**SUPPLEMENTARY DATA**

**APPENDIX**: Methods of estimating skeletal and live shoulder heights, using ulnas, femurs, and tibias. The sources of the ratios are described in the text.

**Ulna:** The Ratio + Regression method could not be used because no Regression equation exists.

In the Ratio-only method, we measured diaphysis length DL (Table A1), then predicted AL by multiplying DL by 1.18, then multiplied that value by 3.9 to predict SSH-2, and multiplied that value by 1.06 to predict LSH-2. We note a gap in DL values between 17 and 31 cm, perhaps reflecting a lack of individuals in a juvenile cohort (Laws age groups VIIIb-X, ~7 – 12 AEY) which also appears underrepresented in the mammoth mortality profile (Fig. 1).

**Femur**: In our Ratio + Regression approach to estimating LSH-1 from femurs (Table A2), MC was multiplied by different coefficients depending on relative size (see text), to estimate DL.

To estimate GL, the DL was multiplied by 1.23.

The GL was entered into the Regression equation ([GL x 3.0438] – 549.104 mm) in Lister and Stuart (2010: table 16), to predict SSH-1; that value was multiplied by 1.06 to estimate LSH-1.

In the Ratio-only method, the GL was estimated as in the Ratio + Regression method above. To estimate SSH-2, the GL was multiplied by 2.44; the SSH-2 was then multiplied by 1.06 to estimate LSH-2.

**Tibia**: In the Ratio + Regression method to calculate LSH-1 using tibia diaphysis (Table A3), we extrapolated GL by multiplying the measured DL x 1.16. We then applied the regression equation ([GL x 3.8455] + 462.384 mm) from Lister and Stuart (2010: their table 16) to estimate SSH-1, and multiplied that value by 1.06 to predict LSH-1.

In the Ratio-only method, we estimated LSH-2 by first multiplying the extrapolated tibia GL (DL x 1.16, as above) by 4.31 to estimate SSH-2, and multiplied SSH-2 by 1.06 to estimate LSH-2 (Table A2).

As with the ulnas, a gap appears in tibia DL values between 16.8 and 24 cm, again possibly reflecting a lack of individuals of certain juvenile age groups (suggested to be Laws groups VIIIb-X, 7 – 12 AEY), which is also underrepresented on the mortality profile (Fig. 1).

**Summary of the two methods used to estimate SSH and LSH:**

To estimate SSH-2 and LSH-2 from ulna (Ratio-only method)

Measure DL= diaphysis length on complete specimens lacking unfused epiphyses.

 Predict/measure Articular Length (AL) = (DL\*1.18) (length of the articulating part of the bone with distal epiphysis in place).

SSH-2 = (AL \* 3.9)

LSH-2 = (SSH-2 \* 1.06)

To estimate SSH-1 and LSH-1 from femur (Ratio + Regression equation method):

Measure MC = Midshaft circumference of diaphysis.

Estimate DL = 2.0 \* MC, or 2.1 \* MC, or 2.2 \* MC, or 2.3 \* MC, or 2.4 \* MC, or 2.5 \* MC. The coefficients are dependent on relative size (see text).

SSH-1 = ((GL\*3.0438) – 549.104)

LSH-1 = (SSH-1 \* 1.06)

To estimate SSH-2 and LSH-2 from femur (Ratio-only method):

Measure MC = Midshaft circumference of diaphysis.

Estimate DL (as above) = 2.0 \* MC, or 2.1 \* MC, or 2.2 \* MC, or 2.3 \* MC, or 2.4 \* MC, or 2.5 \* MC.

Predict/measure GL = (DL\*1.23) (maximum length with both epiphyses in place)

SSH-2 = (GL\*2.44)

LSH-2 = (SSH-2 \* 1.06)

To estimate SSH-1 and LSH-1 from tibia (Ratio + Regression equation method):

Measure DL = diaphysis length on complete specimens lacking unfused epiphyses

Predict/measure GL = (DL \* 1.16) (maximum length with both epiphyses in place).

SSH-1 = ((GL \* 3.8455) + 462.384)

LSH-1 = (SSH-1\*1.06)

To estimate SSH-2 and LSH-2 from tibia (Ratio-only method):

Measure DL= diaphysis length) on complete specimens lacking unfused epiphyses.

Predict/measure GL = (DL\*1.16) (maximum length with both epiphyses in place).

