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research

Islam in Iberia or Iberian Islam: bioarchaeology and the analysis of emerging Islamic identity in Early Medieval Iberia

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This research explored the emergence of Islam in Écija, southern Iberia (AD 711-1000), through the analysis of changes to patterns of activity-related skeletal modifications potentially related to the appearance of Islamic gender traditions. Skeletal material from pre-Islamic Coracho and Islamic Écija were compared. Stable isotope and funerary evidence supported the idea that Écijan Islamic identity was formed by indigenous adherence to tradition. This traditional Islamic identity was shaped by proximity to Christian Europe, as Écijan Muslims tried to maintain a distinction between 'us' and 'them'.
Keywords: Southern Iberia, Early Middle Ages, islamic identity, stress markers, stable isotopes

Questa ricerca ha indagato l'origine e lo sviluppo dell'Islam a Écija (Spagna meridionale, 711-1000), attraverso l'analisi degli stress occupazionali potenzialmente riferiti a tradizioni islamiche di genere, comparando questi materiali con quelli del sito preislamico di Coracho. Le analisi degli isotopi stabili e le evidenze funerarie dimostrano che l'identità islamica si formò con una aderenza degli indigeni alla tradizione islamica, formatasi per contatto con l'Europa Cristiana, con cui i musulmani di Écija tentarono sempre di mantenere una distinzione netta.
Parole chiave*: Penisola Iberica meridionale, altomedioevo, identità islamica, stress occupazionali, isotopi stabili*

1. Islam in Iberia

In AD 711, Arabs, Berbers and Islam arrived into Iberia initiating an extremely important Spanish and European era (Díaz-Andreu 1996; Ballard 1996). During the Islamic period, the landscape was altered, mosques and purpose built cities appeared, new decorating styles flourished and trade opportunities emerged. The population of Iberia grew and prosperity returned to the region. Islam undeniably became an important part of the region. However, research into Islamic identity lags far behind research into Roman or later medieval identities.

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19th and 20th century research viewed the Islamic period as an invasion, as it did not follow the normal trajectory for Western European powers (Ballard 1996). This largely stemmed from political structures in Spain where an Islamic past was not considered a research priority (Díaz-Andreu 1996). As far as traditionalist scholars were concerned, Muslims were foreigners (e.g. Olagué 1969) who were quickly absorbed in to Hispanic culture (Boone 2009). Islam therefore had no impact on Iberian identity. This school of thought, however, has failed to retain support, as the material and historical evidence is clear, particularly as cultural traces of Islamic and Arab culture are present in modern Spanish identity. The end of the Franco era permitted research into Islam (Carvajal López, Puertas 2011) and the proposal that the arrival of Muslims altered the social structure in Iberia (Guichard 1974) was accepted. These newer theories suggested that Muslims arrived into Iberia, displaced the native population, and remained an autonomous group until they were driven out in the Reconquista. This, as admitted by Guichard (1992), however informs little about what happened to the native population, or the interactions between Christians and Muslims.

Since the 1980s, archaeological and historic research has suggested that, in addition to the arrival of immigrants from other parts of the *Dar-al-Islam*, significant parts of the indigenous population converted to Islam. Converts took on many aspects of the faith including the use of Arabic language, ritual behaviour, dress, diet, which represented an Islamisation of the region (Pereira *et alii* 2006). This conversion was realised by the work of historians Bulliet (1979; 1994) and Barceló (1997), who despite disagreeing on the timing, concur that large-scale conversion was a reality. More recently, scholars argued that a process of Arabisation, or social conversion, took place prior to Islamisation, because of the newly converted status of conquerors that did not yet have a full knowledge of Islam (Boone 2009). Accordingly, as Islam was the religion of the Arabs, a strong link between being Arab and being Muslim existed in the 7th and 8th centuries, especially as initially, the only way to become Muslim, was to submit to Arab. This is seen as an important mechanism in the early spread of Islam (Kennedy 1996; Carvajal López 2009). Regardless, conversion theories still see Islam as something that arrived into the region and as something that was adopted. As such Islam has been identified through the appearance of features typically associated with Islamic practice (e.g. mosques, Islamic/Arabic names). This is unfortunately myopic, as it assumes that Islam is equal to a set of practices or material circumstances. In short, Islam has been viewed as homogeneous, a standpoint that is at odds with the clear global variation in Islamic identity. This informs archaeologists very little about what it meant to be a Muslim, in a particular time or place, and reinforces stereotypes.

2. Iberian Islam

Recently, archaeologists have acknowledged the failings of approaching Islam as the summation of stereotyped archaeological features (Edwards 2005; Insoll 2007). To move beyond this, archaeologists have turned to anthropology, where the regional construction of Islamic identities has been recognised (e.g Charrad 2001; Marranci 2008). This has shifted focus to assessment of how regional difference arises, in particular, where some pre-Islamic customs continued to persist, and where others did not (e.g. alcohol consumption (Edwards 1999). Key to these interpretations has been the notion of syncretism, a process whereby other behaviours are made acceptable or taken into a pre-existing system to form something new. In archaeology, syncretism has been viewed as a key mechanism to the construction of Islamic identity in West Africa, Arabia (Insoll 2004; 2007) and Egypt (Oestigaard 2009). Furthermore, men and women may have different roles in producing Islamic identity. Edwards (2005) has identified that Islam contains religious and customary traditions, with the former being the domain of men, and the latter, of females. Edwards (2005, p. 125) argues that while religious traditions link Islamic groups, it is the customary differences that define them.

Of late, anthropologists have sought to explain why identity variation had occurred, as not all changes to Islam and Islamic identity can be related to practices/beliefs of other religions (e.g. Marranci 2008). Research has begun to focus on the nature of Islam as a source of variation. Many authors now agree that Islam should be viewed as a tradition (Asad 1986). The key to understanding the variable nature of Islamic Identity is to understand how Islamic traditions have been realised in pre-existing structures (Eickelmen 1982). This not only includes the religious, but also political and historic circumstances. Agency is becoming central to these interpretations, and while it has been used in archaeology and anthropology to explore identity, the role of agency in religious identity construction has not been realised (Díaz-Andreu 2005). It is as people conform to Islamic traditions, that they maintain and create Islam, by reaffirming their Islamic identity. It is this that permits the emergence of regional Islam and therefore different Islamic identities.

Accordingly, from an anthropological point of view, Marranci (2008) has argued that that an "Anthropology of Islams" should be realised, as each is unique due to local circumstance. Such a 'bottom up' approach could also be taken in archaeology. As such, the objective of this research is to explore the emergence and development of Islamic identity in Iberia, and therefore, Iberian Islam. For this, an exploration of the degree of immigration, as well as local and wider historic, legal and political factors on the development of Iberian Islamic identity will be considered.

3. Islam as an archaeologically detectable tradition

As this research aims to explore the emergence of Iberian Islam, it is important to outline here how it is possible to detect Islam and Islamic identity in the archaeological record. An understanding of the doctrine and legal aspects of Islam is well developed (Bowie 2000, p. 25). As many Islamic laws are concerned with behaviour and practices, Islamic tradition can be seen to emphasise orthopraxy, or the practice of correct behaviour in order to observe God (Lindsay 2005, p. 22). This is exemplified by the observance of the 'Five Pillars' or five obligatory behaviours in Islam including pilgrimage, five daily prayers, fasting, alms giving and the profession of faith. Other behaviours are also ritualised including diet, culinary habits and the division of male and female space. This creates a link between behaviour, belief and practice. It is the material expression of these beliefs and Islam as either items (e.g. prayer beads) or symbols (e.g. gender division) that are recordable in the archaeological record (Alexander 1979). The degree of material observance to religious tradition can be analysed. As such, behaviour divergence can be assessed within the wider geographic, historic and social context, in order to understand possible influences in the expression of Islamic identity, and therefore, the emergence of regional Islams.

It is not possible to analyse the many Islamic traditions and their related ideologies within the scope of this paper, so the present research considers one as a case study. An important ideology in Islam is the distinction between men and women. While in the eyes of the Qur'an the sexes are spiritually equal (Minai 1981, p. 13; Waines 1995, p. 95), it also states 'men have authority over women because God has made one superior to the other' (4: 34a). Although clearly regarded as different, the roles of men and women are supposed to be complementary (Charrad 2001). Although technically there is nothing in Islam that precludes either sex from any role, men are generally assigned the strenuous activities and to financially provide for the family (Lindsay 2005, p. 180).

Females are tasked with maintaining the household and bringing up children (Waines 1995, p. 95). Waines (1995, p. 95) and Jewell (2007) suggest that as financial stability is solely the responsibility of men, women became subordinated. This had led to the division of space into male and female, and gender roles and practices have been defined. As such analysis of changing gender division in Iberia provides an ideal opportunity to explore whether the emergence of Islam altered the pre-existing gender divisions, and if this changed over time because of external influencing factors.

