A DIACHRONIC STUDY OF ACTIVITY IN PORTUGAL USING ENTHESEAL CHANGES

María Soledad Salega [1]; Ana Maria Silva [2, 3]; Charlotte Yvette Henderson [2]

1. IDACOR-CONICET (National Council of Scientific and Technical Research); Museo de Antropología, Universidad Nacional de Córdoba, Argentina.
2. CIAS – Research Centre for Anthropology and Health, Portugal.
3. Department of Life Sciences, University of Coimbra, Portugal.

UID/ANT/00283/2013

INTRODUCTION

The aim of this work is to study the changes in entheseal change frequency through time in Portugal to assess the effect of increased urbanisation and industrialisation. Previous research has found that agriculturalists have the lowest frequency of entheseal changes in the past, with hunter-gatherers the second highest and those living in an industrial setting having the highest frequencies (Henderson 2013). However, this study was a meta-analysis of previously published papers and was subject to several limiting factors, such as inter-observer error. But more seriously, the method used to record entheseal changes was not biologically appropriate. This study therefore aims to address these issues by using a newly devised biologically appropriate recording method (Henderson *et al*. 2015), and using one observer to record all entheseal changes.

MATERIALS AND METHODS

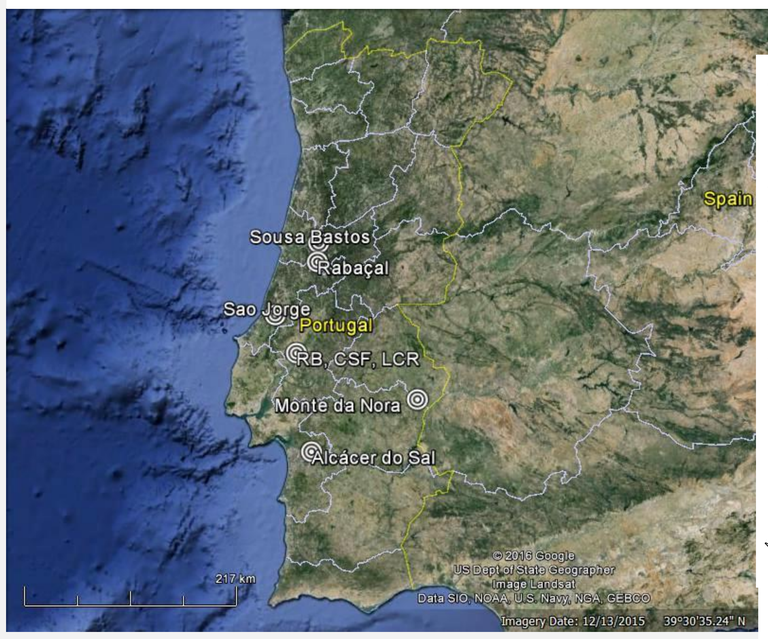
Eight archaeological sites were recorded (Fig.1), and grouped by chronology as Pre-Modern (Monte da Nora, Rua dos Barcos, São Jorge-Batalha, Convento São Francisco), and Modern (Largo Candido dos Reis, Sousa Bastos, Rabaçal, Alcacer do Sal-Castelo).

In total, 208 adult individuals were recorded, but in the present study only those individuals with data of both sex and age were included (Fig.2), resulting in a sample size of 138.

Two age categories were used: young adults (bones unfused or just fusing) and older adults (medial clavicle and other late fusing epiphyses fully fused).

One researcher recorded eleven entheses (upper and lower limb), in right and left sides, using the new Coimbra method for recording entheses (Henderson *et al*. 2015). Intra-observer reliability was calculated using percentage agreement for each enthesis and feature.

Figure 1. Map of Portugal, with the location of registered archaeological sites. References: RB=Rua dos Barcos. CSF=Convento São Francisco. LCR=Largo Candido dos Reis.



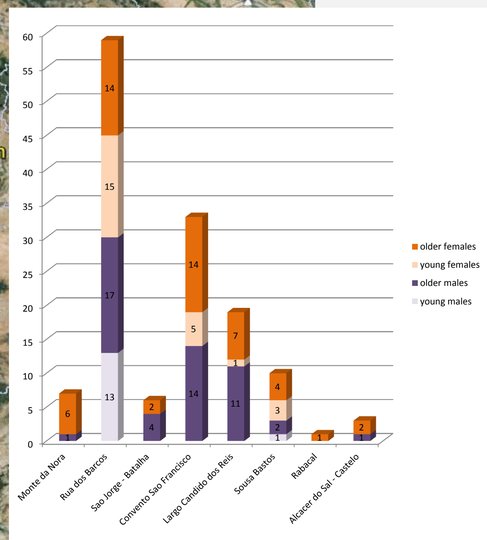


Figure 2. Sample composition. Numbers refer to the amount of individuals per age category.

