Dental and Skeletal Age Determinations of Ontario Iroquois Infant Burials

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Forty articulated infant burials from nine Late Woodland Iroquoian sites were examined dentally and skeletally for their biological age estimates. We offer a detailed chart of the stages of dental calcification for all deciduous teeth of these burials which should allow future researchers narrower age estimates of infant burials, particularly fragmentary ones. Estimates of age based on diaphyseal length measurements are comparable to a larger study of Arikara skeletons but again allow finer estimates of age in the infant category. It is possible to identify a concentration of individuals who probably died at or just after the birth event. However, the existence of this `birth size concentration' is probably not due to demographic factors but to human social factors and mortuary practices.

Introduction

It is well known that the majority of human skeletal remains recovered from Late Ontario Iroquois sites consist of disarticulated bones from ossuaries. These communal bone pits are a consequence of the Iroquoian cultural practice of reburying the deceased relatives of one village or region at the **Feast of the Dead,** to allow for the commingling of souls. Although Iroquoian ossuaries represent a unique demographic sampling of genetically close individuals interred over a short time period, the inability to `put skeletons back together again' remains the major drawback of this kind of sample to effective skeletal biological research.

Yet, as intensive archaeological excavation of southern Ontario Iroquoian habitation sites has proceeded over the past two decades, archaeologists have discovered that primary or complete burials can be found in longhouse floors and other village areas. Based on investigations of burials uncovered at three extensively excavated sites, Draper, Keffer and Ball, we calculate that better than 40^{0}*10* of these village graves contain the remains of infants and very young children. These subadult burials have received considerable attention in the literature because of the potential cultural significance of their mortuary context (Fitzgerald 1979; Kapches 1976; Knight and Melbye 1983; Spence 1986; Williamson 1978) and because they constitute the primary source of complete skeletons for the Late Ontario Iroquois period.

It is easier to make an estimate of age-at-death of the human subadult skeleton because of the regular, sequential stages of development of the teeth and bones during the growth period. Skeletal biologists attempting to determine age-at-death of subadult skeletons make use of dental development and length measurements of the leg bone diaphyses. Initially, human growth researchers produced standards of dental eruption for age estimation. However, dental calcification is a superior method of age estimation because it is less disturbed by exogenous factors. All of the teeth may be used at the same time to judge development rather than individual teeth as is required with eruption standards. Dental eruption as an age indicator is limited to certain stages of the growth period when teeth are actively erupting whereas calcification can be assessed over the entire growth period. Finally, stages of dental eruption are defined as occurring through the gums, rather than through the bony alveolus as is the case with skeletal samples. A number of excellent dental calcification studies have been carried out since the 1950's. However, only two of these studies derived detailed calcification standards for the deciduous dentition, applicable for aging young infants. Moorrees et al. (1963) assessed development of the mandibular deciduous canine and mandibular first and second molar. Kraus and Jordan (1965) produced a detailed study of the development of deciduous tooth crowns during the fetal period but their sample ends at birth so that estimates of tooth development close to the time of birth may underestimate age.

Extensive research has been carried out on long bone growth of European and Euroamerican children using serial radiographs (Maresh 1970) but only a few studies have investigated skeletal development in samples which span the birth event. Recently, Scheuer et al. (1980) published regression equations for estimating fetal and perinatal age from long bone lengths. This source is valuable in that it provides separate formulae for each long bone based on individuals whose known age is recorded in weeks.

One of the most complete sets of standards for skeletal age estimation using direct measurements of the long bones is that of Merchant and Ubelaker (1977). These researchers studied a large, historic Arikara sample from the Mobridge Site, South Dakota. They estimated dental age using the standards of Moorrees et al. as a basis for biological development and then compared these dental ages to diaphyseal length measurements. Although the Merchant and Ubelaker sample is large, it is lumped into a six month long age category from birth to one-half year and one year age categories thereafter. Consequently, researchers wishing to estimate age-at-death of Iroquoian infant burials will always obtain estimates of birth to six months or 0.5-1.5 years from long bones. Merchant and Ubelaker's growth curves do not allow for finer discrimination.

