Enthesis directional asymmetry: the effect of occupation

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1.0 Introduction

Entheseal changes (ECs) have been widely used to infer activity patterns in past populations, based on the principle that repetitive (or heavy) muscle use causes increasingly severe modifications to entheses[1]. Recent research has shown that this is an oversimplification of the relationship, with other factors, including the ageing process, playing a significant role[2,3]. Importantly studies of comparing cross-sectional properties with ECs has shown that they are recording different processes[4,5].

Research on the development of entheses, focussing on their size, has shown that, like muscle cross-sectional area, enthesis area continues to increase during adolescence, but only in boys[6]. It was therefore assumed that those undertaking manual work in adolescence, whose muscle cross-sectional area should be larger, would have a larger enthesis area than non-manual workers, but this was not found to be the case. Directional asymmetry in bone size, has however, been shown to relate to activity patterns[7]. The aim of this poster is to test whether directional asymmetry in enthesis area is related to activity-patterns.

2.0 Materials and Methods

Males aged over 15 without signs of boneforming disease[8] (n=221) were recorded in the Coimbra identified skeletal collection[9]. Occupations from the documentation were categorised into four groups: heavy manual, manual, non-manual and soldier[10]. Two measurements of the humerus were taken: vertical head diameter and epicondylar width. Two measurements were made of two perpendicularly bisecting chords (Fig. 1) of three rotator cuff entheses alongside the common flexor and extensor origins[11]. These measurements were multiplied together to approximate area and were also standardised by bone size: by vertical humeral head for the rotator cuff entheses and using the epicondylar width for the others. Percentage directional asymmetry was calculated (%DA)[12], for the enthesis areas and the size-standardised enthesis areas. Statistical graphs were plotted in R (Rstudio version Version 0.99.489) using package gplots[13] and, where differences in means were present (without overlapping standard errors), ANOVAs were run.