4. Bioarchaeology and the expression of identity

The link between gender and biological sex in Islam is strong. As such, the analysis of human skeletal remains provides an opportunity to examine variations to gender roles and division because sex can be inferred with a high degree of accuracy from complete skeletons (Cox, Mays 2000). Specifically, it is the fact that bone tissue remodels to support stresses imposed on the skeleton during life that has made this type of analysis possible (Mays 2010). Population level analysis of activity-related skeletal changes can be analysed in a similar manner to other material culture, to inform on social change (Sofaer 2006). This type of approach has proven to be successful when examining gender divisions and other changes in social organisation in various populations (e.g. Dlamini, Morris 2005; Munson Chapman 2007; Ruff 1994; Sofaer-Derevenski 2000). Diachronic analyses of activity-related skeletal changes therefore provide a mechanism to explore the impact of Islamic tradition on gender division in Iberia. The results obtained from the analysis of activity-related skeletal modifications will also be supported by published evidence from burial rites, as well as evidence for migration from strontium isotope analysis.

5. Cortijo de Coracho, Lucena and Plaza España, Écija, Sevilla, Andalusia.

The pre-Islamic cemetery at Cortijo de Coracho is outside the modern city of Lucena, 60km south of Córdoba, 105km west of Granada and 50 km from Écija (see fig. 1). During the construction of the Córdoba to Málaga autoroute, a basilica and burials were excavated. Dating evidence (coins and ceramics) and stratigraphy infers that all the burials are Visigothic in time period (5^{th}-7^{th} century) (Diéguez Ramírez 2011). The cemetery may be related to a small urban centre (possibly implied by

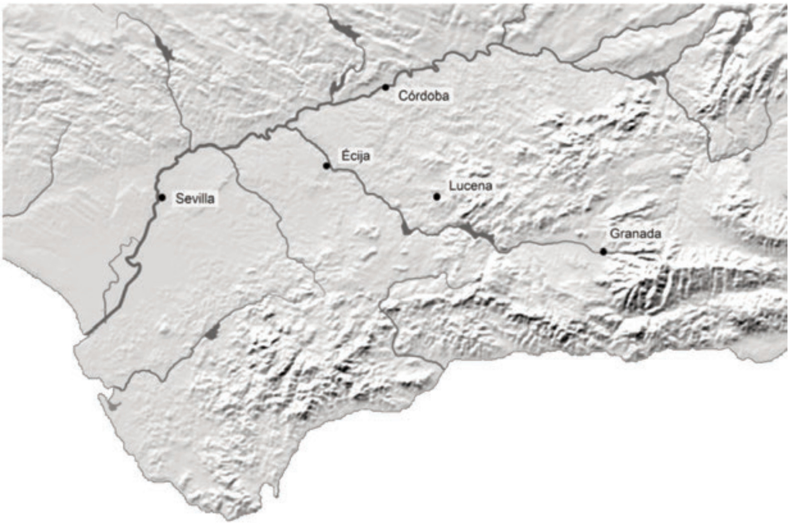

Fig. 1. Andalucía, Spain. Lucena and Écija locations relative to Seville, Córdoba and Granada.

post-Roman period (Dieguez Ramírez 2011). The skeletal remains are probably those of settlers and farmers, who often worked the land for the wealthy land owner (Imamuddin 1981). The cemetery at Coracho is one of the largest excavated Visigothic/early Medieval cemeteries in the region. The skeletal remains are currently curated at the Museo Arqueologico y Etnologico, Ayuntamiento de Lucena, Lucena.

The Islamic cemetery was located in Plaza España in the city of Écija, in the province of Seville. Écija is approximately 50km south of Córdoba and 160km northwest from Granada (fig. 1). post-Roman Écija was inhabited by Visigoths (García-Dils de la Vega *et alii* 2005). Écija was conquered in the first few months of the arrival of North African Berbers and Arabs in AD 711 (Hitti 2002; Kennedy 2007) (for more details on the invasion see Kennedy 2007). The town was initially settled by Arabs, rather than Berbers, who probably made up the majority of the first arrivals into the region (García Baena 2006). Écija has been documented as having a large converted Ibero-Muslim population and this is thought to be one of the reasons for unrest in the town during the early 10th century (Melville, Ubaydli 1992). In the 11th and 10th centuries, two waves of fundamentalist Muslims from North Africa (the Almoravids and Almohads) arrived in Iberia (Chejne 1974), but the impact on the population at Écija is unknown. Studies focussing on the size of the town imply that

Écija was of medium size with around 14000-16000 inhabitants in the 12th century (García Baena 2006, p. 22). It has been suggested that although Écija was technically urban, it was very rural in character in that it was made up of many close villages (García Baena 2006). What is believed to be the central mosque in Écija was described as being old in the 9th century in historic sources (García Baena 2006) and is an important indicator of Islam.

The *makbara* (cemetery) was excavated between 1997 and 2002 (Romo Salas n.d.). The remains of over 4500 Islamic individuals, including males, females and children of all ages, were excavated from seven phases of activity spanning the 8th to 12th centuries. The majority of burials came from the Umayyad period (8th-11th centuries). Osteologically Écija is an important site being the largest excavated Islamic cemetery in Europe, if not the world. As its use spanned the Islamic period in Écija, the cemetery offers an opportunity to undertake a diachronic population level analysis. The skeletal remains are currently curated at the Municipal Museum in Écija.

6. Methods

To meet the objective outlined above, a number of Islamic and pre-Islamic comparisons were required. Firstly to assess whether gender roles and gender division changed in Iberia in line with Islamic tradition, a comparison of pre-Islamic and Islamic activity-related skeletal modification (ARSM) data was needed. This required separate analysis of ARSM for males and females in the pre-Islamic and Islamic groups. The sex difference in the pre-Islamic group was then compared to that identified the Islamic group. To distinguish if gender roles changed with the arrival of Islam, and if one sex was affected more than the other, the pre-Islamic and Islamic sexes were compared individually (e.g. pre-Islamic females compared to Islamic females).

As the second part of this research aimed to detect whether Islamic identity alters diachronically, a comparison of early and late Islamic individuals was required. To permit statistical comparison, the 7 occupation phases at Écija were split into two groups: early (phases 7-3) and late (phases 1-2). To assess for a temporal change in gender division, male and female ARSM were compared in the early Islamic and late Islamic groups to determine the degree of gender division in each phase. The degree of gender division was then compared to determine if a change had taken place temporally. To assess if gender roles changed over time, the sexes were compared individually (e.g. early Islamic females compared to late Islamic females).

The analysis of ARSM has proven to be most reliable when multiple indicators are used (Merbs 2009). This is due to the complex relationship between activity and skeletal modification. Entheses and osteoarthritis (OA) were analysed, and the results were combined with the bone geometry analysis of Pomeroy and Zakrzewski (2009) and non-pathological articular modifications in Inskip (2013). The methods for entheseal analysis and OA are outlined below. As age has proven to be a significant factor in the expression of OA and entheseal scores (Waldron 2009, Weiss 2004), skeletons where age appeared over 50 years were excluded from analysis. See Inskip (2013) for specific methods on ageing and sexing. All statistical analysis was carried out using SPSS 19 for windows.

Osteoarthritis (OA)

Patterns of OA were recorded to explore how high impact, repetitive loaded activities were distributed in the population, and if this changed with the emergence of Islam. The six joints analysed in this study are listed in tab. 1.

Multiple methods exist for scoring osteoarthritis in dry bone (Buikstra, Ubelaker 1994; Jurmain 1980; Rogers, Waldron 1995; Rojas-Sepulveda *et alii* 2008; Waldron 2009). Generally, all methods agree on the types of changes attributable to the disease (sclerosis, eburnation, pitting and new bone growth on, and around the joint surface), but differences of opinion arise from the combination of changes required for the disease to be recognised (Jurmain, Kilmore 1995). Only eburnation is a pathogonomic indicator of OA as it is caused by erosion of synovial

Region	**Peripheral joint**
Upper body	Acromioclavicular
	Glenohumeral
	Wrist
Lower body	Hip
	Knee
	Ankle

Tab. 1. Joints examined for OA in the study of the Écija and Coracho samples.

cartilage and bone on bone contact (Larsen 1997; Jurmain 1999; Waldron 2009). However, relying solely on eburnation would underestimate the prevalence of the disease (Mays 2007; Waldron 2009). Therefore, an additional criterion was required for the diagnosis of OA. A recent multifaceted study by Rojas-Sepulveda *et alii* (2008) argued that scoring positive for OA with any modification except isolated pitting was the best approach. However, methods that use a single indicator are at high risk of over-estimating the prevalence of the disease. Rogers and Waldron (1995) also caution that using marginal new bone growth as a sole indicator of osteoarthritis is problematic, as this is also associated with ageing. Therefore, in the absence of eburnation, to prevent over estimation of osteoarthritis, this research required two or more indicators to be present, following Rogers and Waldron (1995) and Waldron (2009). Table 2 describes the criteria for the osteoarthritis features scored.

