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GROWTH AND DEVELOPMENT IN A HISPANO-MUSLIM SUBADULT POPULATION.

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Summary

Patterns of growth and developmental are analyzed in the Hispano-Muslim skeletal collection from San Nicolás neocropolis (Murcia, Spain). Results are compared with two other historical populations. A similar pattern is described, although the Hispano-Muslim population shows a growth delay due probably to greater or environmental stress.

Introduction

Childhood growth is an excellent measure, not only of health, but of the life-style of populations; because of this, the analysis of subadult archaeological populations provides the opportunity to evaluate the impact of environmental stress (Martin *et al.*, 1985), through the analysis of some indicators of physiological disruption.

Unfortunately preadult skeletons present some limitations, which difficult their study and interpretation; the lack of sexual dimorphism, the bad preservation and the low number of individuals in the collections are among the most common problems (Sundik, 1978). Despite of this, several studies on growth and development have been carried out, both in American Indians, (Johnston, 1962; Ubelaker and Merchant, 1977; Sundik, 1978) and Medieval European population (Sundik, 1978).

We analyze the patterns of growth and growth disruption in a sample of subadult individuals of a Medieval Hispano-Moslem population from S.E. of Spain (Murcia). For this work we have chosen length measurements of the long bones and we have compared them to the Altenerding and Indian Knoll populations (Sundick, 1978). Use of the cemetery from the XI-XIII Centuries gives the opportunity to evaluate the different patterns of mortality throughout

this period. This populations have been used for comparative purposes, due to the lack of information on growth and development for Spanish archeological populations.

Material and Methods

A Hispano-Muslim skeletal collection from San Nicolás necropolis (Murcia) dated XIth-XIIIth Centuries, and buried at eight different levels, is studied (Navarro, 1984). Although this collection has a high number of subadult individuals (about 200), only 143 have well preserved long bones; 107 correspond to individuals under 11 years. Table 1 shows the number of complete bones used for the analysis.

Measurements have been taken according to Martin and Saller (1957) measuring the maximum length of the bone without the epiphyses up to the age of thirteen, and with the fusioned epiphyses from this to the age of seventeen. Age has been assigned according to dental eruption (Ubelaker, 1978) and following the recommendations of the W.E.A. (1980).

For comparative purposes, the assigned age has been translated to the one proposed by Sundick (1978) (Table 2).

Both sexes are analyzed together. The comparison has only been done up to the age of eleven years because up to this age a clear sexual dimorphism does not emerge. Statistical work has been done using personal computers and the statistical pack Statgraphics.

Results and Discussion

To increase the sample size a statistical reconstruction procedure has been carried out. The regression lines for each right bone with its correspondent from the left side, have been estimated (only for individuals under thirteen years old, Table 3).

Nº INDIVIDUALS	HUMERUS		RADIUS		ULNA		FEMUR		TIBIA	
143	R	L	R	L	R	L	R	L	R	L
BONES	48	28	34	21	31	24	48	31	27	16

Table 1.- Number of bones rebuilt at the laboratory. San Nicolás, Murcia.

Age group	Range (years) (Moorrees,Fanning,Hunt (1963)
1	birth - 6 mo.
2	6 mo. - 15 mo.
3	15 mo. - 24 mo.
4	24 mo. - 30 mo.
5	30 mo. - 42 mo.
6	42 mo. - 54 mo.
7	41/2 yr. - 51/2 yr.
8	51/2 yr. - 61/2 yr.
9	61/2 yr. - 8 yr.
10	8 yr. - 101/2 yr.
11	101/2yr. - 11 yr.

Table 2.- Age groups.

As the number of data for some age groups did not increase, we calculate the lines of regression for each bone, with the evaluation of the left side added, to the other bones. In order not to increase the error in the estimates, stepwise regression analysis was used (Table 4). In this way, it has been completed quite a suitable number of data, and with little error when compared to the amount of information that would have been lost if we had not studied that important part of the population.

We can see in Tables 3 and 4, the number of effective increases for every regression; and in Table 5, the total number of bones we have at this moment in time. With this sample, we have obtained the mean values to compare with other populations. Tables 6 to 10 show the differences between mean values among the analyzed populations.

It is necessary to underline that the greater differences found in some cases could be an artefact of the small size of the statistical sample.

Figures 1 to 10 show that San Nicolás population follows the same pattern of growth as the other two. However, our population does not grow as efficiently as the others. The younger age groups from San Nicolás show similar values to

BONE	REGRESION LINES	Nº ADDED	S. E.	R-SQ
HUMERUS RIGTH	0.37+0.99*HUMERUS LEFT	8	1.812	0.999
ULNA RIGTH	-0.006+1.0106*ULNA LEFT	6	0.887	0.999
RADIUS RIGTH	-2.30+1.026*RADIUS LEFT	9	1.67	0.998
FEMUR RIGTH	1.04+0.995*FEMUR LEFT	8	0.88	0.999
TIBIA RIGTH	2.53+0.985*TIBIA LEFT	2	1.48	0.999

Table 3.- Regression lines for each rigth bone. San Nicolás, Murcia.