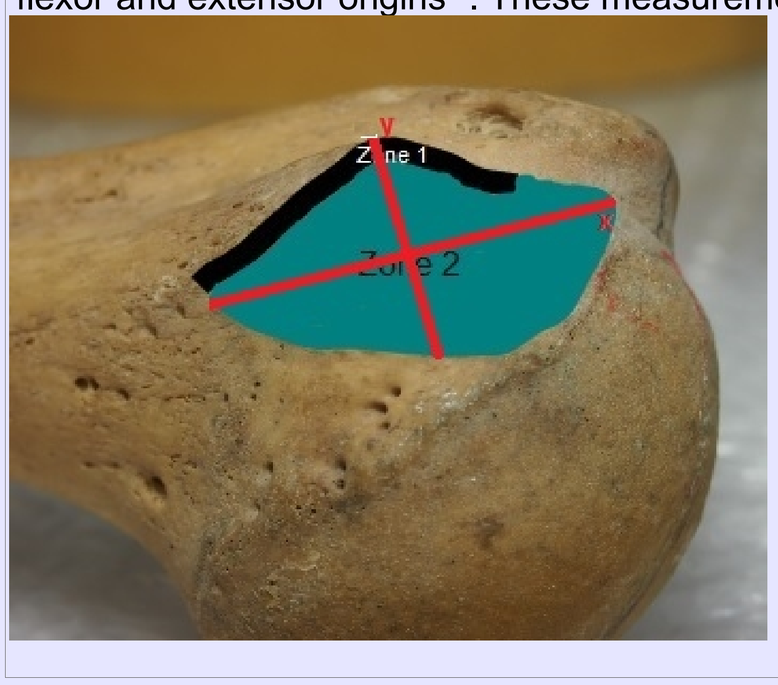
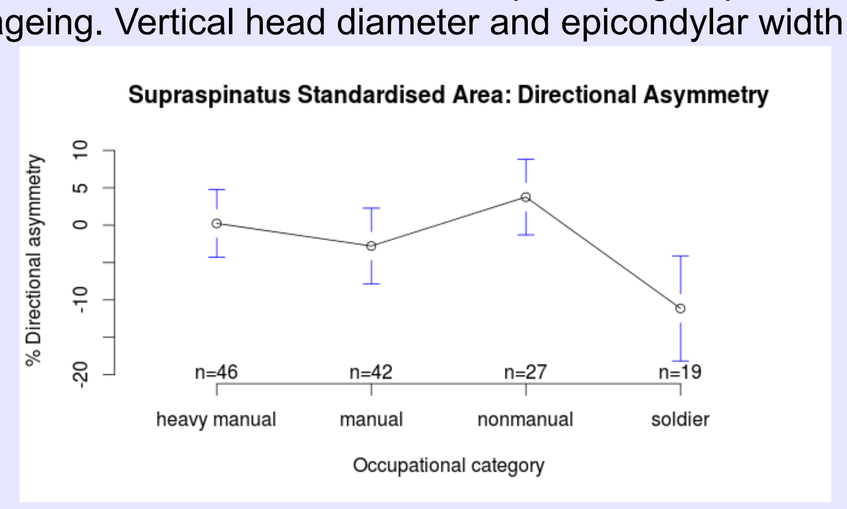
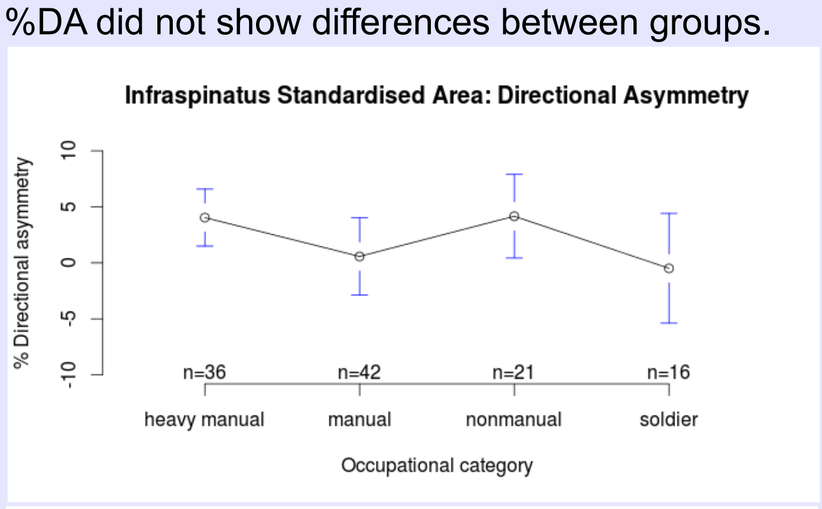


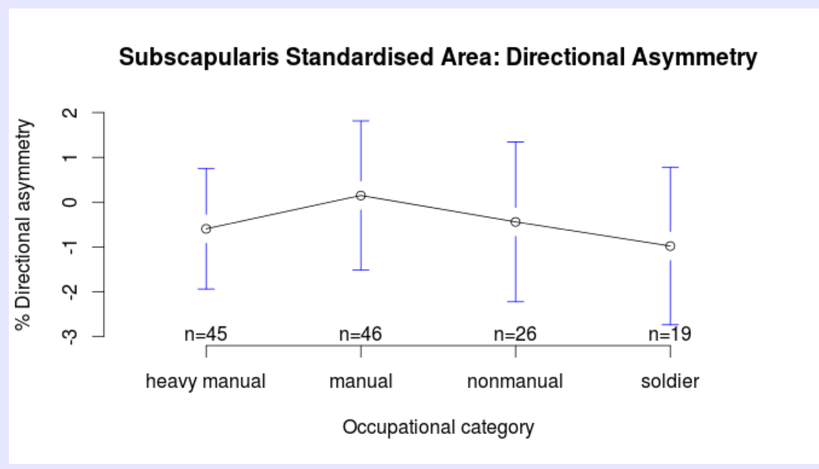
Figure 1. Subscapularis insertion showing aera (balck and blue) with chords marked in red

3.0 Results

The descriptive plots show almost no difference in asymmetry between occupations, except for the supraspinatus insertion which shows a a difference between soldiers and other occupational groups. An ANOVA showed that, for this enthesis alone, it was a statistically significant effect not mediated by ageing. Vertical head diameter and epicondylar width %DA did not show differences between groups.