The following study was conducted to document the detailed stages of dental calcification for all available deciduous teeth and the diaphyseal length measurements of Late Ontario Iroquois infant burials. Such a data summary should allow future researchers narrower distinctions of ageat-death from either teeth or long bones in situations where burials are incomplete. These data are then compared to previous published standards. In addition, recognizing that age-at-death determinations are only estimates which represent a range of possible chronological ages because of individual and sex-based variability in biological development, we consider the frequency distributions of our sample with the intent of detecting any concentrations that represent a particular age group.

Materials and Methods

The sample consists of 40 complete or relatively complete infant burials excavated from Middle and Late Ontario Iroquois sites (Table 1). Normally, demographers define infant as being less than one year of age. In this study, skeletons were selected if the deciduous teeth were still undergoing calcification. This biological demarcation covers individuals up to three years of age but it allows for the recovery of dentally advanced individuals who may be chronologically one year but biologically aged as older. It also sets a developmental standard for sample selection rather than an estimated value.

Dental calcification was assessed according to the standards of Kraus and Jordan (1965) for the upper and lower deciduous molars of those individuals whose molar crowns had not completely coalesced at the time of death. All teeth were then assessed using the developmental stages of Moorrees et al. (1963) (Table 2). Although these stages are based on qualitative biological criteria rather than measurements, they are relatively easy to determine from the actual teeth that were available from the archaeological specimens as compared to using X-rays. It may sometimes be difficult to judge if a tooth root is 1/2 or 3/4 calcified but such uncertainty can be recorded on the data sheets.

Due to the small size and short age range of our sample we chose to list all individuals sequentially in order of dental development rather than produce lumped categories. All available deciduous teeth were evaluated so as to place an individual into the sequential order. However, since it has been demonstrated that there is symmetry in dental development (Demirjian 1978; Liliequist and Lundberg 1971) only one calcification stage is reported for any one side of an arch. In fact, less than 4% of the observed 139 pairings between right and left teeth in this sample showed any differences in degree of dental development and none of these were more than one stage apart in formation.

Where possible all individuals possessing mandibular deciduous canines and first and second molars were assigned a chronological age estimate

TABLE 1

List of Skeletal Material

Site	Location	*Indiv	Date	Reference
Perry(P)	Waterloo Co.	1	AD 1350-1400	Kapches 1976
Steward(S)	Grenville Co.	3	AD 1450-1500	Wright1972
Draper(D)	Durham Co.	8	AD 1450-1500	Finlayson 1985
Roebuck(R)	Grenville Co.	2	AD 1450-1530	Molto 1983
MacKenzie(M)	York Co.	2	AD 1505-1535	Johnson 1980
Keffer(K)	York Co.	16	AD 1500-1575	Spence 1986
Benson(Be)	Victoria Co.	2	AD 1580	Ramsden 1977
Ball(Ba)	Simcoe Co.	3	AD 1590-1600	Melbye 1983
Hood(H)	Wentworth Co.	3	AD 1640-1641	Lennox 1984

TABLE 2

Tooth Formation Stages and Their Coded Symbols*

Coded Symbol	*Formation Stage*
Cco	Coalescence of cusps
Coc	Cusp outline complete
Cr 1/2	Crown 1/2 complete
Cr 3/4	Crown 3/4 complete
Cr c	Crown complete
Ri	Initial root formation
Cli	Initial cleft formation
R 1 /4	Root length 1 /4
R 1 /2	Root length 1 /2
R 3/4	Root length 3/4
Rc	Root length complete
A 1 /2	Apex 1 /2 closed
Ac	Apical closure complete

*follows Moorrees, Fanning and Hunt (1963)

according to the Moorreeset al. standards (1963). Because sex is unknown for this sample, age was estimated by comparing the stages of development of the three posterior mandibular teeth to the Moorrees et al. charts of formation and resorption for both males and females. A mean age was then calculated by averaging the age estimates from the standards for all three teeth and for both sexes. Assessments of chronological age were calculated last so that they would not bias our at-tempts to sequentially order the sample by dental calcification.

The major long bone diaphyses as well as the clavicle, length and breadth of the scapula, length and height of the ilium and pars lateralis and pars basilaris of the occipital were measured using sliding calipers. All measurements except those from the Keffer Site and the Ball Site were taken by Saunders. Spence took the length measurements and assessed the dental stages for the Keffer Site bur' s and F.J. Melbye provided the measurements and dental stages for the Ball Site individuals. To investigate the magnitude of interobserver error we compared our measurements on a small subsample from the Keffer Site and found differences to be minimal. The risk of interobserver error is low with such short bones. If there was slight damage to the ends of the bones the length was estimated and the value recorded in brackets on the data sheets. Six individuals lacking teeth for dental aging acted as test cases and were fitted into the length measurement chart. Wherever possible, dental calcification stages and length measurements were checked at least twice.