BONE	REGRESION LINES	Nº ADDED	S. E.	R-SQ
HUMERUS	175.9+0.649*FEMUR	17	3.767	0.994
ULNA	3.98+1.0862*RADIUS	23	3.255	0.996
RADIUS	-3.32+0.917*ULNA	14	2.99	0.996
FEMUR	-26.7+1.530*HUMERUS	26	5.78	0.994
TIBIA	-24.26+1.509*ULNA -5.87+0.790*FEMUR -9.39+0,78*ULNA+0.37*FEMUR	20 22 8	3.39 3.58 2.61	0.997 0.997 0.998

Table 4.- Regression lines for each bone. San Nicolás, Murcia.

HUMERUS	RADIUS	ULNA	FEMUR	TIBIA
71	52	52	69	63

Tabla 5.- Total number of bones (under 13 years) after statistical reconstruction. San Nicolás, Murcia.

Age Group	1	2	3	4	5	6	7	8	9	10
Nº - Nº	8 14	7 3	8 5	7 -	11 2	6 7	7 1	3 2	6 7	9 6
I.KN.- HM.	-5.19	2.81	5.5	-	10.3	14.1	2.5	12.5	20.4	8.68
Nº - Nº	1 14	2 3	1 5	-	3 2	5 7	1 1	6 2	4 7	3 6
ALT. - HM.	5.41	3.71	14.9	-	13.04	17.9	28	29.8	24.4	14.9

Tabla 6. - Differences between means (Humerus).
IK: Indian Knoll, ALT: Altenerding, HM: Hispano-Muslim.

Age Group	1	2	3	4	5	6	7	8	9	10
Nº - Nº	8 11	5 4	7 6	5 -	7 1	6 3	6 -	3 2	6 6	7 6
I.KN.- HM.	-1.66	-1.2	11.4	-	11.8	16.8	-	18.5	16.7	5.3
Nº - Nº	1 11	1 4	- 6	1 -	3 1	5 3	1 -	3 2	4 6	4 6
ALT. - HM.	4.54	-13	-	-	7.22	20.9	-	33.5	17.7	2.72

Table 7.- Differences between means (Radius).

Age Group	1	2	3	4	5	6	7	8	9	10
Nº - Nº	7 10	6 4	8 6	6 -	7 1	4 3	5 -	2 2	6 6	9 6
I.KN.- HM.	-2.9	-3.4	10.9	-	13.9	16.1	-	19.8	16.9	4.03
Nº - Nº	- 10	1 4	- 6	1 -	2 1	4 3	- -	4 2	4 6	2 6
ALT. - HM.	-	-16.1	-	-	7	15.9	-	28.2	17.5	11.8

Table 8.- Differences between means (Ulna).

those of Indian Knoll and Altenerding. For the other age groups, a delayed growth is patent in our population as it becomes shorter than the other two. In the last age group (in which the pubertal growth spurt takes places), the difference between our population and the others levels off slightly. These differences persist in adults when comparing the height in the Indian Knoll and Alternanding populations to the Hispano-Muslim.

Using Trotter and Glesser forms, adult height is: 167 cm for Indian Knoll, 172.9 for Altenerding and 164 cm for Hispano-Muslim. These data reflect the final differences that we have observed in our studies.

Differences found in the development of the long bones, between our population and the other populations, both children and adults, could be due to environmental stress during childhood.

Age Group	1	2	3	4	5	6	7	8	9	10
Nº - Nº	8 14	7 3	8 5	7 -	11 2	7 7	7 1	3 2	6 7	9 6
I.KN.- HM.	-3.56	5.3	7.18	-	17.1	17.6	1	23.4	36.7	16.7
Nº - Nº	1 14	- 3	1 5	1 -	3 2	5 7	3 1	6 2	4 7	6 6
ALT. - HM.	9.44	-	20.2	-	17.2	27.7	12.3	37.3	38.1	16.1

Table 9.- Differences between means (Femur).

Age Group	1	2	3	4	5	6	7	8	9	10
Nº - Nº	7 12	7 6	8 5	6 -	10 2	6 5	6 -	3 -	6 5	9 6
I.KN.- HM.	-2.33	9.32	8.96	-	13.2	17.9	-	-	28.5	11.3
Nº - Nº	- 12	- 6	1 5	2 -	2 2	3 5	3 -	7 -	4 5	6 6
ALT. - HM.	-	-	10.5	-	8	17.3	-	-	21.7	6.93

Table 10.- Differences between means (Tibia).