RESULTS

Intra-observer reliability: According to the intra-observer reliability calculation (Table 1), 80.2% of the percentage agreements for each enthesis and feature are equal or higher than 90%, and the values for minimum agreements are between 75 and 90.

Table 1. Intraobserver repeatability for each enthesis by feature and pooled. N=40 (20 individuals with left and right sides). References: S+I=supraspinatus and infraspinatus combined. Z1=zone 1. Z2=zone 2. BF=bone formation. ER=erosion. TC=textural change. FPO=fine porosity. MPO=macroporosity. CA=cavitations.

ENTHESIS	All	BFZ1	ERZ1	TC	BFZ2	ERZ2	FPO	MPO	CA
Supraspinatus	90.6	85.0	85.0	95.0	87.5	92.5	95.0	95.0	90.0
Infraspinatus	88.8	87.5	90.0	92.5	82.5	85.0	92.5	90.0	90.0
S+I	88.8	85.0	90.0	92.5	80.0	87.5	92.5	92.5	90.0
Subscapularis	87.5	87.5	90.0	90.0	85.0	80.0	90.0	87.5	90.0
Common extensor origin	92.5	82.5	92.5	97.5	87.5	92.5	97.5	95.0	95.0
Common flexor origin	95.0	90.0	95.0	97.5	97.5	90.0	95.0	97.5	97.5
Biceps brachii	90.0	77.0	90.0	97.5	85.0	90.0	95.0	87.5	97.5
Triceps brachii	90.9	92.5	92.5	97.5	77.5	87.5	92.5	90.0	97.5
Semimembranosus	85.9	80.0	85.0	90.0	77.5	75.0	90.0	90.0	100.0
Gluteus medius	95.6	97.5	90.0	100.0	100.0	97.5	97.5	92.5	100.0
Patellar tendon	99.1	97.5	97.5	100.0	97.5	100.0	100.0	100.0	100.0
Triceps surae	90.0	75.0	85.0	95.0	87.5	95.0	92.5	95.0	95.0
Minimum agreement	85.9	75	85	90	77.5	75	90	87.5	90

Frequencies: The results show that different sites have very different profiles of frequencies of each feature. Trends in the upper limb are more disparate than in the lower limb, with the triceps surae enthesis having the most consistent pattern of changes between sites. Also this enthesis show the higher frequency values for bone formation in zone 1 in both periods, together with the semimembranosus enthesis (bone formation and erosion in zone 2), while in the upper limb entheses, the highest values are recorded in the Modern period.

Table 2. Frequency distributions in Pre-Modern -A-, and Modern -B- periods (see Table 1 for references).

(A)	BFZ1				ERZ1				TC				BFZ2				ERZ2				FPO				MPO				CA			
	n	frequency			n	frequency			n	frequency			n	frequency			n	frequency			n	frequency			n	frequency			n	frequency		
ENTHESIS		0	1	2		0	1	2		0	1	2		0	1	2		0	1	2		0	1	2		0	1	2		0	1	2
Supraspinatus	65	0.86	0.07	0.06	65	0,98	0.00	0.01	77	1.00	0.00	0.00	77	0.92	0.06	0.01	77	0.84	0.11	0.03	77	1.00	0.00	0.00	77	1.00	0.00	0.00	77	0.97	0.02	0.00
Infraspinatus	64	0.90	0.06	0.03	64	0.96	0.03	0.00	74	1.00	0.00	0.00	74	0.87	0.10	0.01	74	0.81	0.16	0.02	74	1.00	0.00	0.00	74	0.96	0.02	0.01	74	0.92	0.05	0.02
S+I	67	0.85	0.12	0.03	67	0.95	0.04	0.00	75	1.00	0.00	0.00	75	0.88	0.09	0.03	75	0.76	0.21	0.03	75	1.00	0.00	0.00	75	0.97	0.01	0.01	75	0.92	0.07	0.01
Subscapularis	70	0.77	0.18	0.04	70	0.97	0.03	0.00	77	1.00	0.00	0.00	77	0.75	0.20	0.04	77	0.74	0.23	0.03	77	1.00	0.00	0.00	77	0.97	0.03	0.00	77	0.93	0.06	0.00
Common extensor origin	114	0.63	0.22	0.16	114	0.99	0.01	0.00	129	1.00	0.00	0.00	129	0.84	0.15	0.01	129	0.94	0.06	0.00	129	1.00	0.00	0.00	129	0.99	0.01	0.00	129	1.00	0.00	0.00
Common flexor origin	115	0.88	0.09	0.03	115	1.00	0.00	0.00	140	1.00	0.00	0.00	140	0.93	0.07	0.00	140	0.99	0.01	0.00	140	1.00	0.00	0.00	140	1.00	0.00	0.00	140	1.00	0.00	0.00
Biceps brachii	124	0.76	0.17	0.07	124	0.98	0.02	0.00	128	1.00	0.00	0.00	128	0.85	0.15	0.00	128	0.93	0.06	0.01	128	1.00	0.00	0.00	128	0.99	0.01	0.00	128	0.96	0.02	0.01
Triceps brachii	143	0.75	0.17	0.08	143	0.98	0.02	0.00	144	1.00	0.00	0.00	144	0.87	0.13	0.00	144	0.90	0.08	0.02	144	0.99	0.01	0.00	144	1.00	0.00	0.00	144	0.98	0.01	0.01
Semimembranosus	137	0.73	0.23	0.04	137	0.98	0.02	0.00	148	0.99	0.01	0.00	148	0.53	0.47	0.00	148	0.63	0.36	0.01	148	1.00	0.00	0.00	148	0.97	0.03	0.00	148	0.96	0.03	0.01
Gluteus medius	76	0.84	0.09	0.06	76	1.00	0.00	0.00	94	1.00	0.00	0.00	94	0.90	0.09	0.00	94	0.94	0.06	0.00	94	1.00	0.00	0.00	94	1.00	0.00	0.00	94	1.00	0.00	0.00
Patellar tendon	74	0.99	0.01	0.00	74	1.00	0.00	0.00	76	1.00	0.00	0.00	76	0.71	0.29	0.00	76	0.99	0.00	0.01	76	1.00	0.00	0.00	76	1.00	0.00	0.00	76	1.00	0.00	0.00
Triceps surae	72	0.33	0.42	0.25	72	1.00	0.00	0.00	75	1.00	0.00	0.00	75	0.91	0.09	0.00	75	1.00	0.00	0.00	75	1.00	0.00	0.00	75	1.00	0.00	0.00	75	1.00	0.00	0.00