Next we examined the magnitude of length increases and the relative frequencies of individual bone lengths when compared to dental age. To estimate chronological age we compared bone diaphyseal lengths to the standards of Scheuer et al. (1980) and Merchant and Ubelaker (1977). Finally, we investigated what proportion of these burials might represent newborns by examining the frequency distributions of long bone lengths, as well as the estimated ages according to dental and skeletal standards and by comparison to a study made by Stewart (1979) of long bone size concentrations. Stewart found that of ninety-six Mobridge femora in the 62.5 - 100 mm size range, 74% fall into three measurement class intervals and likely represent individuals who died at birth. The diaphyseal length values for the six major long bones from the present study were compared to Stewart's estimates of `birth size concentrations'.

Results

The use of all available teeth to arrange individuals by dental development made sequential ordering a surprisingly easy process. These results are reported in Table 3. Admittedly, those burials possessing only two or three teeth would be difficult to place in sequential order because of the lack of dental information. However, by using all maxillary and mandibular teeth for the entire sample it was in fact easier to identify the approximate placement of the incomplete dentitions when they could be compared to the rest of the sample. Sequential ordering was also problematic when there were cases of nonsequential variablity in the development of individual teeth. The decision was made to place an individual further along in dental development if two or more teeth could be found to be advanced in the entire dentition even though another tooth might be behind in development. However, in some cases such a decision was arbitrary, as with individuals K 8 and R 197.

The greatest problems in sequential ordering came when the anterior teeth were advanced while the mandibular deciduous molars were still completing their cusp formation. Such was the case with individual D 14. Table 3 illustrates that the mandibular molars are the most variable deciduous teeth in terms of their development. The assessed calcification stages and the estimates of chronological age-at-death using the Moorrees et al. standards are also reported in Table 3. When these chronological age estimates are compared to our sequential ordering based on