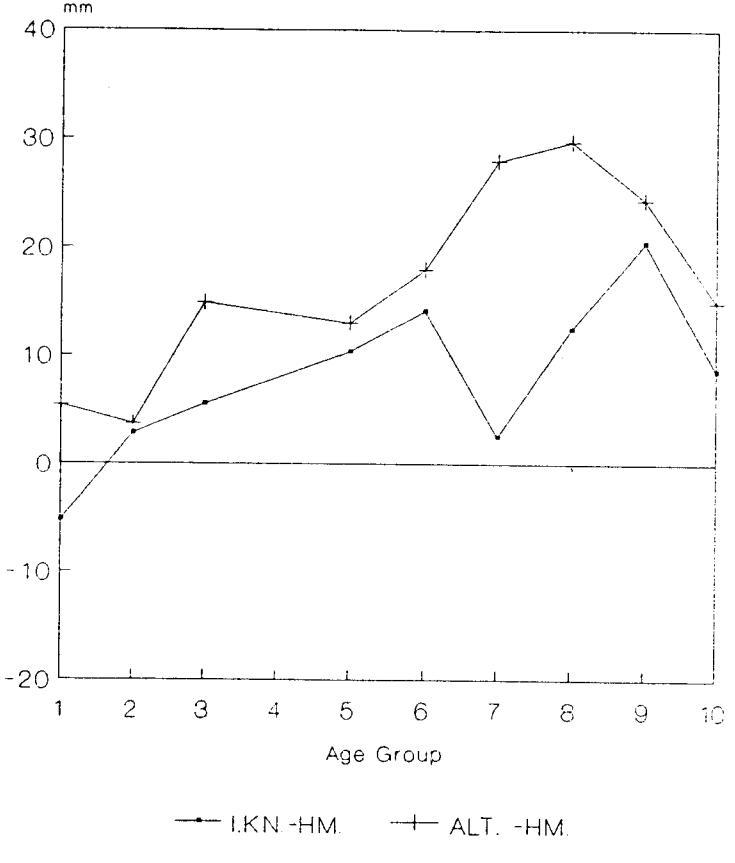

Figure 2.- Differences between Humerus means.

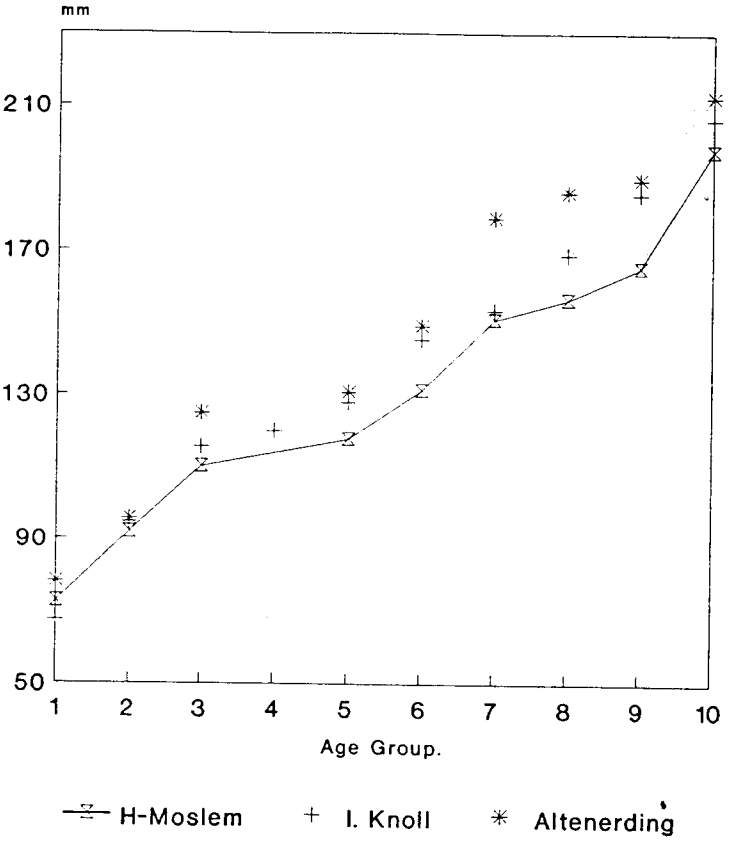

Figure 1.- Humerus: A comparison between lenght means.

