

# Broken ribs: Healed fractures evidence from the 'Lisboa collection', Portugal

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## INTRODUCTION

Healed rib fractures are common findings during skeletal analysis of past<sup>1-2</sup> and modern<sup>12,17</sup> human populations. However, there are few palaeopathological<sup>2-5</sup> or forensic<sup>17</sup> publications reporting their prevalence and characteristics. The absence of precise data on broken ribs precludes an accurate understanding of ribcage fracture patterns and restricts comparisons between studies either from archaeological or forensic contexts.

- Aims:**
- Report healed rib fractures prevalence.
  - Interpret fractures based on a biocultural approach.
  - To test if pulmonary diseases increases fractures prevalence.

## MATERIAL

Human Skeletal Identified Collection from the Museu Bocage (National Museum of Natural History, Lisboa, Portugal). Complete biographical data is available. The collection represents urban people from to lower-middle socioeconomic classes of the Lisbon population who lived between 1805 and 1975<sup>6</sup>.

- 197 individuals observed:
  - 109 males and 88 females
  - Age at death: 13-88 years old
  - Dates of birth: 1819-1941
  - Dates of death: 1881-1959

## METHODS

- Sample profile designed in a previous research<sup>7</sup>.
- Macroscopical detection of rib fractures was based on the presence of healing or healed bony callus.
- Fractures were recorded attending to rib segments: vertebral end, shaft, and sternal extremity.
- Siding and numbering of the ribs followed standard published criteria.
- Radiographs were done at Coimbra University Hospitals.
- Data analyses with SPSS and Epilinfo programs.

## MAIN RESULTS and DISCUSSION

- The main results are summarized in table 1.

Table 1 – Rib fractures summarized results.

INDIVIDUALS	Group of cause of death		Total
	Pulmonary	Non-pulmonary	
Observed	133	64	197
With at least one rib fracture	34	13	47 (23,9%)
% between groups	72,3%	27,7%	-
% within groups	25,6%	20,3%	-
With a sole rib fractured	14	8	22
With two or more ribs affected	20	5	25
Adjacent ribs fractured	14	5	19
<b>RIBS AFFECTED</b>			
Total number of ribs	87	36	123
Mean by individual	2,64	2,77	2,67
Median by individual	2	1	2
Standard deviation	2,205	2,713	2,329
Range by individual	1-8	1-8	1-8
Most common affected	6,8	8-9	7-9
Number of multi-fractured ribs	4	3	7
<b>LOCATION OF FRACTURES</b>			
On the rib cage			
Unilateral left	14	5	19
Unilateral right	8	6	14
Bilateral	11	2	13
Undetermined	1	-	1
On the rib			
Vertebral end	1	-	1
Shaft	20	9	29
Sternal end	7	1	8
Undetermined location	1	-	1
Two rib zones affected	3	2	5
Three rib zones	2	1	3

- 47 (23,9%) out of the 197 individuals presented at least one broken rib.
- Men (55,3%, n=26) are more affected than women (44,7%, n=21).
- Fractures prevalence is positively correlated with older age classes (Fig. 1).
- No group of cause of death (ICD-10) is preferentially affected (Fig. 1).
- 5 individuals with traumatic related causes of death do not present rib fractures.
- Rib fracture prevalence between pulmonary and non-pulmonary groups is not significant.

## INJURY RELATED FRACTURES

- The single rib fractures found probably results from direct impact to the chest<sup>10-12,18</sup>, while multiple ones or upper rib fractures derives from violent forces<sup>10-12</sup>.
- An isolated first rib fracture (Sk. 1123) can be secondary to its avulsion by muscular attachments rather than direct trauma<sup>11</sup>.
- Posterior rib fractures (Sk. 1158) indicates anteroposterior compressing forces<sup>11,14</sup>.

## PNEUMONIA and RIB FRACTURES

Rib fractures are a frequent origin of pulmonary complications<sup>11,18</sup>, specially pneumonia that commonly causes death in individuals with broken ribs<sup>19-21</sup>. Medical reports<sup>21</sup> shows that pneumonia incidence increases with higher number of ribs fractured. In fact, the present study reveals that 3 out of 4 individuals with 8 ribs fractured (the highest value observed) died from pneumonia.



1<sup>st</sup> - 3<sup>rd</sup> left ribs (Sk. 1106)



10<sup>th</sup> left rib (Sk. 102)



6<sup>th</sup> - 12<sup>th</sup> left ribs (Sk. 53)



6<sup>th</sup> left rib (Sk. 1139)



8<sup>th</sup> - 9<sup>th</sup> left ribs (Sk. 119)



9<sup>th</sup> - 11<sup>th</sup> right ribs (Sk. 119)