TABLE 3

SAMPLE ARRANGED SEQUENTIALLY ACCORDING TO DENTAL CALCIFICATION

	MAXILLA					MANDIBLE					Chron. Age Estimate in months (MFH)
	dm_2	dm_1	c	i_2	i_1	i_1	i_2	c	dm_1	dm_2	
K22b		Cr_{co}		$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$	Cr_{oc}	Cr_{oc}		1.1
K8				$Cr\frac{3}{4}$		$Cr\frac{1}{2}$	$Cr\frac{1}{2}$				-
D8		Cr_{co}	$Cr\frac{1}{2}$	$Cr\frac{3}{4}$	$Cr\frac{3}{4}/c$	$Cr\frac{1}{2}/\frac{3}{4}$	$Cr\frac{1}{2}$	$Cr\frac{1}{4}/\frac{1}{2}$	Cr_{co}		1.5
H H2F23	Cr_{oc}	Cr_{oc}		$Cr\frac{1}{2}$	$Cr\frac{3}{4}$		$Cr\frac{3}{4}$				-
D5	Cr_{oc}	Cr_{oc}	$Cr\frac{1}{2}$	$Cr\frac{3}{4}$	$Cr\frac{3}{4}$	$Cr\frac{3}{4}$	$Cr\frac{3}{4}$		Cr_{oc}		.5
H H8F50		$Cr\frac{1}{2}$		$Cr\frac{3}{4}$	$Cr\frac{3}{4}$	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$				-
D11						Cr_c	$Cr\frac{3}{4}/c$	$Cr\frac{1}{2}$	Cr_{oc}	Cr_{co}	2
K16	Cr_{co}	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	$Cr\frac{3}{4}$	Cr_c					Cr_{co}	0.3
K10	Cr_{co}	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	Cr_c	Cr_c	Cr_c	Cr_c	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	Cr_{co}	2.3
K22a	Cr_{co}	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	Cr_c	Ri	Cr_c	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$	$Croc/\frac{1}{2}$	Cr_{oc}	1.8
R197	Cr_{co}	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	Cr_c	Cr_c	Cr_c					-
S163	Cr_{oc}					Cr_c	$Cr\frac{3}{4}/c$	$Cr\frac{1}{2}$		Cr_{co}	2.3
D-sq120/270				Cr_c	Cr_c						-
Ba10								$Cr\frac{1}{2}$	$Cr\frac{3}{4}$		3.8
K23		$Cr\frac{3}{4}$					Cr_c		$Cr\frac{3}{4}$	Cr_{co}	2.2
K24			$Cr\frac{1}{2}$		Cr_c	Cr_c	Cr_c		$Cr\frac{3}{4}$	Cr_{co}	2.0
Be1	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	Cr_c	Cr_c	Cr_c	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$	Cr_{oc}	Cr_{oc}	1.9
M-C2	$Cr\frac{1}{2}/\frac{3}{4}$	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$	Cr_c	Cr_c	Cr_c	Cr_c	$Cr\frac{1}{2}$	Cr_{co}		2.1
D14	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	Ri	Ri	Ri	Cr_c	$Cr\frac{1}{2}$	Cr_{co}	Cr_{co}	1.5
M-C1	$Cr\frac{1}{2}$	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$	Cr_c	Cr_c	Cr_c	Cr_c	$Cr\frac{1}{2}$	Crco	Crco	2.2
D4				Cr_c		Cr_c		$Cr\frac{1}{2}$	$Cr\frac{1}{2}$		2.6
P1	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	$Cr\frac{1}{2}/\frac{3}{4}$	Cr_c	Cr_c	Cr_c	Cr_c	$Cr\frac{1}{2}/\frac{3}{4}$	$Cr\frac{1}{2}$	$Cr\frac{1}{2}$	3.4
K20	$Cr\frac{1}{2}$	Cr_c	$Cr\frac{3}{4}$	$R\frac{1}{4}$	$R\frac{1}{4}$	$R\frac{1}{4}$	Cr_c	$Cr\frac{3}{4}$	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$	3.7
K17	$Cr\frac{3}{4}$	Cr_c	Cr_c	$R\frac{1}{4}$	$R\frac{1}{4}$	$R\frac{1}{4}$	$R\frac{1}{4}$	$Cr\frac{3}{4}$	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$	3.7
K15	$Cr\frac{1}{2}$	$Cr\frac{3}{4}/c$	$Cr\frac{3}{4}$		$R\frac{1}{4}$	$R\frac{1}{2}$	$R\frac{1}{4}$	$Cr\frac{3}{4}$	$Cr\frac{3}{4}$	$Cr\frac{1}{2}$	3.7
D1	$Cr\frac{3}{4}$	$Cr\frac{3}{4}/c$	Cr_c	$R\frac{1}{4}/\frac{1}{2}$	$R\frac{1}{4}/\frac{1}{2}$	$R\frac{1}{2}$	$R\frac{1}{4}/\frac{1}{2}$	$Cr\frac{1}{2}/\frac{3}{4}$	Cr_c/Ri	$Cr\frac{1}{2}/\frac{3}{4}$	4.8
K1	Cr_c	Ri	Ri	$R\frac{1}{4}/\frac{1}{2}$	$R\frac{1}{4}/\frac{1}{2}$	$R\frac{1}{2}$	$R\frac{1}{4}/\frac{1}{2}$	Cr_c	Cli	Cr_c	7.8
D7						$R\frac{3}{4}$	$R\frac{1}{2}$	Ri	Ri	Cr_c	8.5
K21		$R\frac{1}{4}$	$R\frac{1}{4}$	$R\frac{3}{4}$	$R\frac{3}{4}$	$A\frac{1}{2}$	$R\frac{1}{2}$	$R\frac{1}{4}$	$R\frac{1}{4}$		10.2
Be2	Ri	$R\frac{1}{2}$	$R\frac{1}{2}$	$R\frac{1}{2}/\frac{3}{4}$	$R\frac{1}{2}/\frac{3}{4}$	$R\frac{3}{4}$	$R\frac{1}{2}/\frac{3}{4}$	$R\frac{1}{2}$	$R\frac{1}{4}/\frac{1}{2}$	Ri	12.2
Ba8								$R\frac{1}{2}$	$R\frac{3}{4}$		15.1
K11			R_c	A_c	A_c	A_c	A_c	$R\frac{3}{4}/c$	$A\frac{1}{2}$	$R\frac{3}{4}$	21.5
K6		A_c	A_c	A_c	A_c	A_c	A_c	$A\frac{1}{2}$		R_c	27.1