To ascertain whether the degree of loaded activity changed with the arrival of Islam, to make the samples comparable it was necessary to calculate the overall prevalence, and individual joint prevalence of osteoarthritis for each group analysed. Calculation of true prevalence rate is the standard method for comparing osteoarthritis between groups (Waldron 2009). This takes into account that not all skeletons may be complete. This was carried out using the following formula:

(Total joints affected/Total number of observable joints) x 100=True prevalence rate %)

In terms of individual joint prevalence, the same equation was used but joints were analysed separately. Fisher's exact tests were used to explore differences between the males and females, and between Islamic and pre-Islamic groups. Statistical significance was set at P=0.05.

Osteoarthritis feature	Description
Eburnation	Polishing and ivory-like appearance which may have grooving on the joint surface
Pitting	Porosity or holes on the joint surface
Sclerosis	Densification of the joint surface without polishing
New bone growth	New bone growth on the joint surface
Lipping around joint margin	New bone growth around the joint margin

Tab. 2. Description of features scored in osteoarthritis.

Enthesis analysis

The Hawkey and Merbs' (1995) method scores on a scale of 0-3 for robusticity and stress lesions (tab. 3), which with the combination of good guiding imagery, allows researchers to assess subtle differences in entheseal expression. This is something not permitted by a presence and absence method (e.g. al-Oumaoui *et alii* 2004). Accordingly, entheses were scored following Hawkey and Merbs' (1995) method. As muscles do not work individually but in groups, 19 upper limb entheses were examined (see tab. 4). Lower limb entheses were not studied as results tend to reflect the locomotor role of the legs rather than activity differences (al-Oumaoui *et alii* 2004; Weiss 2004). All entheses recorded were easily identified, and have been demonstrated to be useful in the reconstruction of past activities (al-Oumaoui *et alii* 2004; Munson Chapman 1997; Weiss 2003; Weiss 2004). It should be noted that the data used in this analysis was collected and analysed prior to the 2010 Coimbra workshop on MSM research.

Many factors influence enthesis scores scores, particularly age and body size (Merbs 2009; Robb 1998; Weiss 2003, 2007). However, investigations by Weiss (2003, 2004, 2007) have indicated that if these factors are checked, and subsequently controlled for through aggregate correlation analysis, it is possible to observe differences in muscle use.

Enthesis score	Visible appearance
Stress	
Grade 0	No expression
Grade 1	'faint' shallow pitting observable, lytic appearance. Less than 1mm deep
Grade 2	'moderate' pitting is now between 1 and 3 mm deep
Grade 3	'strong' pitting is over 3mm deep.
Robusticity	
Grade 0	No expression
Grade 1	'Faint' exostosis extends less than 2mm from cortical bone surface
Grade 2	'Moderate' distinct shape. Extends over 2mm but less than 5mm from cortical surface
Grade 3	'Strong' pronounced mass extending over 5mm from the cortical bone surface

Tab. 3. Grading criteria for enthesis robusticity and stress lesions according to Hawkey and Merbs (1995, p. 328).

Muscle	Action	Enthesis location
Humerus		
Deltoid	Flexes and extends shoulder. Abducts and medially and laterally rotates arm.	Deltoid tuberosity.
Teres major	Extends shoulder, adducts and rotates arm.	Medial to the intertubercular groove on proximal humerus.
Latissimus dorsi	Adducts and medially rotates arm, extends shoulder.	Proximal end of the intertuberculer groove.
Pectoralis major	Flexes shoulder, adducts and medially rotates arm. Extends shoulder from flexed position.	Lateral to the intertubercular groove.
Brachioradialis extensor carpi radalis longus	Flexes elbow.	Distal lateral shaft.
Common extensor	Various muscles involved in extension of the hand and wrist.	Lateral epicondyle.
Radius		
Pronator teres	Pronates forearm.	Lateral side of the midshaft.
Supinator brevis	Supinates forearm.	Lateral surface of proximal midshaft.
Flexor pollicus longus	Flexes thumb.	Inferior to the radial tuberosity and superior to the interosseous crest.
Pronator quadratus	Pronates forearm.	Distal anterior section of the shaft.
Ulna		
Triceps brachii	Extends shoulder, adducts and medially rotates arm.	Most superior part of the olecranon.
Flexor digitorium superficials (Supinator crest)	Supinates forearm.	Lateral shaft, inferior to the radial facet. Supinator crest.
Pronator quadratus (origin)	Pronates forearm.	Medial surface of the distal ulna shaft.
Brachialis	Flexes elbow, supinates forearm.	Inferior to the semilunar notch and medial to the supinator crest.
Clavicle		
Subclavius	Fixes clavicle and elevates first rib.	Inferior surface of the clavicle midshaft.
Costoclavicular ligament	Fixes sternal end of clavicle prevents excess superior, anterior and posterior movement of clavicle.	Inferior surface of the sternal clavicle end.
Deltoid	Elevation of the arm, shoulder rotation.	Posterior superior surface of the lateral clavicle.
Trapezius	Shoulder elevation and depression.	Anterior superior surface of the lateral clavicle.

Tab. 4. Muscle attachment location and bone with associated action.

Indeed, research conducted following Weiss' (2003) methodology by Doyling (2010) and Godde and Wilson-Taylor (2012) on known activity samples demonstrate that there is a link between enthesis score and activity levels. Tests on aggregate enthesis scores with body size and age were carried on both samples using Spearman's correlation tests (see Inskip 2013). The results indicated that age and body size were not a statically significant predictor of aggregate entheses score. This indicated that it was viable to analyse the sample for activity differences. When the relationship between body size and individual enthesis score was assessed using a Spearman's correlation test, only the radial biceps brachii score correlated strongly with body size on both sides, as it did in Weiss' (2003) study. Accordingly, the biceps brachii was not analysed further in this research. Readers are asked to refer to Weiss (2003) for detailed methodology on entheseal scoring and aggregate analysis.

Entheseal scores were then compared between samples using a Spearman's correlation test. Where an individual enthesis site score correlated with sex and/or phase, but also correlated with age, age was controlled for using a partial Spearman's correlation test following Weiss (2003). This was critical as Weiss (2007) demonstrates that sex differences can disappear when these other factors are controlled. To ascertain whether a sex difference existed in entheseal scores for the Islamic or pre-Islamic samples, sex was scored in two categories, female (1) and male (2), and correlation test was run with enthesis scores scores. The number of sex differences was compared between groups to investigate if the emergence of Islam impacted on gender division. Similarly, a Spearman's correlation test was carried out on individual sexes (male and female) to determine if changes in gender roles over time occurred. To do this, pre-Islamic individuals were scored as 1 and Islamic individuals as 2. To explore whether the sex difference in muscle use changed overtime in the Islamic group, thus demonstrating a change in gender division and malleability in Islamic gender tradition, sexes were compared in early phase and in the late phase, and the difference was compared. Statistical significance was set at P=0.05.

7. Osteoarthritis results

152 Islamic and 110 pre-Islamic individuals had at least one joint observable for the analysis of osteoarthritis. Tables 5 and 6 present the total number of joints for each group tested. Table 7 presents the results of Fisher's exact tests outlining the significance of any prevalence differences observed between comparison groups.

Statistically, pre-Islamic males had more osteoarthritic joints than the Islamic males (pre-Islamic male 22.7%, Islamic male 8.1%: P≤0.001 n=761). There were significant prevalence differences for the glenohumeral (pre-Islamic male 43.8%, Islamic males 9.4%: P≤0.001 n=96) and hip joints (pre-Islamic males 31.8%, Islamic male 7.6%: P=0.002 n=110). The pre-Islamic males had an unusually high level of glenohumeral OA. Furthermore, elbow OA was more prevalent in the pre-Islamic men, although not quite reaching significance (P=0.089 n=108). This suggested a decrease in male high impact loading with the emergence of Islam, inferring that Islamic males had less physically demanding

Joint	Pre-Islamic Male			Islamic Male			Early Islamic male			Late Islamic male		
	NA	NO	%A	NO	NA	% A	NA	NO	% A	NA	NO	%A
Acromioclavicular	3	15	20	66	7	10.6	4	30	13.3	4	36	11.1
Glenohumeral	14	32	43.8	64	6	9.4	4	31	12.9	2	33	6
Elbow	6	30	20	78	6	7.8	4	39	10.3	2	39	5.1
Wrist	3	20	15	72	7	9.7	4	34	11.7	3	38	7.9
Hip	14	44	31.8	66	5	7.6	1	27	3.7	4	39	10.3
Knee	6	40	15	77	7	9.1	5	38	13.2	2	38	5.3
Ankle	1	26	3.8	61	1	1.6	1	29	3.4	0	36	0
Total	47	207	22.7	484	39	8.1	23	228	10.1	17	259	6.6