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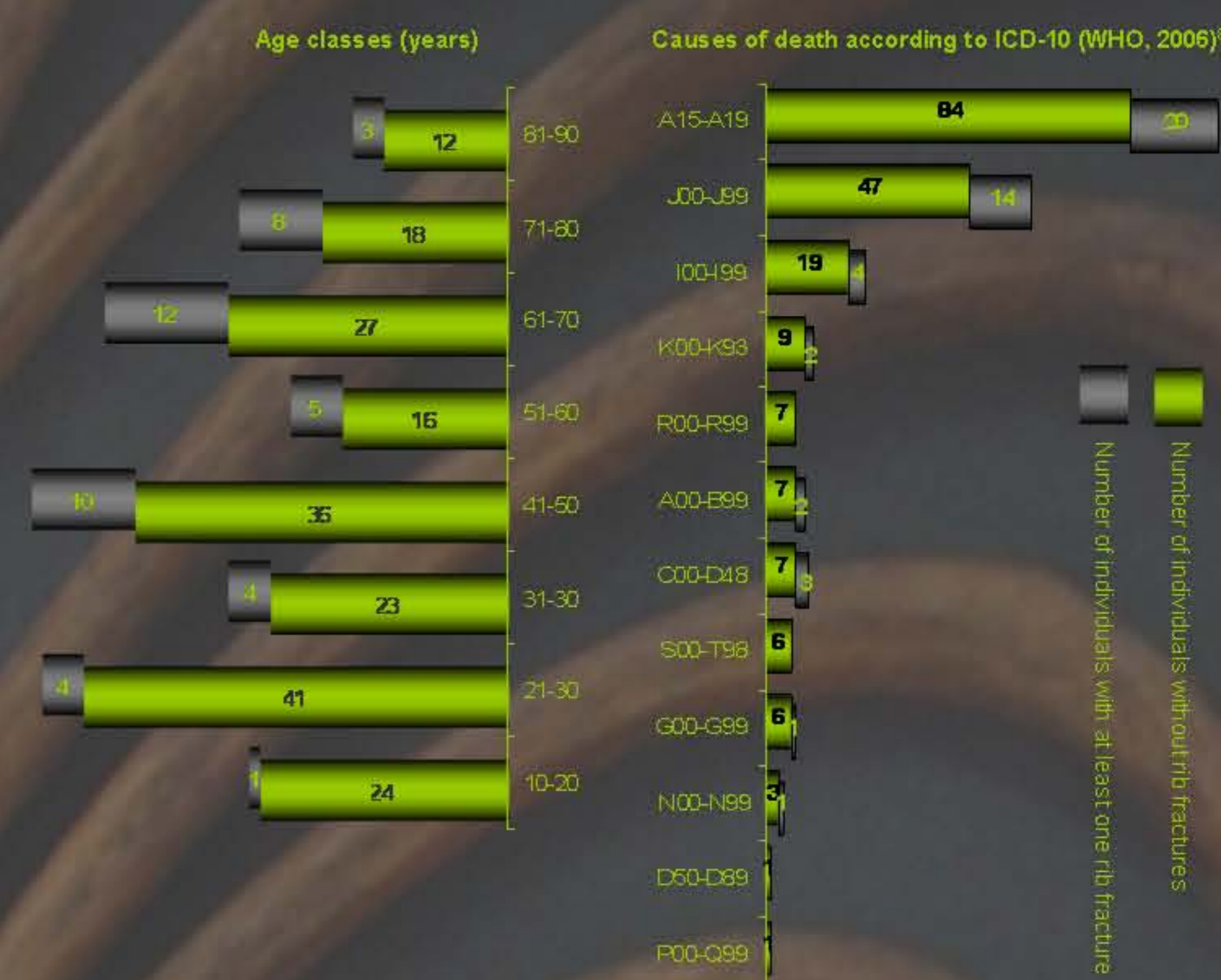


Figure 1 – Age distribution (left) and grouped causes of death (right) of the sample.

Legend for cause of death codes according to ICD-10 classification (WHO, 2006):

Pulmonary TB (A15-A19), Respiratory system (J00-J99), Heart and circulatory diseases (I00-I99), Digestive system (K00-K93), General symptoms and signs or unknown cause of death (R00-R99), Certain infectious and parasitic diseases (TB excluded) (A00-B99), Neoplasms (C00-D48), Injury, poisoning and other consequences of external causes (S00-T88), Nervous system (G00-G99), Genitourinary system (N00-N99), Blood and blood-forming organs and certain disorders involving the immune mechanism (D50-D89), Pregnancy, childbirth and the puerperium (P00-Q99).

## STRESS FRACTURES and PULMONARY TB

Rib stress fractures can result from severe and prolonged coughing<sup>13,15,16</sup>. The present study doesn't show evidence of stress fractures in individuals who died from pulmonary TB.

## OTHER STRESS FRACTURES

**Skeleton 257: Epilepsy stated as the cause of death**

- Male, 42 years old, commerce employee.
- Bilateral involvement in the middle-lower rib cage.
- 7 ribs with fracture callus in different healing stages.
- 9<sup>th</sup> right rib shows two fractures in different healing stages.
- Pattern of fractures resulted probably from continuous and involuntary muscle contraction occurring in epileptic seizures.

## FRACTURES SECONDARY TO PATHOLOGY

**Skeleton 1106: Breast cancer as the cause of death**

- Female, 65 years old, housekeeper.
- 1<sup>st</sup> to 3<sup>rd</sup> left ribs fractured with striking bony callus that probably resulted from a direct force applied to the chest.
- Additionally, it is suggested that those fractures are pathological ones. These occurs when bone structural integrity is compromised by a local pathological process<sup>9</sup> such as neoplasms.