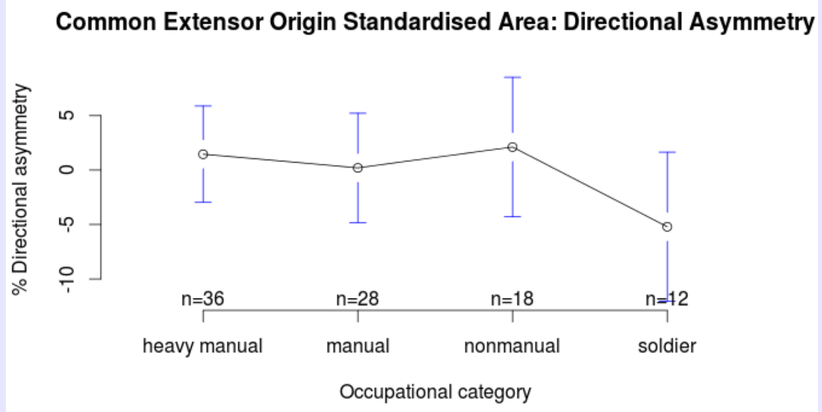


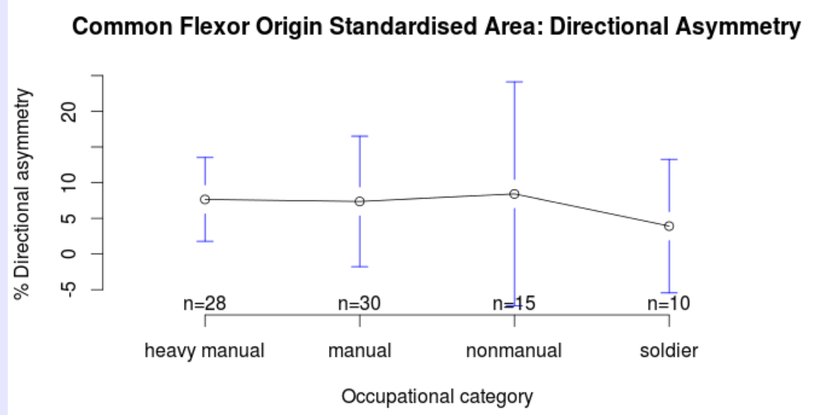


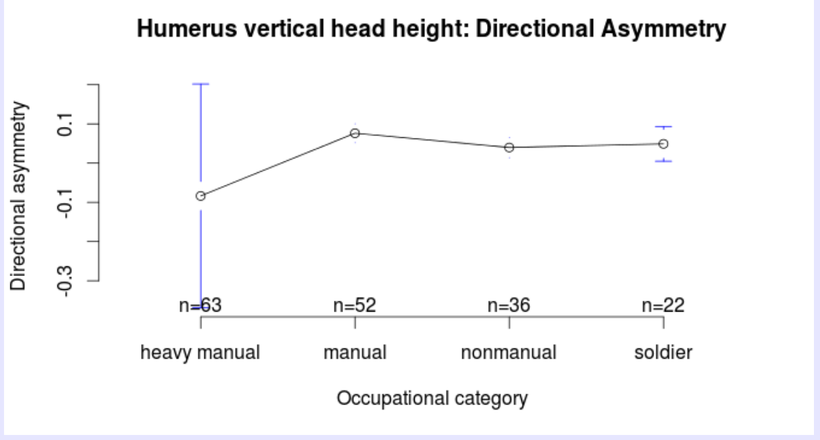


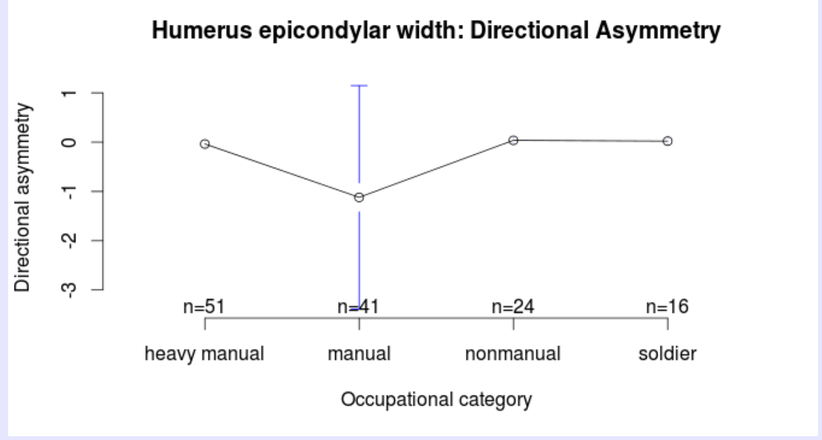
ANOVA:Supraspinatus

	F value	Pr(>F)
Occupation	3.940	0.010 *
Age	0.012	0.912
Occupation * Age	0.581	0.628









Figures show mean %DA by occupation for each enthesis, with error bars showing 95% confidence interval for standard errors. n= sample size for each occupation group

4.0 Discussion and conclusions

If enthesis area is related to muscle cross-sectional area then enthesis area should be an indicator of physical strength. A previous study has shown that, like muscle cross-sectional area, enthesis area continues to enlarge during adolescence in males[6]. However, it has been found that occupations (undertaken during adolescence) did not affect enthesis size[14]. Directional asymmetry in body size has been linked to handedness and shown to be affected by occupation[7]. However, these results indicate that directional asymmetry: 1) varies by enthesis 2) is not linked to occupation as categorised in this poster. In vivo studies are needed to determine the link between enthesis and soft tissue size.

References:

1. Hawkey, D. E. & Merbs, C. F. Activity-induced musculoskeletal stress markers (MSM) and subsistence strategy changes among ancient Hudson Bay Eskimos. Int. J. Osteoarchaeol. 5, 324–338 (1995). 2. Alves Cardoso, F. & Henderson, C. Y. The Categorisation of Occupation in Identified Skeletal Collections: A Source of Bias? Int. J. Osteoarchaeol. 23, 186–196 (2013). 3. Milella, M. et al. The effect of age, sex, and physical activity on entheseal morphology in a contemporary Italian skeletal collection. Am. J. Phys. Anthropol. 148, 379–88 (2012). 4. Michopoulou, E. et al. Evaluating the efficiency of different recording protocols for entheseal changes in regards to expressing activity patterns using archival data and cross-sectional geometric properties. Am. J. Phys. Anthropol. 