SSH-2 = (GL\* 4.31)

LSH-2 = (SSH-2 \* 1.06)

Supplementary Data Table A1: Measured Kraków Spadzista ulna midshaft circumferences (MC) and diaphysis lengths (DL), projected articular lengths (AL), SSH-2s, and LSH-2s, reported in cm. The SH values have been rounded to one decimal place after all calculations were completed.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Specimen number | Midshaft circumference of diaphysis(cm) | Diaphysis Length(cm) | Projected AL(cm) | Projected SSH-2(cm) | Projected LSH-2(cm) |
| G0-0162 | 8.5 | 14.5 | 17.11 | 66.7 | 70.7 |
| C12-472 | 10.4 | 15 | 17.7 | 69.0 | 73.2 |
| G2-0201 | 8.8 | 15.5 | 18.29 | 71.3 | 75.6 |
| F14-2574 | 11.5 | 16 | 18.88 | 73.6 | 78.0 |
| F1-0081 | 11.5 | 17 | 20.06 | 78.2 | 82.9 |
| E8-1224 | 17.5 | 31.5 | 37.17 | 145.0 | 153.7 |
| G0-2076 | 22 | 36 | 42.48 | 165.7 | 175.6 |
| D8-1158 | 24.7 | 40 | 47.2 | 184.1 | 195.1 |
| I0-164 | 23.6 | 46 | 54.28 | 211.7 | 224.4 |
| I0-2163 | 23.6 | 46 | 54.28 | 211.7 | 224.4 |
| 2329 | 27.7 | 47 | 55.46 | 216.3 | 229.3 |
| F12/13-2096 | 29 | 52.5 | 61.95 | 241.6 | 256.1 |

Supplementary Data Table A2: Measured Kraków Spadzista femur midshaft circumferences (MC), and projected GL, SSH-1, LSH-1, SSH-2, and LSH-2, reported in cm. The SH values have been rounded to one decimal place after all calculations were completed.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Specimen number | Midshaft circumference of diaphysis(cm) | Projected GL | Projected SSH-1 (cm) | Projected LSH-1 (cm) | Projected SSH-2 (cm) | Projected LSH-2 (cm) |
| E(-1) 0124 | 10.7 | 26.322 | 25.2085036 | 26.7 | 64.22568 | 68.1 |
| MF-2178 | 12 | 29.6676 | 35.39184088 | 37.5 | 72.388944 | 76.7 |
| E8 1134 | 13 | 33.579 | 47.2973602 | 50.1 | 81.93276 | 86.8 |
| C10 173 | 13 | 35.178 | 52.1643964 | 55.3 | 85.83432 | 91 |
| I2 2335 | 13.9 | 39.3231 | 64.78125178 | 68.7 | 95.948364 | 101.7 |
| E6 975 | 14 | 39.606 | 65.6423428 | 69.6 | 96.63864 | 102.4 |
| F(-1) 0838 | 14 | 39.606 | 65.6423428 | 69.6 | 96.63864 | 102.4 |
| F2 0272 | 14 | 39.606 | 65.6423428 | 69.6 | 96.63864 | 102.4 |
| F1/E1 0118 | 14.7 | 41.5863 | 71.66997994 | 76 | 101.470572 | 107.6 |
| B15 150 | 15.3 | 44.22465 | 79.70058967 | 84.5 | 107.908146 | 114.4 |
| E11 1854 | 15.8 | 45.86424 | 84.69117371 | 89.8 | 111.9087456 | 118.6 |
| E11 1550 | 16.3 | 47.51613 | 89.71919649 | 95.1 | 115.9393572 | 122.9 |
| H(-2) 2164 | 16.3 | 47.71662 | 90.32944796 | 95.7 | 116.4285528 | 123.4 |
| K0 161 | 16.3 | 47.91711 | 90.93969942 | 96.4 | 116.9177484 | 123.9 |
| D8 1234 | 18.2 | 53.7264 | 108.6220163 | 115.1 | 131.092416 | 139 |
| D11 1539 | 18.5 | 54.612 | 111.3176056 | 118 | 133.25328 | 141.2 |
| C7 351 30 | 19.3 | 56.9736 | 118.5058437 | 125.6 | 139.015584 | 147.4 |
| 2(17) | 19.6 | 57.8592 | 121.201433 | 128.5 | 141.176448 | 149.6 |
| F3 0051 | 19.7 | 60.5775 | 129.4753945 | 137.2 | 147.8091 | 156.7 |
| E8 1075 | 19.8 | 60.885 | 130.411363 | 138.2 | 148.5594 | 157.5 |
| G2 0174 | 20 | 61.5 | 132.2833 | 140.2 | 150.06 | 159.1 |
| C10 374 | 21.3 | 65.4975 | 144.4508905 | 153.1 | 159.8139 | 169.4 |
| I(-1) 2295 | 21.8 | 67.035 | 149.130733 | 158.1 | 163.5654 | 173.4 |
| I1 062 | 22 | 67.65 | 151.00267 | 160.1 | 165.066 | 175 |
| E7 1101 | 23.3 | 71.6475 | 163.1702605 | 173 | 174.8199 | 185.3 |
| D3 634 | 23.5 | 72.2625 | 165.0421975 | 174.9 | 176.3205 | 186.9 |
| E7 1023 | 24.2 | 74.415 | 171.593977 | 181.9 | 181.5726 | 192.5 |
| E3 FE1 | 24.3 | 74.7225 | 172.5299455 | 182.9 | 182.3229 | 193.3 |
| C7 520 | 25 | 76.875 | 179.081725 | 189.8 | 187.575 | 198.8 |
| I(-1) 2218 | 25.8 | 79.335 | 186.569473 | 197.8 | 193.5774 | 205.2 |
| E11 1723 | 26.2 | 80.565 | 190.313347 | 201.7 | 196.5786 | 208.4 |
| D10 1409 | 27.4 | 84.255 | 201.544969 | 213.6 | 205.5822 | 217.9 |
| E10 1452 | 30.5 | 93.7875 | 230.5599925 | 244.4 | 228.8415 | 242.6 |
| E11 1544 | 32.5 | 99.9375 | 249.2793625 | 264.2 | 243.8475 | 258.5 |
| ?2013 | 32.8 | 100.86 | 252.087268 | 267.2 | 246.0984 | 260.9 |