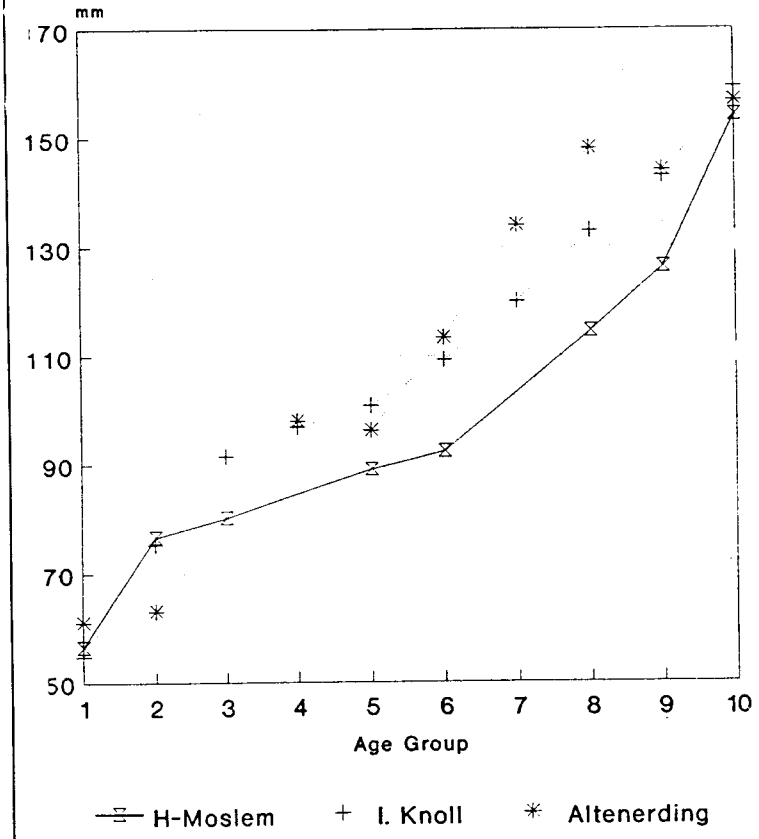

Figure 3.- Radius: A comparison between length means.

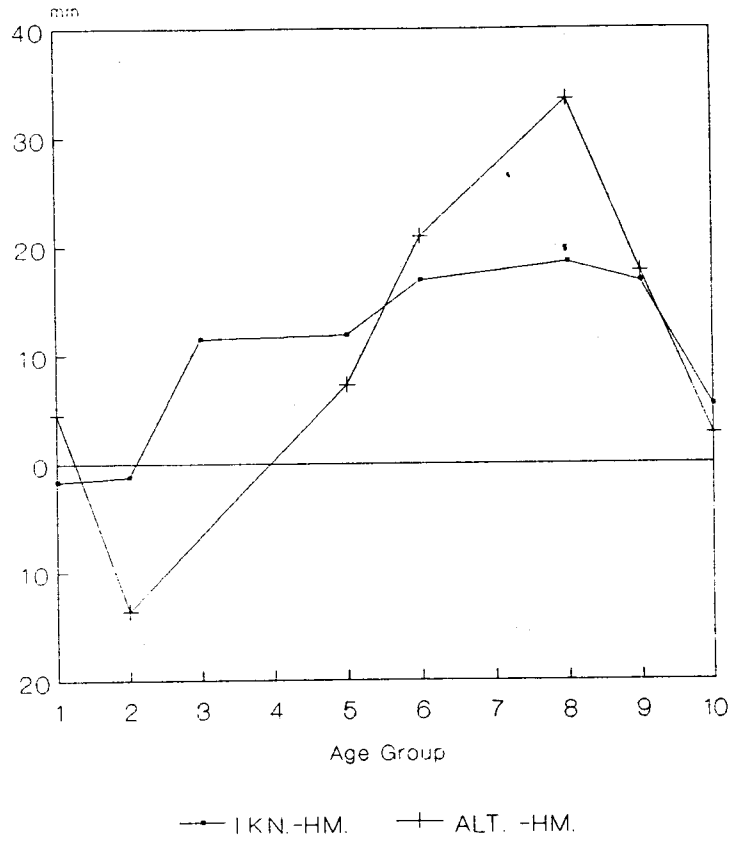

Figure 4.- Differences between Radius means.