158, 557–568 (2015). 5. Michopoulou, E. et al. A test of the effectiveness of the Coimbra method in capturing activity-induced entheseal changes. Int. J. Osteoarchaeol. (2016). 6. Henderson, C. Y. Maintaining relationships: growth and development during puberty. in Little Lives Conference (2016).7. Özener, B. Fluctuating and directional asymmetry in young human males: Effect of heavy working condition and and socioeconomic status. Am. J. Phys. Anthropol. 143, 112–120 (2010).

8. Henderson, C. Y. When hard work is disease: the interpretation of enthesopathies. in Proceedings of the Eighth Annual Conference of the British Association for Biological Anthropology and Osteoarchaeology (eds. Brickley, M. & Smith, M.) 17–23 (British Archaeological Reports: International Series, 2008). 9. Rocha, M. A. Les collections ostéologiques humaines identifiées du Musée Anthropologique de l'Université de Coimbra. Antropol. Port. 13, 7–38 (1995). 10. Villotte, S. et al. Enthesopathies as occupational stress markers: Evidence from the upper limb. Am. J. Phys. Anthropol. 142, 224–234 (2010). 11.Henderson, C. Y. Technical note: Quantifying size and shape of entheses. Anthropol. Sci. 121, 63–73 (2013). 12. Auerbach, B. M. & Ruff, C. B. Limb bone bilateral asymmetry: variability and commonality among modern humans. J. Hum. Evol. 50, 203–18 (2006). 13. Warnes, G. R. et al. Package 'gplots' Title Various R Programming Tools for Plotting Data. (2016). at: https://cran.r-project.org/web/packages/gplots/gplots.pdf 14. Henderson, C. Y. Enthesis size: the relationship with occupation and entheseal changes. in Working your Fingers to the Bone: An interdisciplinary conference on identifying occupation from the skeleton. Coimbra, Portugal 6th – 8th of July (2016).

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