(B)	BFZ1				ERZ1				TC				BFZ2				ERZ2				FPO				MPO				CA			
	n	frequency			n	frequency			n	frequency			n	frequency			n	frequency			n	frequency			n	frequency			n	frequency		
ENTHESIS		0	1	2		0	1	2		0	1	2		0	1	2		0	1	2		0	1	2		0	1	2		0	1	2
Supraspinatus	22	0.91	0.05	0.05	22	1.00	0.00	0.00	26	1.00	0.00	0.00	26	1.00	0.00	0.00	26	0.85	0.11	0.04	26	1.00	0.00	0.00	26	1.00	0.00	0.00	26	1.00	0.00	0.00
Infraspinatus	22	0.91	0.09	0.00	22	0.95	0.05	0.00	24	1.00	0.00	0.00	24	0.83	0.17	0.00	24	0.58	0.38	0.04	24	1.00	0.00	0.00	24	1.00	0.00	0.00	24	0.96	0.04	0.00
S+I	22	0.86	0.14	0.00	22	0.95	0.05	0.00	24	1.00	0.00	0.00	24	0.83	0.17	0.00	24	0.58	0.42	0.00	24	1.00	0.00	0.00	24	1.00	0.00	0.00	24	0.96	0.04	0.00
Subscapularis	26	0.77	0.19	0.04	26	1.00	0.00	0.00	29	1.00	0.00	0.00	29	0.72	0.28	0.00	29	0.65	0.31	0.04	29	0.96	0.04	0.00	29	1.00	0.00	0.00	29	0.90	0.07	0.03
Common extensor origin	33	0.85	0.12	0.03	33	0.97	0.03	0.00	39	1.00	0.00	0.00	39	0.85	0.13	0.02	39	0.90	0.08	0.02	39	1.00	0.00	0.00	39	0.98	0.02	0.00	39	1.00	0.00	0.00
Common flexor origin	36	0.89	0.12	0.00	36	0.97	0.03	0.00	48	1.00	0.00	0.00	48	0.94	0.06	0.00	48	0.87	0.10	0.02	48	0.98	0.02	0.00	48	1.00	0.00	0.00	48	1.00	0.00	0.00
Biceps brachii	53	0.83	0.11	0.06	53	0.98	0.02	0.00	52	1.00	0.00	0.00	52	0.79	0.21	0.00	52	0.92	0.08	0.00	52	0.98	0.02	0.00	52	0.94	0.04	0.02	52	0.98	0.02	0.00
Triceps brachii	43	0.63	0.30	0.07	43	0.93	0.07	0.00	43	1.00	0.00	0.00	43	0.70	0.30	0.00	43	0.86	0.14	0.00	43	1.00	0.00	0.00	43	0.95	0.05	0.00	43	1.00	0.00	0.00
Semimembranosus	41	0.76	0.22	0.02	41	0.90	0.10	0.00	44	0.93	0.07	0.00	44	0.57	0.41	0.02	44	0.57	0.39	0.04	44	0.98	0.02	0.00	44	0.98	0.00	0.02	44	0.98	0.02	0.00
Gluteus medius	22	0.77	0.18	0.04	22	1.00	0.00	0.00	27	1.00	0.00	0.00	27	0.92	0.08	0.00	27	0.92	0.08	0.00	27	0.96	0.04	0.00	27	0.89	0.07	0.04	27	1.00	0.00	0.00
Patellar tendon	33	1.00	0.00	0.00	33	1.00	0.00	0.00	38	1.00	0.00	0.00	38	0.92	0.08	0.00	38	1.00	0.00	0.00	38	1.00	0.00	0.00	38	1.00	0.00	0.00	38	1.00	0.00	0.00
Triceps surae	27	0.33	0.40	0.26	27	1.00	0.00	0.00	33	1.00	0.00	0.00	33	0.91	0.03	0.06	33	1.00	0.00	0.00	33	1.00	0.00	0.00	33	0.97	0.03	0.00	33	1.00	0.00	0.00