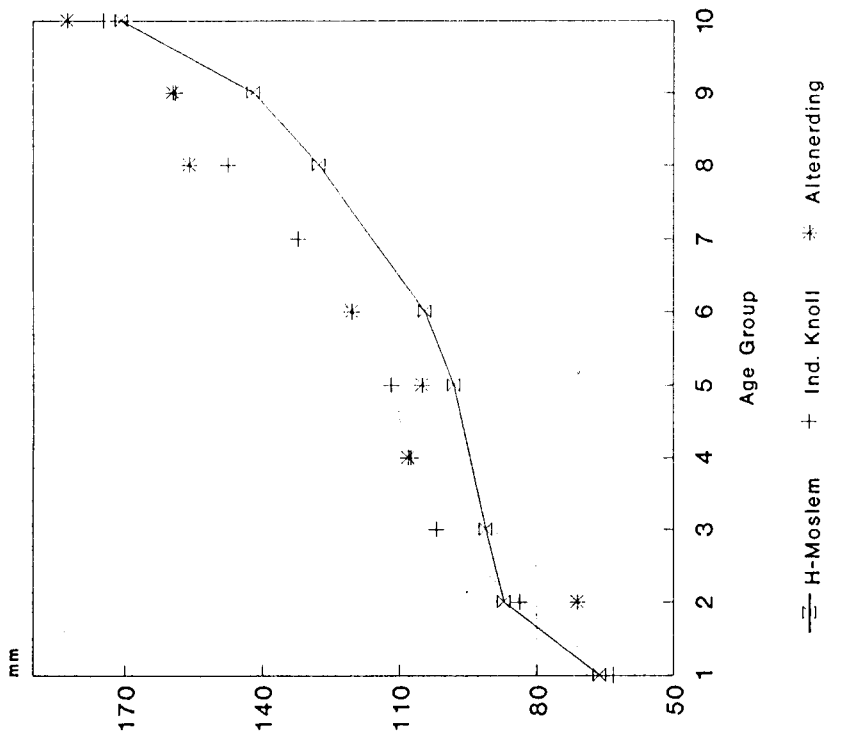

Figure 5.- Ulna: A comparison between length means.

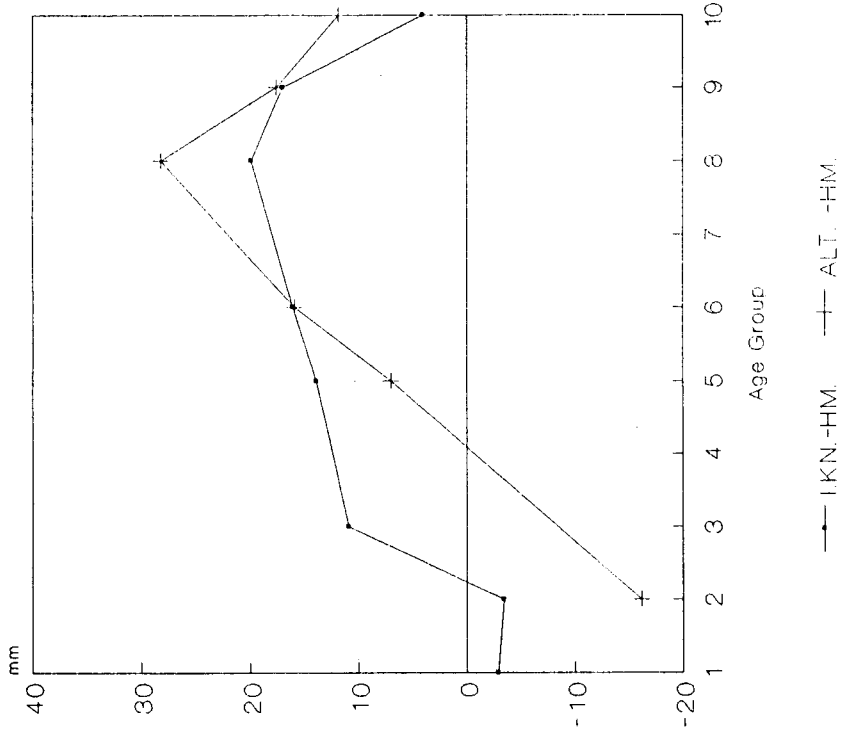

Figure 6.- Differences between Ulna means.