TABLE 4**Diaphyseal Length Measurements Arranged Sequentially by Dental Calcification**

	Humerus	**Radius**	**Ulna**	**Ilium**	**Femur**	**Tibia**	**Fibula**
K26	47	**38**	**45**		52		
S174a	**52***	**-**	**49**	23	57	52	-
S174b	52	**42**	**50**	**25**	57	51	**49**
K22b	53	45	52	26	59	53	51
K8	-	-	-	-	(60)	51	-
D8	60	47	55	-	69	60	58
H-F23	59	-	-	33	69	61	-
D5	63						
D11	65+	53+	61+	33	74+	65+	62+
H-H2F9	**66+**	**56+**	70	31			
K16	67+	56+	64+	-	79+	70+	67+
K10	68+	53+	61+	37	81+	68+	64+
K22a	67+	54+	63+	35	77+	((66)+	(65)+
R197	68+	55+	62+	36	77+	66+	65+
S163	67+	56+	64+	35	76+	68+	66+
K23	70+	55+	63+	35	85	71+	68+
K24	67 +	54 +	62 +	36	79 +	70 +	66 +
Bel	67 +	53 +	62 +	34	77 +	67 +	63 +
M-C2	67 +	55 +	63 +	37	77 +	68	65 +
D14	68+	55+	62+	-	76+	-	-
M-C 1	72	58 +	67 +	38	-	75	
D4	-	55+	64+	(34)	76+	68+	65+
P I	71 +	57 +	67 +	38	83	72 +	69 +
K20	77	63	73	42	91	76	72
K17	77	63	73	44	91	77	72
K15	78	65	73	42	94	78	75
D1	83	70	80	46	100	86	-
K1	-	-	-	-	118	106	93
D7	83	-	75	44	102	87	84
Ba6	(91)	(70)	**(80)**	**(50)**	**(105)**	**-**	**-**
K21	90	71	81	46	(106)	(95)	(94)
R185	**(93)**	**-**		**-**	(113)		
Be2	101	78		58	128	102	100
K14a				**65**	**-**	129	127
K11	124	97	-	-	144	131	-
K6	141	110	122	76	193	161	157

*individual values in bold do not have dental age estimates and were fitted in on the basis of their measurements, they were not included in Fig. 1 or in calculations **individual values identified with a + fit into Stewart's (1979) birth size concentrations

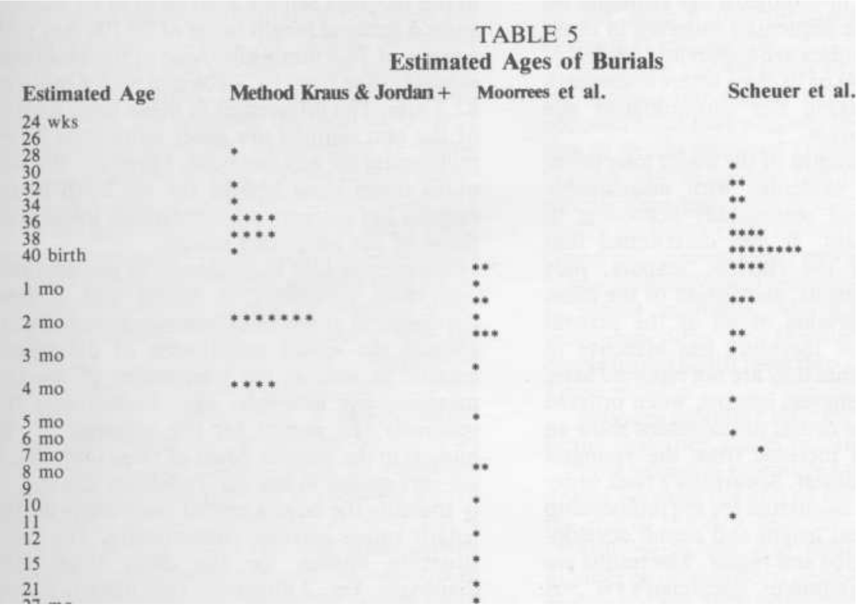

TABLE 5

Estimated Ages of Burials

Estimated Age	**Method Kraus & Jordan +**	**Moorrees et al.**	**Scheuer et al.**
24 wks			
26			
28	*		
30			*
32	*		**
34	*		**
36	****		*
38	****		****
40 birth	*		********
		**	****
1 mo		*	
		**	***
2 mo	*******	*	
		***	**
3 mo			*
		*	
4 mo	****		
			*
5 mo		*	
6 mo			*
7 mo			*
8 mo		**	
9			
10		*	
11			*
12		*	
15		*	
21		*	
		*	