Odds ratios: In Table 3, only odds ratios greater than 2 are presented. When chronology is considered, there are differences between the two periods in upper limbs and hip entheses, with higher ratios for the Modern period (except for erosion in zone 1 of the common extensor origin enthesis). Taking into account sex differences, the only value was registered for macroporosity in the infraspinatus enthesis for females, although not statistically significant. Finally, on age differences, the higher ratios correspond to the older-adult group, and it is also noticeable that p-values are more common for this variable.

		Chronology		Sex		Age	
		Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value
Supraspinatus	BFZ1	-	-	-	-	4.151	0.145
	ERZ2	-	-	-	-	**7.632**	**0.020**
Infraspinatus	ERZ2	-	-	-	-	**3.061**	**0.027**
	MPO	-	-	2.318	0.454	-	-
	CA	-	-	-	-	2,806	0.307
S+I	BFZ1	-	-	-	-	**6.612**	**0.039**
	BFZ2	-	-	-	-	**5.426**	**0.005**
	ERZ2	2.262	0.081	-	-	-	-
	CA	-	-	-	-	2.903	0.293
Subscapularis	BFZ1	-	-	-	-	**6.444**	**0.006**
	BFZ2	-	-	-	-	**19.644**	**<0.001**
	ERZ2	-	-	-	-	**6.545**	**0.001**
Common extensor	BFZ1	-	-	-	-	**14.950**	**<0.001**
origin	ERZ1	3.531	0.400	-	-	-	-
	BFZ2	-	-	-	-	**5.303**	**0.010**
	MPO	3.368	0.411	-	-	-	-
Common flexor	BFZ1	-	-	-	-	**8.404**	**0.011**
origin	ERZ2	**19.857**	**0.001**	-	-	2.354	0.377
Biceps brachii	BFZ1	-	-	-	-	**2.750**	**0.021**
	BFZ2	-	-	-	-	**4.500**	**0.006**
	ERZ2	-	-	-	-	5.426	0.062
	MPO	7.776	0.073	-	-	-	-
	CA	-	-	-	-	2.131	0.429
Triceps brachii	BFZ1	-	-	-	-	**9.722**	**<0.001**
	BFZ2	**2.851**	**0.011**	-	-	**7.573**	**0.001**
	ERZ2	-	-	-	-	**4.070**	**0.036**
Semimembranosus	BFZ1	-	-	-	-	**4.083**	**0.001**
	ERZ1	**7.297**	**0.026**	-	-	2.288	0.398
	TC	**10.756**	**0.038**	-	-	-	-
	BFZ2	-	-	-	-	**3.876**	**<0.001**
	CA	-	-	-	-	2.209	0.413
Gluteus medius	BFZ1	-	-	-	-	**11.000**	**0.004**
Triceps surae	BFZ1	-	-	-	-	**10.500**	**<0.001**

Table 3. Odds ratios and p-values. Only odds ratios values greater than 2 are represented, and statistically significant p-values (p≤0.05) are in bold.

DISCUSSION AND CONCLUSIONS

Results seem to be in accordance with previous works that show higher frequencies for industrial settings when compared to other subsistence economies. However, activity is not the only explanatory factor in these results, since different age and sex profiles contribute to the different trends. Moreover, small sample sizes in the individual sites and in age/sex groups also contribute to high frequencies of some changes. And, although some chronological differences were detected, there are many more corresponding to age, thus reinforcing the importance of this variable when studying the development of entheseal changes.

REFERENCES

Henderson CY. 2013. Subsistence strategy changes: the evidence of entheseal changes. Homo - J Comp Hum Biol 64:491–508.

Henderson CY, Mariotti V, Pany-Kucera D, Villotte S, Wilczak C. 2015. The new "Coimbra method": a biologically appropriate method for recording specific features of fibrocartilaginous entheseal changes. Int. J. Osteoarchaeol., doi: 10.1002/oa.2477.