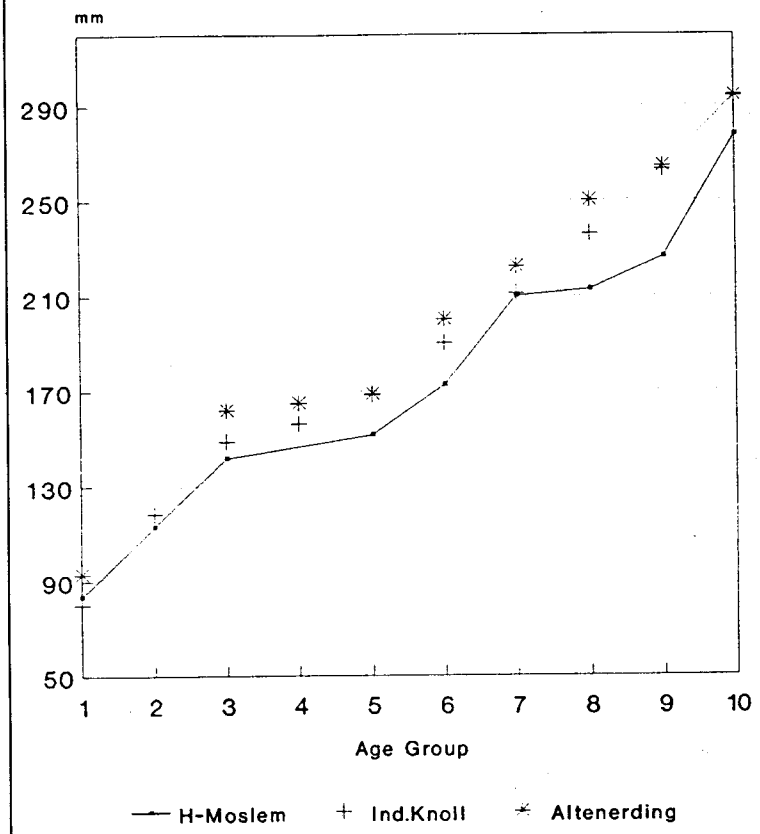

Figure 7.- Femur: A comparison between lenght means.

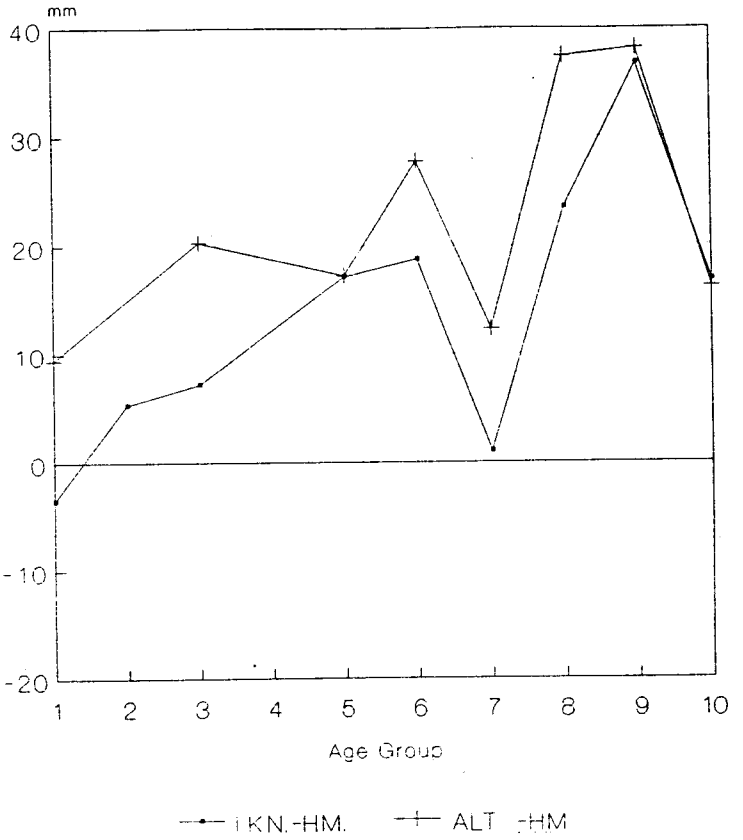

Figure 8.- Differences between Femur means.

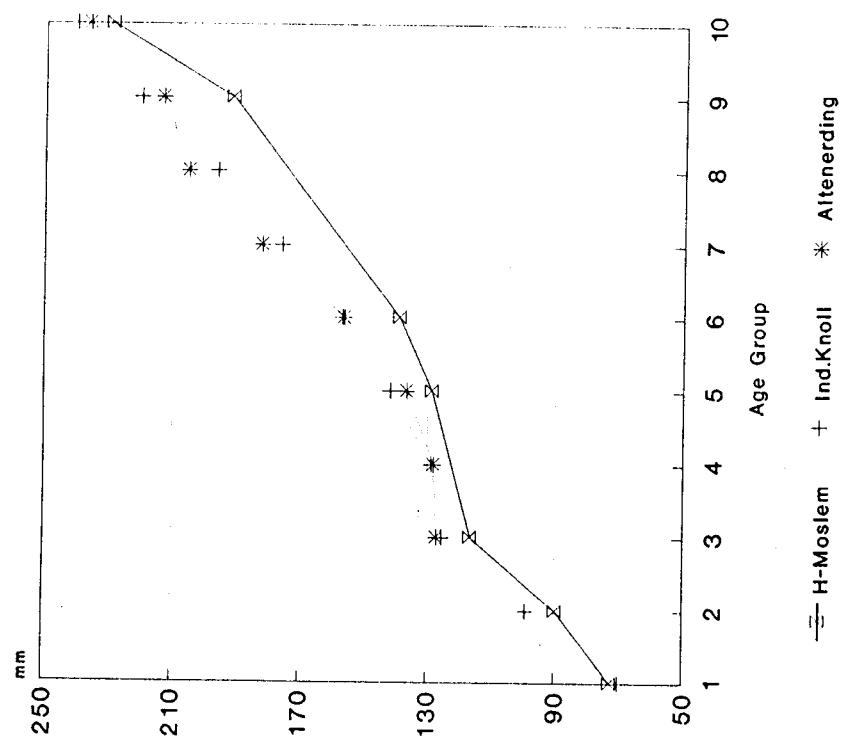

Figure 9.- Tibia: A comparison between lenght means.

