant hemozoin stuffed vacuoles, the light is partially blocked. Preliminary testing shows that the test is more sensitive at detecting the parasite than either microscopy or the currently available rapid diagnostic kits. The manufacturer hopes that, once developed, each diagnostic test would cost as little as 50 cents – making this cost effective in the areas where it is needed most. I am certainly hoping that, in the near future, a traveler will return to my clinic and tell me that they developed a fever while traveling, but testing showed that they did not actually have malaria.*

Noted by WVR, MD

The Incidence of Positional Plagiocephaly: A Cohort Study

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