+ Kraus & Jordan calculate full gestation at 38 weeks; the data using their method of age determination have been adjusted in this table to conform with 40 weeks as an estimate of full gestation

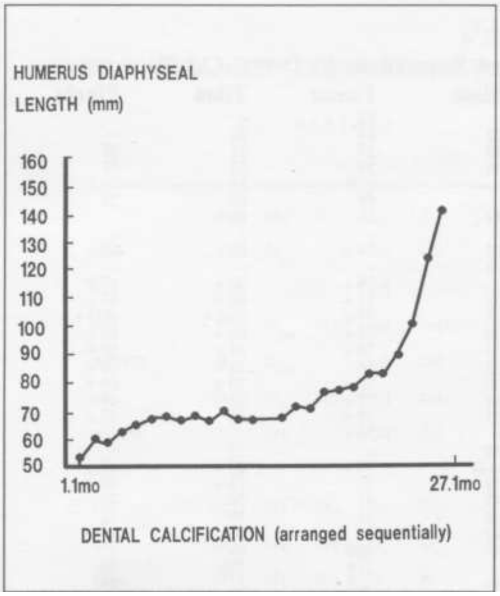

Fig. 1
Plot of humerus diaphyseal lengths against chronological age estimates based on dental calcification.

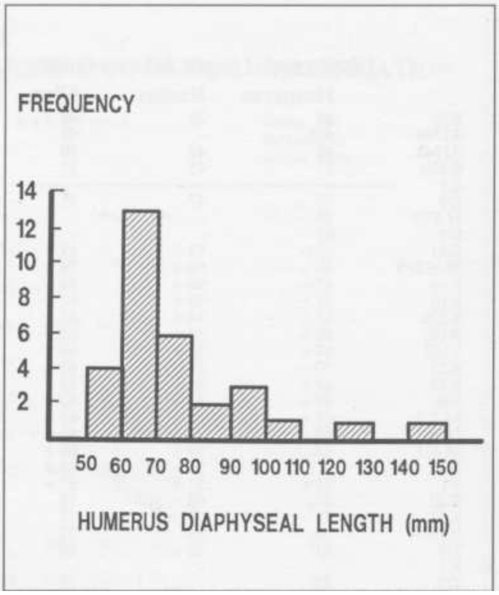

Fig. 2
Frequency of humerus diaphyseal lengths arranged in 10 mm increments.

the dental development of all of the teeth the correlation is high (Spearman's r = .899 P(.005) but not perfect. The chronological age estimates do not agree with the sequential ordering in those cases where the molars are apparently behind in development (D14) or in cases where some teeth are missing, making the chronological age estimate less accurate.

Table 4 lists the lengths of the major long bones recorded for all skeletons with measureable diaphyses arranged sequentially according to dental development. It was determined that measurements of the clavicle, scapula, pars basilaris, pars lateralis, and height of the ilium were the least variable of all of the skeletal measurements and therefore less effective in estimating age so that they are not reported here. However, all diaphyseal lengths, when ordered by the sequence of dental development show an almost consistent increase from the youngest dental age to the oldest. Spearman's rank order correlations were calculated for the relationship between diaphyseal length and dental development of the humerus and femur. The results are highly significant (humerus, Spearman's r = .968 P(.005); femur, Spearman's r = .904 P(.005).

The ranges in diaphyseal length measurements of our sample, aged dentally from birth to six months, are comparable to those of Merchant and Ubelaker (1977). For example, individuals in the Iroquois sample aged birth to six months show a femoral length range of 59-100 mm with a mean of 78.6 mm while those of the Mobridge sample range from 62.5-106 mm with a mean of 82.2 mm. The differences in mean bone lengths of the two samples are never more than a few millimeters for any one bone. However, the Iroquois mean bone lengths for the birth to six months age category are consistently lower than those of the Mobridge sample.