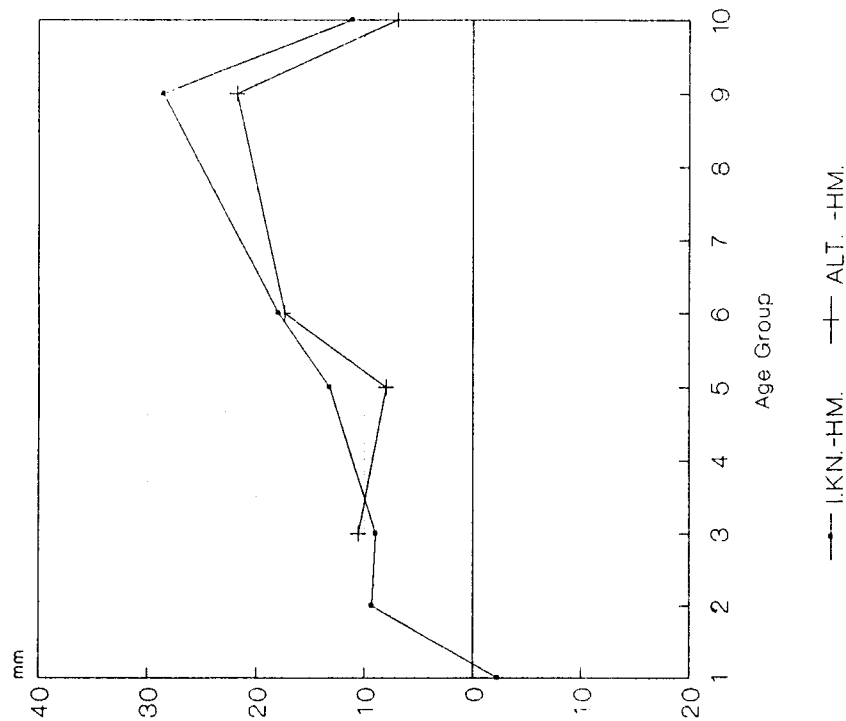

Figure 10.- Differences between Tibia means.

Knowing that dental enamel hypoplasia is a stress indicator (El Najjar *et al.*, 1978) and taking into account that for this Hispano-Muslim population the rate of dental enamel hypoplasia affects up to 100% of male adults and up to 95% of females (Bernis *et al.*, 1985), we could conclude that the weaning period is characterized by strong nutritional stress which produces growth delays.

In the same way, the presence of a high number of adults with tibia asymmetries (Bernis *et al.*, 1989) -which is also considered to be an environmental stress indicator- corroborate that during childhood period, the population was affected by strong environmental stress, resulting in stunted growth.

Figure 11 shows death frequencies in age groups according to our notation, and Figure 12 shows the distribution of individuals found in the eight different burial levels. The levels had been numbered from the oldest number 8 to the newest number 1.

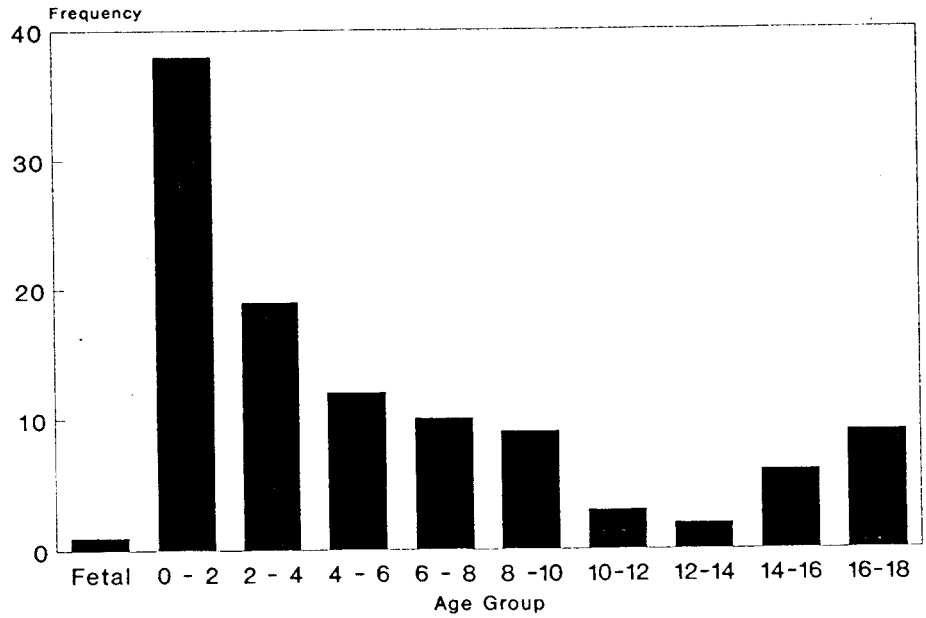

Figure 11.- Death frequencies by age groups.

