

# DISH

# Diffuse Idiopathic Skeletal Hyperostosis:

paleoepidemiological profile on the Modern Identified Skeletal Collection from the Museu Bocage, Portugal

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DISH is a chronic disorder, characterized by bone proliferation with predilection for the axial skeleton, although appendicular entheses may be involved<sup>(1)</sup>. It is commonly reported as an older age-related phenomenon and prevailing in males<sup>(1-3)</sup>. There is scarcity of epidemiological survey at population level, with varying prevalence reports<sup>(1-6)</sup>. Ongoing debate focus on the interplay between metabolic/endocrine (e.g. diabetes mellitus, obesity, growth hormone levels, hyperuricemia), cardio and cerebrovascular diseases, genetic, environmental and life style risk factors on its pathogenesis, persisting with unknown etiology<sup>(1,2,7-17)</sup>.

**AIMS:** - Portray DISH paleoepidemiological profile in a large sample of identified skeletons  
- To evaluate DISH distribution by major groups of cause of death and occupation

## STUDY-BASE

Human Identified Skeletal Collection of the Museu Bocage (NMNH, Lisbon), late 19<sup>th</sup> - mid 20<sup>th</sup> century:

Urban sample from low to middle socioeconomic strata of Lisbon inhabitants<sup>(18)</sup>

Biographical data available for individuals (e.g. occupation, age, date and cause of death)

514 adult skeletons (similar proportion of males= 239 [46.5%] and females= 275 [53.5%] [p=0.112])

Age at death range: 20-98 years (Mean/SD: Total= 61.6/18.4; ♂= 57.8/17.2; ♀= 64.9/18.8 [p< 0.001])

73% of the skeletons with complete vertebral column; 96% with complete thoracic segment

## INTRODUCTION

## METHODOLOGY

**Sample selection:**

Complete biographical records; ≥ 20 years old; Vertebral region preserved [ranging from 60%-100%]

**Dish cases:**

Diagnosed accordingly to Rogers & Waldron (2001) criteria<sup>(10)</sup>

**Occupation:**

Coded by the national classification (CNP-94)<sup>(19)</sup>; Subsequently allocated in 2 major groups based on presumed heaviness of work (ambiguous or unspecific occupations excluded: e.g. housekeeper):

**Group A** – Allude to less demanding physical work [Combined: Administration/services, Army/security forces, Intellectual/scientific specialists, land or business owners and clergymen]

**Group B** – Allude to demanding physical work [skilled and unskilled workers, artisans, similar]

**Causes of death on the biographical records:**

Coded by the WHO<sup>(20)</sup> International Classification of Diseases (ICD-10) and analyzed by major groups

**Statistical analysis:**

Chi-square tests ( $\chi^2$ ), Mann-Whitney (U), OR (odds ratio), 95% CI (confidence interval), Significance when p< 0.05

## RESULTS

### DISH EPIDEMIOLOGY

-DISH crude prevalence rate: 8.8% [45/514] (Table 1)

-Males 2 times more affected than females (p= 0.04; OR= 2.01, 95% CI= 1.073-3.779) (Table 1)

-Prevalence increases significantly with age ( $\chi^2$  for the trend= 8.222, df= 7; p= 0.004):

by a 2.52 factor per age group (OR= 2.55, 95% CI= 1.32-4.79) (Table 1)

-No differences between the mean age of death between males and females (Table 1)

### CAUSE OF DEATH

-DISH was present in 10 out of the 14 major ICD-10 groups of cause of death represented (Fig. 1)

-Significance was solely found for *Diseases of the circulatory system* (I00-I99) and *Certain infectious and parasitic diseases* (A00-B99) ICD-10 groups. The odd of having DISH was 1.84 higher for circulatory system diseases and, inversely, a rare comorbidity between DISH and *Certain infectious and parasitic diseases* (Figure 1). Yet, this last group comprises a unique DISH case, a 59 years-old female who died from typhoid fever

-None of the 6 skeletons within *Endocrine, nutritional and metabolic diseases* (ICD-10 - E00-E90), whose cause of death was diabetes, matched the criteria for DISH



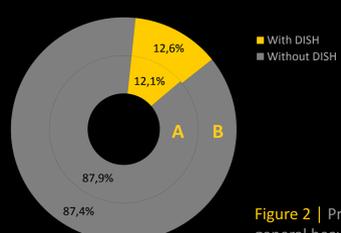
**FIGURE 1** | Distribution of the 45 individuals with DISH by major groups of cause of death coded by the ICD-10 (WHO, 2006)<sup>(20)</sup>

Legend for cause of death codes according to ICD-10 classification (WHO, 2006)<sup>(20)</sup>:

(AB) Certain infectious and parasitic diseases (A00-B99); (CD) Neoplasms (C00-D48); (D) Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism (D50-D89); (E) Endocrine, nutritional and metabolic diseases (E00-E90); (F) Mental and behavioural disorders (F00-F99); (G) Diseases of the nervous system (G00-G99); (I) Diseases of the circulatory system (I00-I99); (J) Diseases of the respiratory system (J00-J99); (K) Diseases of the digestive system (K00-K93); (M) Diseases of the musculoskeletal system and connective tissue (M00-M99); (N) Diseases of the genitourinary system (N00-N99); (O) Pregnancy, childbirth and the puerperium (O00-O99); (R) Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99); (ST/VY) Injury, poisoning and certain other consequences of external causes/ External causes of morbidity and mortality (S00-T98/V01-Y98)