Tab. 5. Total number of observable joints and joints affected by osteoarthritis for males.
Key: NA=number affected, NO=number observed, A=affected

Joint	Pre-Islamic Female			Islamic Female			Early Female			Late Female		
	NA	NO	%A	NA	NO	% A	NA	NO	% A	NA	NO	% A
Acromioclavicular	1	7	14.3	5	51	10	1	18	5.6	3	33	9.1
Glenohumeral	0	25	0	3	58	5.2	1	21	4.8	2	37	5.4
Elbow	1	24	4.2	4	69	5.8	2	26	7.7	3	43	4.8
Wrist	0	18	0	1	64	1.6	0	25	0	1	39	2.6
Hip	1	34	2.9	1	55	1.8	0	19	0	1	36	2.8
Knee	4	29	13.8	6	64	9.4	3	24	12.5	4	41	7.8
Ankle	0	20	0	1	59	1.7	0	22	0	1	39	2.6
Total	7	157	4.5	21	420	5	7	155	4.5	15	268	5.6

Tab. 6. Total number of observable joints and joints affected by osteoarthritis for females.
Key: NA=number affected, NO=number observed, %A=percentage affected

Joint	Pre-Islamic Islamic comparison				Male female comparison				Islamic early late comparison				Islamic male female comparison			
	Male		Female		Islamic		Pre-Islamic		Female		Male		Early		Late	
	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N
AC	0.383	81	1.000	58	1.000	117	1.000	22	1.000	51	1.000	66	0.638	48	1.000	76
GH	**≤0.001**	96	1.000	73	0.496	122	**≤0.001**	57	1.000	48	0.419	64	0.636	52	1.000	74
E	0.089	108	1.000	93	0.750	147	0.117	54	0.633	69	0.675	78	1.000	65	1.000	82
W	0.449	92	1.000	92	0.066*	136	0.232	38	1.000	74	0.700	72	0.127	59	0.616	81
H	**0.002**	110	1.000	89	0.219	121	**0.001**	78	1.000	55	0.641	66	1.000	62	0.366	80
K	0.363	117	1.000	92	1.000	141	1.000	69	0.703	65	0.430	76	1.000	48	0.679	85
A	0.511	87	1.000	79	1.000	120	1.000	46	1.000	61	1.000	65	1.000	51	1.000	76
Total	**≤0.001**	691	1.000	576	0.148	904	**≤0.001**	364	0.821	423	0.182	487	0.084	385	0.727	554

Tab. 7. Fisher's exact tests results of Islamic and pre-Islamic comparisons of osteoarthritis data. Significant results in bold.
Key: AC= acromioclavicular, GH=glenohumeral, E=elbow, W=wrist, H=hip, K=knee, A=ankle, P= P value, N= number, * = Near statistical significance,

lifestyles. Contrastingly, in females there was no change in the overall prevalence of OA, or prevalence at any joint, inferring similarity in female high impact activities between faith groups.

In terms of the sex difference within each faith group, in the Islamic sample, the overall prevalence of OA was not significantly different between Islamic males and females, but data from Romo Salas (n.d.) for the whole Écija sample indicated that males did have more OA than females. Only wrist OA prevalence differed between the sexes in this sample (Islamic male 9.7%, Islamic female 1.6%: P=0.066 n=136), which was just outside significance. In the pre-Islamic sample, males also had significantly more OA than females (pre-Islamic males 23.2%, pre-Islamic females 3.5%: P≤0.001 n=435). Differences in OA prevalence were observed at the glenohumeral and hip joints (glenohumeral P≤0.001 n=57, hip P=0.001 n=78). The sex difference in high impact physical loading was clearer in the pre-Islamic material and appeared to be related to a particularly high OA prevalence in males. This inferred a very specific activity in pre-Islamic males.

Regarding sex specific temporal changes in loading in the Islamic group, in women, there was no difference in the overall prevalence of osteoarthritis (early 4.7%, late 5.5%) or at any specific joint over time, inferring no difference in female high impact physical activity with the development of Islam (see tab. 7). The same trend was observed in the Islamic men (early 9.6%, late 6.4%). This suggests that the degree of high impact loading assigned to Islamic males and females remained constant over time.

There were no statistically significant sex differences in the overall prevalence of osteoarthritis, or in the prevalence of osteoarthritis at any specific joint in either the early or late Islamic groups (see tab. 7). This infers that there was no change in sex difference for high impact physical loading. A low level of high impact loading appeared to be a characteristic of Islamic individuals at Écija, as age was controlled for in the sample selection.

8. Entheses results

Entheses scores were analysed from 228 individuals in total; 145 Islamic and 83 pre-Islamic. The enthesis scores, standard deviations and individual numbers for Islamic and pre-Islamic males and females are presented in table 8. Enthesis scores, standard deviations and individual numbers for Islamic individuals split by early and late phase are displayed in table 9. Table 10 presents the results of Spearman's correlation test

Marker	Islamic Female						Islamic Male						Female pre-Islamic						Male pre-Islamic					
	Left			Right			Left			Right			Left			right			left			right		
	N	x	SD	N	x	SD	N	x	SD	N	x	SD	N	x	SD	N	x	SD	N	x	SD	N	x	SD
TRAP	44	2.09	0.60	40	2.1	0.67	41	1.78	0.94	40	1.85	0.92	24	3.42	1.28	24	3.58	1.38	27	4.04	0.98	26	3.50	1.74
DEL C	45	2.93	1.14	39	2.87	1.11	39	2.64	1.16	41	2.85	1.09	24	1.92	0.65	20	2.00	0.73	23	1.96	0.77	26	1.90	0.74
SUB	44	1.57	0.55	37	1.62	0.55	42	1.67	0.75	39	1.57	0.62	21	1.19	0.81	20	1.50	1.10	23	1.83	1.43	17	1.29	0.47
CCL	44	2.27	1.21	35	2.94	1.28	42	3.07	1.42	35	3.97	1.34	30	3.67	1.55	26	4.15	1.29	18	3.94	1.43	21	4.33	1.24
DEL H	38	1.97	0.82	59	1.92	0.68	40	2.30	0.79	62	2.33	0.82	24	2.13	0.90	20	2.20	1.06	29	2.48	0.91	22	2.41	1.22
TM	38	2.34	1.15	53	2.51	0.82	38	2.83	1.10	62	2.66	1.10	18	3.06	1.80	17	3.00	1.77	20	3.70	1.26	16	3.38	1.36
LD	31	0.87	0.85	41	0.90	0.63	33	0.91	0.58	48	1.06	0.76	6	1.00	0.00	9	1.00	0.50	8	1.13	0.35	8	2.13	1.55
PM	40	2.63	0.95	53	2.68	0.94	40	3.08	1.40	63	3.46	1.26	20	2.20	1.96	23	2.43	1.08	21	3.33	1.53	23	3.57	1.34
BE	36	1.94	0.63	56	1.89	0.56	35	1.94	0.54	65	2.02	0.63	13	1.92	0.28	10	2.00	0.82	21	2.05	0.38	23	2.26	0.76
CET	33	1.79	0.65	54	1.85	0.71	30	1.90	0.61	62	1.94	0.67	3	1.67	0.58	5	1.40	0.55	7	1.57	0.54	6	1.67	0.82
FPL	58	1.90	0.67	52	1.87	0.63	66	1.85	0.61	46	1.74	0.61	20	1.20	0.41	16	1.44	0.63	23	1.48	0.67	23	1.87	0.92
PT	62	1.42	0.62	54	1.57	0.77	72	1.72	0.76	49	1.84	0.83	18	2.17	1.51	11	2.64	1.57	18	3.17	1.25	21	3.05	1.50
SB	58	1.41	0.75	53	1.21	0.66	71	1.20	0.62	47	1.09	0.62	8	0.88	0.35	6	1.00	0.00	7	1.14	0.38	8	1.00	0.00
Q	43	1.28	0.93	46	1.46	0.86	56	1.34	0.79	32	1.31	0.78	9	0.78	0.97	9	0.56	0.73	10	0.70	0.68	11	0.73	0.63
SC	53	1.72	0.53	60	1.90	0.57	54	1.98	0.53	64	2.14	0.66	16	1.69	0.48	15	1.87	0.35	17	1.76	0.56	20	2.10	0.91
PQ	53	2.23	0.58	55	1.98	0.59	54	1.71	0.73	61	1.74	0.75	10	1.30	0.49	12	1.58	0.52	15	1.67	0.72	12	2.00	1.13
BR	53	3.62	0.99	60	3.40	0.94	54	3.52	1.07	67	3.50	0.96	27	4.67	0.73	19	4.47	1.02	28	4.39	0.96	22	4.50	0.74
TB	43	1.53	0.51	42	1.86	0.81	42	1.69	0.64	54	1.81	0.55	10	1.20	0.42	8	1.13	0.35	10	1.40	0.52	11	1.45	0.52

Tab. 8. Enthesis scores, standard deviation and individual numbers for males and females for pre-Islamic and Islamic individuals.
Key:
TRAP = trapezius;
DEL C = deltoid clavicle;
SUB=subclavius;
CCL=costoclavicular ligament;
DEL C=deltoid clavicle;
TM=Teres major;
LD=latissimus dorsi;
PM=pectoralis major;
BE=brachioradialis;
CET=common extensor tendon;
DEL H=deltoid humerus;
TM = Teres major;
LD=latissimus dorsi;
PM=pectoralis major;
BE=brachioradialis;
CET=common extensor tendon;
FPL=flexor pollicus longus;
PT=pronator teres;
SB=supinator brevis;
Q=quadratus;
SC=supinator crest;
PQ=pronator quadratus;
BR=brachialis;
TB=triceps brachii.