Supplementary Data Table A3: Measured Kraków Spadzista tibia diaphysis lengths (DL), projected GL (or total GL if complete), and projected SSH-1, LSH-1, SSH-2, and LSH-2, reported in cm. The SSH values have been rounded to one decimal place after all calculations were completed.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Specimen number | Diaphysis length (cm) | Projected GL (cm) | Projected SSH-1 (cm) | Projected LSH-1 (cm) | Projected SSH-2 (cm) | Projected LSH-2 (cm) |
| E(-1) 0086 | 13.5 | 15.7 | 106.45893 | 112.8 | 67.5 | 71.5 |
| E4 0093 | 16.8 | 19.5 | 121.179504 | 128.5 | 84 | 89.0 |
| C13 472 | 24 | 27.8 | 153.29712 | 162.5 | 120 | 127.2 |
| E15 2562 | 25 | 29 | 157.7579 | 167.2 | 125 | 132.5 |
| I(-1) 064 | 25 | 29 | 157.7579 | 167.2 | 125 | 132.5 |
| D6 948 | 29.5 | 34.2 | 177.83141 | 188.5 | 147.5 | 156.3 |
| D12 2127 | 31 | 36 | 184.52258 | 195.6 | 155 | 164.3 |
| J(-1) 2222 | 31 | 36 | 184.52258 | 195.6 | 155 | 164.3 |
| F4 0024 | 31.5 | 36.5 | 186.75297 | 198 | 157.5 | 167 |
| I1 128 | 37 | 42.9 | 211.28726 | 224 | 185 | 196.1 |
| B11  | 37.5 | 43.5 | 213.51765 | 226.3 | 187.5 | 198.7 |
| F1 0198 | 38.5 | 44.7 | 217.97843 | 231.1 | 192.5 | 204 |
| I(-2) 2345 | 39 | 45.2 | 220.20882 | 233.4 | 195 | 206.7 |
| I0 2105 | 39 | 45.2 | 220.20882 | 233.4 | 195 | 206.7 |
| F0 0482 | 39 | 45.2 | 220.20882 | 233.4 | 195 | 206.7 |
| I(-1) 2133 | 40 | 46.4 | 224.6696 | 238.1 | 200 | 212 |
| D8 1193 | 40.5 | 47 | 226.89999 | 240.5 | 202.5 | 214.6 |
| (unknown provenience) | 41.5 | 48.1 | 231.36077 | 245.2 | 207.5 | 220 |
| 2632/2633/2630 | 44.2 | 51.3 | 243.404876 | 258.0 | 221 | 234.2 |
| D6 909 | 45.5 | 52.8 | 249.20389 | 264.2 | 227.5 | 241.1 |
| E11 1897 | 41.8 | 48.5 (measured) | 232.74515 | 246.7 | 209.0 | 221.6 |
| I1 040 | n.a. | 50.5 (measured) | 240.43615 | 254.9 | 217.7 | 230.7 |