

# Cortical Bone Ontogeny: Activity, Nutritional Stress, and Archaeology



## Part I: Introduction:

In the past two decades, research on growth in cortical bone cross-sectional parameters has suggested that:

- 1) Percent Cortical Area (total area - medullary area = %CA), once used to determine nutritional status from long bone cross-sections, declines as part of a 'normal' pattern of growth for the first three years of life.
- 2) Individuals that are developing in circumstances of adequate or excellent nutritional status demonstrate a decline in %CA that is accompanied by an increase in mass at the periosteal surface, which provides greater relative strength to the bone despite the thinner cortex.
- 3) An evaluation of relative strength in the humerus and femur demonstrates that the humerus increases in strength relative to the femur during the 6-12 month age category (when infants are generally beginning to acquire locomotor skills related to crawling) and then increases relatively faster in the femur after 12 months of age (when infants become more regularly bipedal).
- 4) Thus the general decline in %CA that people had previously interpreted as nutritional stress (e.g. Garn, 1970; Keith, 1984) was now explained as a function of normal growth.
- 5) Increasing levels of strength through infancy and childhood appeared to be more strongly correlated with body mass and activity levels, rather than nutritional status.

While this pattern of growth has been documented for populations of children with adequate nutritional status, growing up with relatively low levels of biocultural stress, does this pattern of growth vary in populations that experienced developmental stress?



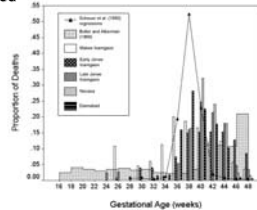
## Part III: Materials:

Out of 300 individuals from 3 Chalcolithic villages (2000-700 B.C.) in India, 90% are under 5 years of age and 72 individuals have long bone lengths as well as dental ages (n = 137 humeri and femora). In this pooled sample (DC), 16 out of 72 (22%) individuals demonstrated evidence of growth suppression in long bone length (Z-scores < 2 standard deviations below the mean for bone length for age). This pooled sample was evaluated against a sample of individuals from the Denver Longitudinal Study (n = 10 males and 10 females) whose cortical bone growth profiles were described previously (Ruff, 2003a, 2003b, 2005).

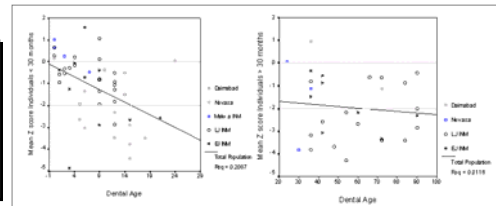


Sample of Long Bones from Infants and Children at Deccan Chalcolithic (DC) Sites

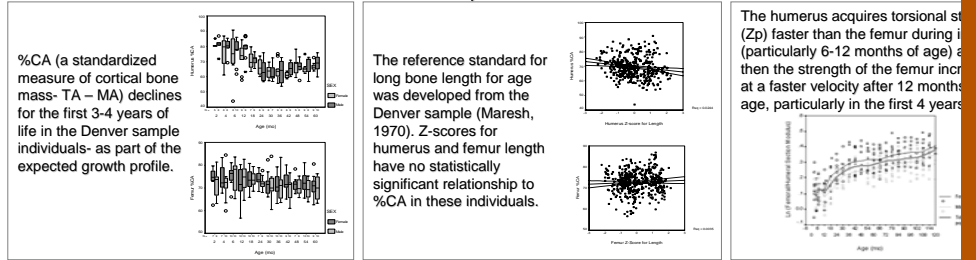
Site	Period	Ind < 120 mos	Ind with long bones	Ind with intact midshaft (cortical bone sample)	
				humerus	femur
Inamgaon	All INM	166	104	45	56
	Malwa	16	14	7	13
	EJ	43	32	8	13
	LJ	107	58	30	30
Nevasa	Jorwe	70	30	9	10
Daimabad	Jorwe	36	25	8	9
<b>Total</b>		<b>272</b>	<b>159</b>	<b>62</b>	<b>75</b>



Bayesian Analysis of perinatal long bone lengths indicated that maternal-fetal health status was sufficient to buffer offspring from growth disruption during gestation. Graph shows low frequency of perinates with age estimates from long bone lengths that are < 35 lunar weeks (perinatal growth should be unaffected). Long bone linear growth suppression began after 3-6 months of age for Deccan Chalcolithic samples. 38% of individuals who died after the age of 30 months had low Z-scores for long bone length.



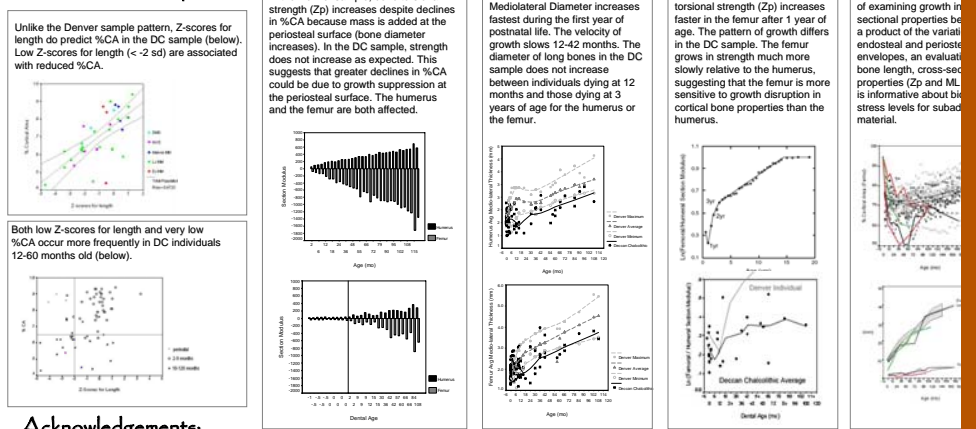
## Part II: Cortical Bone Growth in the Denver Sample:



If this is the growth profile expected for infants and children growing up in circumstances of adequate nutrition, sanitation conditions, and regular exercise, is the same pattern of growth maintained for infants and children experiencing nutritional and biocultural stress?



## Part IV: Results & Interpretation



### Acknowledgements:

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