Female Marker	Early Islamic Female						Late Islamic Female						Early male						Late male					
	left			Right			left			right			left			right			left			right		
	N		SD	N		SD	N		SD	N		SD	N		SD	N		SD	N		SD	N		SD
TRAP	19	2.11	0.57	16	2.25	0.78	23	2.08	0.64	23	1.96	0.64	15	1.6	0.83	17	1.76	0.66	26	1.88	0.99	24	1.96	1.04
DEL C	18	2.78	1.02	16	2.94	1.06	27	3.04	1.31	22	2.91	1.11	13	2.08	1.04	18	2.72	1.13	26	2.92	1.13	24	2.88	1.12
SUB	18	1.61	0.61	15	1.60	0.51	26	1.54	0.51	22	1.64	0.58	16	1.38	1.03	18	1.44	0.71	26	1.85	0.46	21	1.86	0.48
CCL	19	2.11	1.10	12	2.75	1.06	25	2.40	1.29	21	3.14	1.28	19	3.00	1.41	17	4.12	1.22	23	3.13	1.46	20	3.65	1.63
DEL H	15	2.33	0.90	28	2.00	0.72	21	1.76	0.70	31	1.84	0.64	19	2.05	0.91	31	2.06	0.85	18	2.50	0.62	32	2.59	0.71
TM	15	2.40	1.40	24	2.58	0.88	21	2.30	1.17	29	2.45	0.78	17	2.88	1.17	34	2.44	0.99	19	2.79	0.98	28	2.93	1.18
LD	12	0.92	0.67	17	1.12	0.60	18	0.89	0.96	24	0.75	0.61	15	0.87	0.52	23	1.00	0.55	15	0.93	0.70	25	1.12	0.93
PM	15	3.20	1.32	24	2.96	0.96	22	2.50	0.86	29	2.45	0.87	19	3.00	1.29	34	3.12	1.01	19	2.89	1.37	29	3.86	1.41
BE	13	2.00	0.58	25	1.92	0.49	19	1.95	0.71	31	1.87	0.62	18	1.83	0.51	33	2.15	0.67	17	2.06	0.56	32	1.88	0.55
CET	13	2.00	0.58	25	2.00	0.71	17	1.65	0.70	29	1.72	0.70	16	1.94	0.68	30	1.80	0.71	14	1.86	0.54	32	2.06	0.62
FPL	26	1.88	0.59	20	1.90	0.72	32	1.91	0.59	31	1.87	0.56	30	1.77	0.57	18	1.67	0.59	35	1.91	0.66	28	1.75	0.65
PT	28	1.43	0.57	22	1.55	0.80	34	1.41	0.66	31	1.61	0.76	35	1.74	0.61	20	1.95	0.89	36	1.72	0.88	29	1.72	0.80
SB	28	1.46	0.84	21	1.48	0.68	30	1.37	0.67	31	1.03	0.61	35	1.11	0.63	21	1.10	0.70	35	1.26	0.61	26	1.08	0.56
Q	19	1.11	0.99	20	1.30	0.92	24	1.42	0.88	25	1.56	0.82	27	1.04	0.85	12	1.25	0.75	28	1.61	0.40	20	1.35	0.81
SC	22	1.86	0.47	28	1.89	0.57	34	1.65	0.60	32	1.91	0.59	22	2.09	0.43	30	2.10	0.40	29	1.9	0.56	34	2.18	0.83
PQ	16	2.20	0.66	24	1.96	0.39	25	2.10	0.58	31	2.00	0.58	15	1.93	0.80	27	1.78	0.85	21	1.57	0.68	34	1.71	0.68
BR	21	3.76	0.89	28	3.32	0.95	33	3.39	1.09	32	3.47	0.95	21	3.67	1.07	32	3.34	1.04	27	3.56	1.05	35	3.63	0.88
TB	17	1.71	0.47	19	2.11	0.65	28	1.50	0.51	23	1.65	0.94	19	1.63	0.68	28	1.79	0.57	21	1.67	0.66	26	1.85	0.54

Tab. 9. Enthesis scores, standard deviation and number for early and late Islamic males and females.
Key:
TRAP=trapezius
DEL C=deltoid clavicle
SUB=subclavius
CCL=costoclavicular ligament
DEL C=deltoid clavicle
TM=Teres major
LD=latissimus dorsi
PM=pectoralis major
BE=brachioradialis
CET=common extensor tendon
DEL H=deltoid humerus
TM=Teres major
LD=latissimus dorsi
PM=pectoralis major
BE=brachioradialis
CET=common extensor tendon
FPL=flexor pollicus longus
PT=pronator teres
SB=supinator brevis
Q=quadratus
SC=supinator crest
PQ=pronator quadratus
BR=brachialis,
TB=triceps brachii

MSM	Islamic Sex comparison						Pre-Islamic sex comparison						Islamic v pre-Islamic Female						Islamic v pre-Islamic male					
	Left			Right			Left			Right			Left			Right			Left			Right		
	C	P	N	C	P	N	C	P	N	C	P	N	C	P	N	C	P	N	C	P	N	C	P	N
TRAP	-0.229	**0.036**	85	-0.245	**0.031**	76	0.223	0.104	48	-0.050	0.722	47	0.574	**≤0.001**	65	0.579	**≤0.001**	59	0.762	**≤0.001**	65	0.550	**≤0.001**	60
DEL C	-0.161	0.146	84	-0.029	0.801	76	0.111	0.463	44	-0.690	0.651	43	-0.432	**≤0.001**	66	-0.364	**0.006**	54	-0.304	**0.017**	59	-0.410	**≤0.001**	62
SUB	0.107	0.331	86	0.077	0.516	72	0.239	0.122	41	-0.120	0.502	34	-0.254	**0.043**	62	0.083	0.553	52	0.108	0.398	60	-0.272	**0.050**	52
CCL	0.306	**0.004**	86	0.358	**0.003**	72	0.176	0.237	45	0.100	0.507	44	0.448	**≤0.001**	71	0.506	**≤0.001**	56	0.234	0.077	55	0.105	0.450	52
DEL H	0.208	0.060	75	0.235	**0.009**	120	0.165	0.241	50	0.075	0.639	39	0.135	0.305	58	0.162	0.156	76	-0.010	0.936	63	0.044	0.690	80
TM	0.248	**0.032**	73	0.063	0.507	115	0.047	0.781	36	0.114	0.533	30	0.314	**0.021**	52	0.182	0.135	67	0.272	**0.045**	53	0.309	**0.010**	73
LD	0.070	0.585	61	0.094	0.384	89	0.156	0.610	11	0.478	**0.061**	14	0.121	0.488	33	0.080	0.586	47	0.155	0.347	37	0.477	**≤0.001**	51
PM	0.140	0.220	77	0.344	**0.001**	116	0.345	**0.029**	39	0.371	**0.012**	43	-0.163	0.220	56	-0.073	0.536	73	-0.032	0.815	56	0.022	0.880	81
BE	-0.002	0.986	68	0.215	0.215	121	0.064	0.721	32	-0.020	0.915	30	0.005	0.975	46	0.126	0.318	63	0.139	0.315	34	0.193	0.080	84
CET	0.086	0.505	60	0.005	0.961	116	-0.260	0.499	7	0.162	0.635	11	-0.020	0.91	33	-0.127	0.343	56	-0.225	0.187	52	-0.038	0.760	64
FPL	-0.120	0.235	98	0.062	0.495	124	0.211	0.180	40	0.183	0.271	36	-0.460	**≤0.001**	69	-0.245	**0.036**	71	-0.189	0.126	65	0.009	0.940	84
PT	0.174	0.080	100	0.201	**0.021**	134	0.306	**0.074**	33	0.028	0.880	29	0.320	**0.007**	69	0.376	**0.001**	70	0.546	**≤0.001**	63	0.376	**≤0.001**	87
SB	-0.125	0.216	97	-0.142	0.109	129	0.367	0.197	12	0.179	0.620	8	-0.161	0.220	58	-0.080	0.532	61	0.065	0.647	50	-0.106	0.360	75
Q	-0.115	0.317	78	0.017	0.870	87	-0.060	0.804	16	0.125	0.610	17	-0.301	**0.027**	52	-0.327	**0.019**	49	-0.372	**0.018**	38	-0.348	**0.010**	62
SC	0.261	**0.007**	107	0.189	**0.037**	123	0.052	0.779	30	0.125	0.480	32	0.004	0.897	65	0.003	0.979	71	-0.148	0.232	64	-0.024	0.830	81
PQ	-0.356	**0.002**	77	-0.196	**0.036**	115	0.119	0.581	22	-0.050	0.835	21	-0.541	**≤0.001**	45	-0.249	**0.046**	63	-0.002	0.991	49	0.113	0.350	70
BR	-0.074	0.459	108	0.041	0.651	126	-0.05	0.704	52	0.188	0.244	38	-0.468	**≤0.001**	75	0.436	**≤0.001**	75	-0.337	**0.003**	71	0.436	**≤0.001**	86
TB	0.047	0.673	102	0.012	0.905	96	0.810	0.742	17	0.440	**0.077**	15	-0.249	0.079	50	-0.349	**0.016**	45	-0.154	0.291	47	-0.263	**0.040**	62