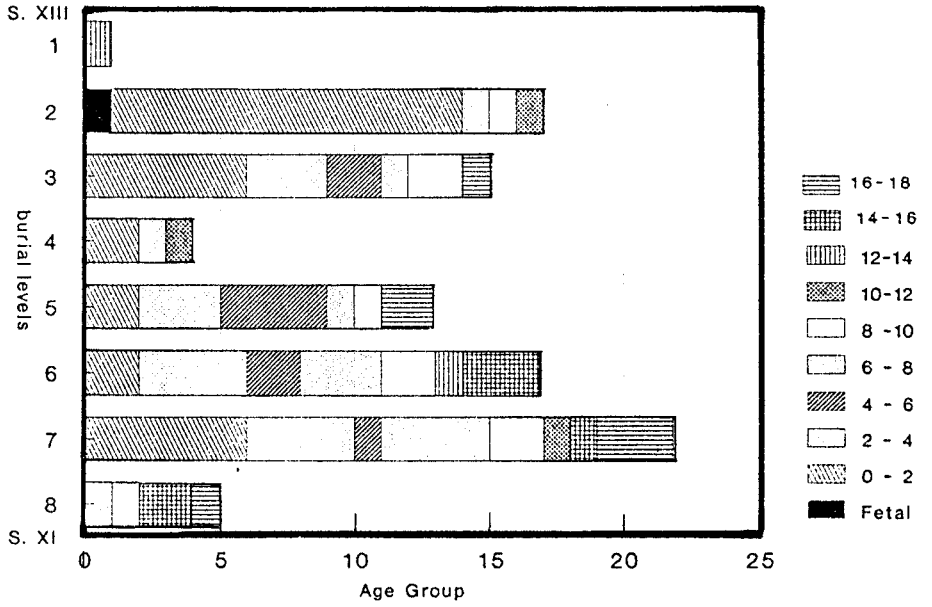

Figure 12.- Number of individuals found in different burial levels.

The highest incidence of mortality is found in the younger age group (0-2 years), decreasing up to the seventh group (12-14 years).

Figure 12 shows, striking differences in patterns of mortality by age groups, among the different levels. The higher concentration of children is found in the sixth and seventh levels, in which all age groups are equally represented, but in the second level infant mortality (age group 0-2 years) is strikingly high.

This high child and infant mortality rate could be due to the increase in population resulting from the big migratory movements, which took place throughout this period (XI - XIII Centuries) in Muslim population because of the Christian expansion in this area (Ariel, 1988).

Migratory movements have been related to an increase in epidemics, infections and undernourishment, particulary when they take place in war conditions (McNeill, 1976). The pressure of the Christian expansion reached its maximum in the XIIIth Century with the conquest of Murcia. Level 2 which shows an striking increase in the death rates of the younger age groups (0-2 years), was used just before the conquest of the city.

It is necessary to compare this population with other Hispano-Muslim populations of this period to confirm this interpretation.

Conclusions

Our population presents differences in the size of individuals when compared to other populations. However, part of these differences are due to the biological distance which exists among the populations tested and the low statistical sample size.

The San Nicolás subadult population suffers a clear growth delay due to nutritional factors or other environmental stress in particular age groups.

It is noticeable that net differences exist in death rates among the different age groups, observed in the burial levels. This difference is more marked in level two, which shows a high concentration of individuals from the younger age groups (0-2 years).

Further studies on the paleopathology of this population will give information on the kind of illnesses they suffered and if the deaths which occurred in the subadults are due to infections corresponding to the population increase due to migrations. In this situation the individuals more sensitive to environmental changes would be more affected, ie, children.

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Resumen

El estudio de restos óseos infantiles, como los encontrados en el yacimiento Hispano-Musulmán de Murcia, nos permite conocer cómo se desarrolló una de las etapas mas importantes de la vida de esta población: la infancia. Hemos comparado las medidas de los huesos largos con las de otras poblaciones infantiles, con el fin de determinar si estos individuos que habitaron en España en los siglos XI-XIII se desarrollaron con normalidad o sufrieron presiones ambientales que pudieran influir en su crecimiento. El período tan extenso de utilización de la necrópolis nos ha permitido observar las diferencias que existen en la distribución de muertes entre los subadultos de esta población.