Recognizing that there should be considerable individual variability in dental and skeletal development at any one chronological age we examined the actual magnitudes of diaphyseal lengths as well as the frequencies of specific measurement intervals. Fig. 1 illustrates the relatively flat curves for the majority of the humeri in the sample. Most of these individuals are very similar in size and variability is low. Only towards the largest end of the sample do the length values increase dramatically. The same situation applies for the other long bone diaphyses. Fig. 2 illustrates that there is a concentration of the sample at a certain bone length, roughly 60-70 mm for the humerus. These high frequencies may represent the concentrations of individuals who died at birth.

When the frequencies of estimated chronological ages were plotted using the Kraus and Jordan (1965) and Moorreeset al. (1963) dental standards and the Scheuer et al. (1980) long bone standards (Table 5), a clustering of the sample is again apparent. The majority of individuals aged by the Kraus and Jordan method cluster at 36-38 weeks which reflects the bias of their reference sample to underage late fetuses and newborns. On the other hand, the Moorrees et al. standards tend to overage; the Ontario Iroquois sample clusters at 2 months of age. Using the Scheuer et al. method our sample clusters at birth.

When the Ontario Iroquois sample is compared to Stewart's calculations it is possible to show which of the Iroquoian infants fall into the birth-size concentrations based on the Mobridge standards. These individuals are indicated in Table 4 by a plus mark. There are 11/19 (58%) femora which fit the category of birth-size concentrations based on Stewart's calculations. If we could include those individuals lacking diaphyseal length measurements but fitting into this cluster based on dental development the percentage would be 13/22 (59%).

Discussion

Researchers using the Moorrees et al. (1963) standards of deciduous dental development for estimating age-at-death of infant skeletons should be aware that the teeth these researchers chose for evaluation, the three posterior mandibular teeth, are probably the most variable of the deciduous dentition. Moorrees et al. chose these teeth because of their relative ease of observation in X-rays of living individuals but ideally all of the teeth should be evaluated when making an age estimate. In addition, the Moorreeset al. study sample only begins at three months of age since it is derived from a longitudinal study of living children. This introduces a bias for overaging newborns. The estimated chronological ages of our sample, based on the Moorrees et al. study, show a concentration around the two to four month period while we would expect this concentration to represent deaths at birth. Such a result is probably due to sample bias of the Moorrees at al. data but it could also be due to the fact that Amerindians are known to be advanced over Europeans in dental development. Although our sample is not large enough to assess the range of variability in biological development of Ontario Iroquoians over the first two years we feel that the sequentially ordered chart of dental calcification for the entire sample can be useful in obtaining age-at-death estimates of future infant burial finds, especially when the mandibular canines and molars are not available.

Dental development is more closely correlated with chronological age than skeletal development (Lewis and Garn 1960). Consequently, the high level of the correlations between the stages of dental development of our sample and the diaphyseal length measurements, although not totally unexpected, were still surprising given the known levels of sex dependent and environmentally dependent variability in body stature at any one age. They cannot be a reflection of lower levels of variability in stature in the first year of life since it has been shown that the relative variability in length at birth is similar to that seen at 5, 10 and 15 years (Johnson 1978). As noted in the results, the long bone measurements of the Iroquoian group aged dentally from birth to six months are very similar to those of the Mobridge sample in ranges and in means. Melbye (1983) has also noted this in his study of the Ball Site skeletons. This is reassuring since it suggests that aging standards from various Northern Amerindian samples are comparable. However, it was also observed that the mean long bone values of the Iroquoian birth to six months age category, though not vastly different, are consistently lower than those of the Mobridge sample. We cannot explain this difference at present or evaluate it statistically.

Despite the known levels of variability in living samples our sample definitely illustrates a concentration that suggests the highest proportion of deaths occurred around the birth event. Stewart (1979) points out that demographic records show high rates of mortality at birth and slowly declining rates thereafter so that we can expect a concentration of newborn infant burials in any archaeological cemetery. But with regard to infant mortality, the actual situation is somewhat different. Demographers normally divide infant death rates into several categories. These include:

neonatal mortality rate: the number of deaths in the first four weeks per 1000 *live* births

post-neonatal mortality rate: the number of deaths between the end of the fourth week and the end of the first year per 1000 *live* births

still births (or late fetal mortality rate): number of infants born dead after 28th week of pregnancy per 1000 *total* births