Tab. 10. Islamic and Pre-Islamic enthesis score correlation results. Significant results in bold.

Key:
TRAP=trapezius
DEL C=deltoid clavicle
SUB=subclavius
CCL=costoclavicular ligament
DEL C=deltoid clavicle
TM=Teres major
LD=latissimus dorsi
PM=pectoralis major
BE=brachioradialis
CET=common extensor tendon
DEL H=deltoid humerus
TM=Teres major
LD=latissimus dorsi
PM=pectoralis major
BE=brachioradialis
CET=common extensor tendon
FPL=flexor pollicus longus
PT=pronator teres
SB=supinator brevis
Q=quadratus
SC=supinator crest
PQ=pronator quadratus
BR=brachialis
TB=triceps brachii

MSM	Islamic Female early v late						Islamic males early v late						Early Islamic males v females						Late Islamic males v females					
	Left			Right			Left			Right			Left			Right			Left			Right		
	CP	P	N	CP	P	N	CP	P	N	CP	P	N	CS	P	N	CS	P	N	CS	P	N	CS	P	N
TRAP	0.041	0.792	41	0.152	0.362	36	-0.134	0.408	38	-0.039	0.809	38	-0.177	0.219	48	-0.096	0.524	44	-0.339	**0.050**	31	-0.307	0.090	30
DEL C	-0.132	0.392	42	0.008	0.961	35	-0.356	**0.028**	36	-0.074	0.647	39	-0.079	0.579	50	-0.042	0.784	43	-0.292	0.117	28	-0.117	0.520	31
SUB	0.043	0.784	41	-0.027	0.877	34	-0.357	**0.022**	39	-0.316	**0.053**	36	0.316	**0.025**	49	0.17	0.281	40	-0.176	0.328	31	-0.094	0.610	30
CCL	-0.117	0.455	41	-0.172	0.348	30	-0.058	0.720	39	0.158	0.359	34	0.263	0.074	45	0.151	0.352	38	0.369	**0.025**	35	0.523	**≤0.001**	26
DEL H	0.319	0.062	33	0.090	0.504	56	-0.180	0.293	34	-0.279	**0.028**	60	0.448	**0.005**	36	0.454	**≤0.001**	60	-0.120	0.507	31	0.044	0.740	56
TM	-0.012	0.945	32	0.062	0.660	50	0.099	0.572	33	-0.163	0.208	59	0.162	0.331	36	0.136	0.319	54	0.230	0.212	29	-0.060	0.660	55
LD	0.014	0.941	27	0.376	0.084	38	0.094	0.629	27	0.019	0.897	45	-0.042	0.821	30	0.163	0.268	46	-0.011	0.958	24	-0.025	0.880	37
PM	0.282	0.095	34	0.276	**0.047**	50	0.137	0.420	35	-0.262	**0.040**	60	0.06	0.713	38	0.497	**≤0.001**	55	-0.077	0.669	31	0.128	0.340	55
BE	0.069	0.712	29	0.064	0.641	53	-0.139	0.434	32	0.299	**0.016**	62	0.057	0.744	33	-0.035	0.789	60	-0.147	0.440	28	0.240	**0.070**	55
CET	0.269	0.158	27	0.085	0.543	51	0.104	0.592	27	-0.135	0.298	59	0.096	0.614	28	0.081	0.537	58	-0.003	0.986	26	-0.115	0.410	52
FPL	-0.050	0.713	55	-0.026	0.856	48	-0.048	0.706	63	-0.007	0.963	44	-0.050	0.692	64	-0.206	0.120	56	-0.067	0.626	53	-0.167	0.320	35
PT	-0.020	0.985	59	-0.134	0.345	50	0.000	0.997	69	0.128	0.382	47	0.145	0.234	67	0.044	0.741	57	0.265	**0.037**	60	0.267	0.090	39
SB	0.044	0.744	55	0.267	**0.058**	49	-0.060	0.623	68	0.038	0.801	45	-0.049	0.701	62	-0.041	0.767	54	-0.220	0.086	60	-0.255	0.110	39
Q	-0.180	0.255	40	-0.228	0.137	42	-0.262	**0.053**	53	0.014	0.941	30	0.057	0.691	49	-0.321	0.171	42	-0.028	0.855	43	-0.053	0.780	29
SC	0.138	0.320	60	-0.061	0.650	56	0.191	0.183	48	-0.040	0.765	61	0.183	0.155	60	0.151	0.230	63	0.324	**0.036**	40	0.265	**0.050**	54
PQ	-0.045	0.786	43	-0.075	0.594	51	0.221	0.202	33	0.050	0.702	58	-0.441	**0.002**	43	-0.291	**0.020**	62	-0.139	0.472	27	-0.109	0.460	47
BR	0.189	0.180	50	-0.119	0.373	56	0.029	0.845	45	-0.167	0.179	64	0.082	0.539	57	0.070	0.575	64	-0.080	0.622	38	0.007	0.960	56
TB	0.128	0.412	41	0.244	0.129	38	-0.002	0.989	37	-0.010	0.945	51	0.070	0.637	46	0.136	0.357	46	-0.075	0.672	32	-0.147	0.340	43

Tab. 11. Spearman's correlation results for Islamic early and late groups and entheses scores. Significant results in bold.
Key:
TRAP=trapezius,
DEL C=deltoid clavicle,
SUB=subclavius,
CCL=costoclavicular ligament
DEL C=deltoid clavicle,
TM=Teres major,
LD=latissimus dorsi,
PM=pectoralis major,
BE=brachioradialis,
CET=common extensor tendon,
DEL H=deltoid humerus,
TM=Teres major,
LD=latissimus dorsi,
PM=pectoralis major,
BE=brachioradialis,
CET=common extensor tendon,
FPL=flexor pollicus longus,
PT=pronator teres,
SB=supinator brevis,
Q=quadratus,
SC=supinator crest,
PQ=pronator quadratus,
BR=brachialis,
TB=triceps brachii,
v = versus (compared to)

between Islamic and pre-Islamic individuals and enthesis scores. Table 11 displays the results of Spearman's correlation tests for early and late Islamic individuals and enthesis scores.

While generally entheseal scores were higher in pre-Islamic males, some entheses scored greater in Islamic males, especially the pronators and supinators of the forearm (see tab. 8). As Inskip (2013) detected no difference in body size between the two groups of males, the difference was likely to be related to activity. Statistically, 15 entheses correlated with faith group in males (see tab. 10). Greater entheseal scores in pre-Islamic males, especially the proximal humeral attachments and costoclavicular ligaments, complements the high prevalence of glenohumeral OA found in the pre-Islamic group. The data suggests a distinct change in the degree and patterns of muscle use in males over time, which coincides with the emergence of Islam, especially in the degree of loading at the glenohumeral joints.

A similar trend was also observed in the Iberian females, with 19 entheses correlating with faith group (Islamic and pre-Islamic) (see tab. 10). The pre-Islamic females scored higher for muscles associated with the use of the upper arm (trapezius, teres major and costoclavicular ligament). Islamic females had higher scores relating to forearm use including the pronator quadratus (radius), supinator brevis, flexor pollicus longus, common extensor tendon and tricep brachii (see tab. 8). The deltoid attachments of the humerus and clavicle produced conflicting results as the humeral attachment scored greater in pre-Islamic women, but the clavicle attachment scored greater in the Islamic females. This probably reflects the multifunction of the deltoid muscle, and indicates differential deltoid use between the groups. This demonstrates that a different pattern of muscle use existed between pre-Islamic and Islamic women.