### OCCUPATION

-DISH and heaviness of workload were not significantly associated (Figure 2):



**Group A** - low workload: 12.1% [12/99]

**Group B** - high workload: 12.6% [13/103]

(p= 1.000; OR= 1.047 [95.0% CI: 0.453-2.421])

**Figure 2** | Prevalence of DISH in the 2 major groups of occupation, distinct in general heaviness of workload (n= 202 [A – low workload; B – high workload])

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**Table 1** | Sex and age-specific prevalence rates (%) of DISH

Age at death group (years)	DISH prevalence rates (% [n/N])			p value
	Total	Male	Female	
20-29	2.5 [1/40]	0.0 [0/17]	4.3 [1/23]	-
30-39	0.0 [0/30]	0.0 [0/17]	0.0 [0/13]	-
40-49	1.9 [1/53]	2.4 [1/41]	0.0 [0/12]	-
50-59	8.3 [8/96]	9.3 [5/54]	7.1 [3/42]	1.000 <sup>a</sup>
60-69	11.5 [10/87]	17.5 [7/40]	6.4 [3/47]	0.176 <sup>b</sup>
70-79	12.9 [15/116]	19.5 [8/41]	9.3 [7/75]	0.203 <sup>b</sup>
80-89	12.0 [10/83]	24.1 [7/29]	5.6 [3/54]	0.029 <sup>b</sup>
≥ 90	0.0 [0/9]	0.0 [0/0]	0.0 [0/9]	-
Total	8.8 [45/514]	11.7 [28/239]	6.2 [17/275]	0.040 <sup>c</sup>
Mean [SD]	69.4 [12.6]	69.6 [11.5]	69.0 [4.7]	0.870 <sup>c</sup>

N=individuals observed in each group; n= number of DISH cases; SD= standard deviation (years); <sup>a</sup> $\chi^2$  test (continuity correction); <sup>b</sup>Fisher's exact test; <sup>c</sup>Mann-Whitney test

## DISCUSSION AND CONCLUSIONS

### GENERAL EPIDEMIOLOGY

-In this study the epidemiological profile of DISH, with male preponderance and tendency to increase with age, is compliant with previous clinical and paleopathological reports<sup>(e.g. 2-5,8,10,15,21,22)</sup>

-The overall prevalence (8.8%) can serve as a prediction of the living group, since DISH do not contribute directly to death, as suggested by Waldron (2007)<sup>(23)</sup>. This large and very well preserved sample allows more reliable comparisons:

**Clinical:** Our frequency is similar to 6% and 12% on autopsy specimens<sup>(24,25)</sup> and to 9.8% in a clinical-base study<sup>(26)</sup>. It differs from: 2.8%<sup>(2)</sup>, 2.9%<sup>(5)</sup>, 19.8%<sup>(4)</sup>, in general population surveys, and 17.0% in an outpatient sample<sup>(6)</sup>. In sum, our prevalence is within the range of modern studies

**Paleopathology:** A broad range of DISH prevalences is published, from 1.5% to 40.4%<sup>(27,28)</sup>, with a note worthy 100% in a Dutch clergymen sample<sup>(27)</sup>

-The 8.8% in our low/medium socioeconomic strata sample, does not markedly differ from archaeological reports of high social status individuals, e.g. 8.6%<sup>(22)</sup>, 11.5%<sup>(10)</sup>, 12.5%<sup>(21)</sup>, 13.3%<sup>(10)</sup>. Inversely, diverge from similar unprivileged samples, e.g. 25%<sup>(29)</sup> and 34%<sup>(30)</sup> respectively in the Hamman-Todd and Coimbra identified collections. These comparative data emphasize the need for caution when inferring DISH as an indicator of social status<sup>(14,31)</sup>

### CAUSE OF DEATH

When DISH and causes of death were scrutinized **two main findings** were obtained:

-Since early clinical works on DISH, diabetes has been suggested as an important risk factor<sup>(9,7,11,15,16)</sup>, yet without raising consensus<sup>(12,32,24,25)</sup>. This relation was not sustained in our study, analogously to recent clinical research that showed a frailty on this association<sup>(revised by 12)</sup>. Nonetheless, it should not be disregarded the bias of sample size (n=6) for diabetes in our collection, that constrains inferences

-The strong comorbidity of DISH and *Diseases of the circulatory system* constitutes a paleopathological finding with relevant clinical interest, corroborating recent evidence on the higher risk of cardio and cerebrovascular morbidity in DISH patients<sup>(9,13,15,17,26)</sup>. However, it remains unclear whether this is a direct or indirect relation, as other DISH predisposing factors (see introduction) are also risk factors for circulatory diseases<sup>(9,13,15,17,26)</sup>

### OCCUPATION

-On the present work, and like Julkunen et al. (1971)<sup>(2)</sup> study, was not demonstrated a relation between demanding physical occupations and higher percentage of DISH as postulated by Pappone et al. (1996)<sup>(8)</sup>

Questions around DISH etiology and comorbidity still remains and paleopathological research has the potential to contribute to future advances on the understanding of this entity

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