According to published demographic data, post-neonatal mortality exceeded neonatal mortality in industrialized countries up until the 1930's. In many developing countries today this situation still applies and might be expected to apply in prehistoric societies. Only in the second third of this century has neonatal mortality exceeded post-neonatal mortality in countries like Canada, Britain and the United States (Forfar and Arneil 1978). This is because post-neonatal mortality is largely caused by environmental factors such as poor sanitation and poor nutrition while neonatal mortality is largely due to physiological and organic weaknesses of infants. However, when stillbirth mortality is added to neonatal mortality (the total is called perinatal mortality) the rates almost always exceed those of post-neonatal mortality. Consequently, the concentrations of individuals around a particular skeletal size and stage of dental development in this sample and in Stewart's sample should reflect perinatal mortality concentrated in a fourteen week period around the birth event. Normally, there is a 150 mm increase in fetal stature from 28 weeks gestation to 38 weeks term (Moore 1973). Our large sample of `birth size concentration' seems too concentrated to represent the whole perinatal period. We would suggest that the concentration of bone sizes observed in the present sample do represent mainly *live* births of full term infants but that the higher concentrations of this group are mainly an artifact of biased mortuary patterns. Although the Iroquoian frequency of `newborns' is lower than that of the Arikara sample the difference is not statistically significant given the smaller sample size of the Iroquoian material. In fact, we feel that the proportion of `newborns' represented by these village burials is substantial given the known limiting factors to their burial and discovery. Although underrepresented, infant skeletons can be found in ossuaries (Katzenberg and White 1979; Pfeiffer 1983). In addition, there is well-known ethnohistoric information that infants who died within a month or two of birth were buried along or near paths so that their souls might find rebirth in the bodies of living women (Thwaites 18%-1901). Based on excavations at the Ball Site, Knight and Melbye (1983) calculate that burial in longhouses was employed about 2º% of the time, not a pervasive mortuary custom. In addition, due to their small size and low density, infant bones do not preserve well and would be expected to be underrepresented in any burial situation. Finally, excavators at an archaeological site, inexperienced in osteological identification, may easily miss or mistake infant burials (particularly fragmentary burials) for something else.

The individuals who are smaller and less developed than the newborn category could be premature births. The infants from the Steward site are small enough to be definitely classified as fetal. There are no specific mortuary patterns that set these premature or fetal infants apart from others. Although all lack grave goods, so do many of the older infant burials. The Keffer 22B individual was tightly bound but there is no specific pattern or burial position for the other `pre-newborn' individuals. Interesting mortuary data was recovered from the Benson 1 burial which would support the age assessment of newborn. Associated grave goods with Be 1 correspond to ethnohistoric descriptions of the treatment of newborn deaths (Ramsden and Saunders 1986). It is well known that many societies accord less special treatment to premature or full term infants who are dead at birth. On the other hand, an infant born live is destined to receive an identity. Although it is not known when Huron children were given names, Brebeuf's description in the Jesuit Relations of infant `path burials' might suggest that naming ceremonies took place sometime within the first few months (Steckley 1986). Recently, Steckley (1986) has suggested that Huron infants who died before naming would be buried in or around a longhouse of the mother's clan since to be `reborn' in the womb of a woman of the father's clan would be considered incest. Consequently, infants who died just after birth might receive such special mortuary treatment. Burials of infants small enough to be confidently identified as fetal may also have been born live and thereby attained preferential burial treatment. We would argue then, that the substantial pro-portion of late fetal and full term infants found in village areas represents infants born live who subsequently died before a naming ceremony and were accorded special mortuary treatment. Presumably, the bulk of infants dying during the postnatal period were buried in the ossuary. However, certainly some post-neonatal infant burials do occur in longhouses and village areas.

Conclusions

Future researchers attempting to determine the age-at-death of isolated infant burials may make use of our sequential charts of developmental stages of dental calcification and long bone diaphyseal measurements. These charts allow one to fit the unknown skeleton into an order which allows for a finer discrimination of the likely age-at-death. In particular, researchers should be aware of the sample biases inherent in reference samples of known age which may over or under-age unknown samples. Finally, it is possible to derive a firmer indication of which burials represent deaths that occurred at the birth event and thereby also indications of which individuals are fetal or represent deaths after birth. These determinations have implications for the reconstruction of mortuary patterns and cultural behavior. It should be noted that the present study cannot sufficiently investigate the range of variability in biological development during the infant period.

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