When observing changes in entheseal score sex differences between Islamic and pre-Islamic individuals, 13 enthesis scores statistically correlated with sex in the Islamic individuals (see tab. 10). Critically, females outscored males at the trapezius, left flexor pollicus longus and ulna pronator quadratus attachment (see tab. 8 for enthesis scores and table 10 for P values). The supinator brevis attachments and the left flexor pollicus longus scores were also greater in Islamic females in comparison to Islamic males, but were not quite statistically different. In contrast, only 7 enthesis scores correlated with sex in the pre-Islamic group (tab. 10). Importantly, pre-Islamic males had greater or equal enthesis scores at all attachments to pre-Islamic females. This suggests that muscle pattern use was more clearly related to sex in the Islamic group, and infers a more clear gendered division of activity.

Diachronic analysis of enthesis scores in the Islamic group by sex demonstrated different trends for males and females. For Islamic males, 6 enthesis scores correlated with phase (early Islamic, late Islamic) (see tab. 11). All differences were observed on the right humerus and left clavicle (see tab. 9). With the exception of the right brachioradialis extensor attachment, all scored greater in the late phase. As there was no diachronic change in male body size over time (Inskip 2013), this implied a different pattern of muscle usage in late Islamic males. Importantly, a greater degree of asymmetry was observed in late Islamic male attachments. This may infer a greater expression of handedness in late Islamic men. In females, only the right pectoralis major decreased in score temporally, suggesting stability in female patterns of muscle use over time.

Sex differences in enthesis scores existed in both the early and late Islamic phases. In the early phase, 7 enthesis scores correlated with sex, 6 statistically (see tab. 11). In the late phase 10 enthesis scores correlated with sex, 6 statistically. Importantly, however, different entheses correlated with sex in each phase. This suggests that although different activities may be undertaken by males and females in the early and late phases, and changes in production may have taken place, a gender division persists in both phases. In general, correlations with sex were stronger in the late phase inferring the appearance of a clearer gender division in the later Muslims.

9. Isotopic evidence from Écija

Écija's position in a river valley means that the strontium isotope signatures are likely to represent a mixture of surrounding soils and, as such, faunal remains provide the most accurate estimation of local strontium ratios. Data from Zakrzewski (2010) indicated that four of the five sheep teeth tested had $Sr^{87/86}$ ratio that ranged from 0.70854–0.70987 and were assumed to represent a local signature.

Twenty seven of the 30 teeth analysed ranged from 0.70828-0.70891 which fits with the results obtained from the sheep teeth (Zakrzewski 2010). The slightly elevated scores of the sheep, may represent transhumance, a known practice in Iberia (Imamuddin 1981). A local origin for the majority of individuals was also supported by other strontium investigations in the region, including those on Andalucían natural mineral waters from Malaga, 80 km south of Écija, which produced $Sr^{87/86}$ ratios between 0.70701-0.70900 (Voerkelius 2010). Human teeth from individuals thought to be indigenous from Almaden, Sevilla 80km north east of Écija, also had similar $Sr^{87/86}$ ratios of 0.70832-0.70935 (Diaz-Zorita *et alii* 2009).

Zakrzewski (2010) identified three individuals that had strontium isotope ratios that were more radiogenic, suggesting immigration into Écija. Two males appeared to have strontium signatures (0.71004 and 0.71033) consistent with being raised in another location, or with having a mobile lifestyle during childhood. Again, it is possible that transhumance between Écija and the region to the north could be possible for these elevated signatures. The mountains to the north of Écija certainly contain rocks capable of producing higher strontium signatures than the city of Écija itself (Fernández *et alii* 2002). Importantly, one male was from one of the earliest phases of the cemetery, phase 5, while the other was from phase 2, the second to last phase of the cemetery.

The female individual, from phase 3, with the highest ratio (0.716612) appears to originate from a region with far older rocks than the rest of the sample. Voerkelius (2010, p. 937), on a study of European natural mineral waters, associated scores above 0.713 with Lower Palaeozoic and crystalline rocks of the old Variscian and Caledonian orogens, which are found in the Meseta in central Spain. High $Sr^{87/86}$ values were also detected in natural mineral water from the Granada region approximately 120km south east of Écija (Voerkelius 2010).

Although the isotopic signatures were varied, the regional diversity in rock mean that all these individuals could theoretically be native to Iberia. This supports the notion that most of the Muslims from Écija were in fact indigenous. This is important in demonstrating that the development of Islam was initiated by indigenous followers of tradition. Conversely, however, this also does not mean that there were no immigrants at all, and taking into consideration historic information, this is extremely unlikely to be the case. According to documentation, Écija was settled by Arabs (García Baena 2006). It does remain a possibility that the three individual with elevated scores did come from elsewhere in the *Dar-al-Islam*, but further isotopic research (e.g. oxygen) would be required to identify where. This demonstrates that difficulty in using just a single isotope type to reconstruct population movements. In addition, more individuals need to be sampled, especially those from the earliest phases of the cemetery. However what was clear was that in the final phase of the cemetery, all individuals had isotopic signatures that could be considered immediately local (n=19).

10. Discussion

The results of the activity-related skeletal modifications, and those of Inskip (2013), Pomeroy and Zakrzewski (2009) and al-Oumaoui *et alii* (2004) demonstrated that there were differences in pre-Islamic and Islamic activity patterns, suggesting a distinct change in social organisation in Iberia at the same time as the emergence of Islam. This was also supported by a distinct change in burial rites in accordance with Islamic traditions, which demonstrated a shift in the direction of burial, right side positioning and a lack of grave goods from the first phase of occupation at Écija (Romo Salas n.d.).

In terms of emerging gender ideology, sex differences were visible in the pre-Islamic and Islamic activity modification data presented here, something not surprising given that gender division is visible in nearly all societies. While the pre-Islamic material had the greatest sex difference in the osteoarthritis, the Islamic individuals had more sex difference in the entheseal data and in non-pathological articular modifications as analysed in Inskip (2013). Importantly, only in the Islamic group do female entheses score higher than those for males. Furthermore, in al-Oumaoui *et alii's.* (2004) study of enthesis patterns, the Islamic population from La Torrecilla had a greater sex dimorphism in enthesis score expression than the comparative Christian population from Villanueva de Soportilla. Additionally, reduced female mobility was identified in the Écija women by Pomeroy and Zakrzewski (2009), and for the Islamic females from La Torrecilla (Robles 1997). These results infer that a stricter gender division existed in the Islamic group, as might be expected from Islamic ideology on the different but complimentary role of men and women.

Islamic males from Écija, in particular, appear to have undertaken less physically demanding activities than pre-Islamic males. This suggests potentially that there were changes in the strategy of production in the population. Historic sources suggest that al-Andalus was stratified based on religion and ethnicity (Chejne 1974; Glick 1979; Hillenbrand 1992; Imamuddin 1981), and Shatzmiller (1994) suggested that labour was divided among these groups. Muslims, in particular Arab Muslims, tended to work in service, trading and religious professions, whereas Ibero-Romans tended to work in physically demanding roles such as agriculture and extraction sectors. It could therefore be argued that low enthesis scores and OA prevalence in early Muslims reflect the presence of Arab elite, who employed Christians to work the land, as is suggested by Imamuddin (1981) and Kennedy (1996). As such, being Muslim in the early years of Islam in Écija might be strongly related to being Arab, as not only were they some of the first arrivals, the only way to become Muslim in the first 100 years was to submit to an Arab as a client (Berkley 2003). Many people took on Arab dress, names and other features (Boone 2009; Kennedy 1996). Also important to this issue may be the ability to speak Arabic and the capacity to undertake religious and legal professions. The very high prevalence of OA in the pre-Islamic males infers a very specific lifestyle in these individuals, which needs further investigation, especially as age was controlled in sample selection. In modern clinical studies of OA, animal husbandry has been identified as a significant risk factor in the development of hip OA (Thelin *et alii* 2004; Thelin, Holmberg 2007). As this made up a large part of the economy in the Roman and Visigothic periods, it is not unreasonable to assume that this would be a causative factor in the pre-Islamic population.

In females, there was no change in the degree of high impact physical loading, but different muscle use patterns were observed. Islamic females had higher scores involved in forearm supination and pronation while the pre-Islamic females had higher scores for medio-lateral humeral movement. Al-Oumaoui *et alii's* (2004) comparative study of entheses in Iberian females had similar results. This indicates that at the time of the emergence of Islam, changes to female activity patterns also took place, suggesting some changes in female identity on the uptake of Islam. Female work in Iberia is thought to have been dominated by domestic activities, both before and after the arrival of Islam, but pre-Islamic European women, however, were known to assist in men's labour if required (Jewell 2007). The increased forearm enthesis scores identified in this research may suggest a greater conformity to traditional intricate female activities by Muslim women, who Shatzmiller (1994) and Hambly (1999) identified as dominating the weaving and cottage industries. Similar trends have been observed in other populations undergoing changes in social organisation (Munson Chapman 1997; Ponce 2010).

The data indicated that there were changes in social organisation in accordance with Islamic tradition after the invasion of AD 711. Furthermore, this evidence, combined with historic and isotope data, suggests that largely the emergence of Islam was related to an indigenous adherence to Islamic tradition rather than to a large influx of immigrants (although more isotope samples are needed from the early phases). It is important here to consider regional circumstances that may have shaped early Iberian Islamic identity and adherence to gender ideology. Écija's geographic position is important. Despite being on the edge of the Islamic world, al-Andulas was not isolated. Scholars travelled to bring back knowledge from the rest of the *Dar-al-Islam* (Safran 2001). Écija, an important trading city (Bridgeman 2007), is close to Córdoba, a renowned centre of Islamic learning and the capital of al-Andalus. Knowledge of how to be a good Muslim could easily have been disseminated to the region. In particular, Maliki law was staunchly followed in al-Andalus from the 9th century (Fierro 2005; Judd 2011; Lapidus 2002). This early school of thought, which has its origins in Mecca and Medina, focuses strongly on practical traditions in the Qur'an. This, Payne (1973) argues, made Iberia orthodox. Secondly, critical in the maintenance of identity is the notion of 'us' and 'them'. Essentially, identities need to exclude in order to exist (Schöpflin 2001). As such, it would be important in the early years of Islam to distinguish oneself from the Christians to the north, and those that remained in conquered regions, especially as Muslims were a minority in the first 100 years of Islam in Iberia (Bulliet 1994; Kennedy 1996). This could be achieved through altering behaviour in line with Islamic tradition. Finally, as better employment opportunities and tax breaks were available to Muslims (Kennedy 1996), adherence to Islamic tradition would be important in obtaining these benefits.

While there was no temporal change in Islamic male OA prevalence or patterns, there was a significant increase in enthesis scores. As a relationship between enthesis score and activity has been identified (Doyling 2010; Godde and Wilson Taylor 2012), this implies a change, and possibly, an increase in physical activity in late Islamic males, as there was no significant increase in male body size over time (Inskip 2013). This change could relate to the loss of the link between being Muslim and Arab, and general Islamic population increase. As mentioned previously, the presence of large numbers of indigenous Muslims in Écija is inferred by documentation of ethnic tensions in 10th century, which was caused by the perceived elitism of Arabs (García Baena 2006; Hitti 2002; Melville, Ubaydli 1992). Therefore, an increase of entheseal scores may be the result of the incorporation of Muslims of different backgrounds and status into the wider Islamic population. This reflects research by Barcelo (1997) and Bulliet (1994) who infer that by the 9th and 10th centuries, 80% of the population were Muslim. This is supported by the stable isotope data, where all but one of the individuals in the late phase (phases 1 and 2) had a signature immediately local to Écija.

There was little temporal change in female activity patterns derived from OA and entheses scores, inferring no change in muscle use or high impact loading. However, when observing changes in sex difference over time, a comparison of enthesis scores by phase demonstrated that a greater sex difference existed in the late phase, suggesting greater gender difference. This was also supported by research on bone geometry and non-pathological articular modifications in the lower limb (Inskip 2013). Furthermore, in the later phases of the Écija cemetery, male and female designated burial areas appeared (Romo Salas n.d.).

In order to interpret why male activity patterns alter more temporally than those of females, and why adherence to gender traditions appears to be clearer in the later phase at Écija, it is important to turn back to Islam, Islamic gender ideology, and to consider the political situation. Sex differences observed in activity patterns may reflect the fact that Islam contains not only religious traditions, but also customary traditions. As Edwards (2005) argues that males are largely involved in religious traditions, whereas females are involved in customary activities, the augmentation of religious identity would depend on the public expression of faith by males. It is therefore not surprising that greater changes in male behaviour are observed. The lack of female change in activity patterns possibly reflects the more customary role of females. Furthermore, as female activity was possibly confined to private arenas, it might not have been so important to visibly change activity.

This however does not mean that women in Iberia did not lead religious lives. In fact data from Pomeroy and Zakrzewski (2009) and Robles (1997) infer that there was a reduction in female mobility in Iberia with the emergence of Islam. This may infer that where female behaviour did cross over in to the public realm, changes did occur. This is certainly supported by religious documentation on women being prosecuted for publically celebrating Christian festivals (Melville and Ubaydli 1992). As a previously Christian region, with Christian neighbours, where women had little restriction on their movements, gender segregation might have been an important tool in the public maintenance of Islamic identity in al-Andalus. Adherence to gender division, however, should not be confused with evidence for oppression. Shatzmiller (1994 and 1997) implies that Islamic females were economically independent from men, despite being restricted in their movements. In addition, assumption that female identity was devoid of religious significance because of continuation of domestic activities is also problematic. Hays-Gilpin (2008) argues that many domestic activities have important religious significance, such as the weaving of shrouds, preparation of ritual foods and pottery production. These are all important items that would be critical in the reproduction of religious identity. Men and women therefore have different roles in creating Islamic identity.

The observance of Islamic traditions by Écijan Muslims, especially those in the later phases of occupation, can be related to a number of factors. Firstly, Islam at the time of the invasion of Iberia was not a cohesive body of doctrine as it is known today. Traditions were still being collated and formed during the 7th to 8th centuries. Greater conformity to Islamic tradition in the later Écijan occupation phases could be related to general consolidation of Islam that occurred in the 9th century (Berkley 2003). Secondly, Christianity, especially in the 11th and 12th

centuries, was beginning to form a significant threat to the Islamic south. Schöpflin (2001, p. 6) argues that when cosmologies and their identities become threatened, stricter definition of self and community often results. This creates a more exclusive, but protected, communal identity. Indeed, acculturation and innovation were real issues for religious leaders in Iberia and numerous court cases of innovation were bought before the *qadis* (judges) of Córdoba (Fierro 1992; Fierro 2005 and Safran 2001). Final, the formation and arrival of more fundamentalist Islamic groups from North Africa (Almoravids and Almohads) in the 11^{th} and 12^{th} centuries may have impacted on adherence, although the isotope evidence for this is not yet clear and requires further research.

The data, combined with funerary and architectural evidence suggests that Islamic tradition made up an important part of identity in Écija. The persistence of a gender division in both Islamic phases, despite potential technological and economic change, infers that Islamic ideals still made up an important part of identity. Whether this was the case for more rural populations, or individuals living more distant to Córdoba and closer to Christianity is unknown. This research could move forward by comparing the results here to populations synchronic to Écija. This would permit a greater analysis of how other social-political and economic factors were important in the construction of Islamic identity and what other factors may be important in dictating activity.

11. Conclusions

This research aimed to explore the emergence and development of Islamic identity as a native phenomenon through the comparative diachronic analysis of human skeletal remains and Islamic traditions surrounding gender. The data presented here demonstrated that there was a distinct change in social organisation that coincided with the emergence of Islam. This was suggested by an increase in gender division as evidenced from the comparison of activity-related skeletal modifications between Islamic and pre-Islamic skeletal material. Funerary evidence also supported this notion. Such a change could be related to attempts to create distinction between remaining Christians and Muslims, and the manipulation of gender roles would indeed be one powerful way to achieve this. Islamic identity in Iberia therefore appears to be characterised by a strong gendered division of labour. In addition, the data may also support a notion of changes in social strategy when it came to production, which may have been based on ethnic and religious lines.

The data also demonstrated temporal variations in gender division and patterns which infers variability in Islamic identity. Specifically, the emergence of sex specific activity patterns implies a greater conformity to gender ideology in the late phase. While there were more changes in male markers, initially suggesting that men were more affected than women, a decrease in female mobility implies that the public expression of Islam was important. This notion seems to be supported by the formation of burial areas reserved for men and women in the later phases of the cemetery. As funerals are highly public events, they can be seen as critical in the construction and maintenance of identity (Halevi 2007). The increasing importance of public expression of Islamic identity is linked to other changing social factors, which largely revolve around the position of Écija on the edge of the Islamic world. The organisation of the Christian north into a credible threat could be seen as driving factor behind increasing display of Islamic identity. As a frontier identity, Muslims would have tried to maintain the distinction between 'us' and 'them' in a world that was becoming disordered. As there were no definite immigrants identified in preliminary isotope analysis, this integrative approach suggests that development of Islam in Iberia was largely through the conformation of indigenous inhabitants to Islamic tradition in a specific social situation. Iberian Islam thus represents a native phenomenon.

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