

PRELIMINARY ANALYSIS OF A SET OF SELECTED DENTAL NON-METRIC TRAITS AMONGST SOUTHERN JORDANIANS

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ABSTRACT

The study was done to determine the expression frequency and sexual dimorphism of five dental morphological traits on the permanent dentitions of those living in South Jordanians.

Dental stone casts for the dentitions of 380 adult Jordanians (196 females, 184 males; age range = 16-22, mean ages 18.2, St.d = 2.3 years) were studied in 2017. The traits were classified using the Arizona State University dental anthropology system, counted with the individual count method, and dichotomized according to the criteria of Scott & Turner for the purpose of group comparisons. Fisher's exact test for dichotomized scores was used to assess sexual dimorphism in these traits.

Statistically significant sexual dimorphism was found in three out of the five traits: Carabelli's tubercle / cusp and cusp 5 (metaconule) on UM1 in favor of females, and hypoconulid absence (4-cusped form) on LM1 in favor of males. The expression frequencies of four out of the five traits examined were different from the other non-Middle Eastern Western Eurasian groups, and the differences were in the direction of more trait manifestations amongst the Jordanian group.

It was concluded that the dental morphological pattern of South Jordanians showed more trait elaboration than that of non-Middle Eastern Western Eurasian groups.

Keywords: Dental morphological pattern, sexual dimorphism, Carabelli's tubercle / cusp, metaconule, hypoconulid absence

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INTRODUCTION

The study of non-metric (morphological) traits of teeth has been widely used to address questions related to archeology, modern human variations and paleoanthropology (Gomez-Robles et al., 2013; Guatelli-Steinberg et al., 2013; Hanihara, 2008; Irish, 2016; Irish & Scott 2016; Scott, 1980; Scott et al. 2018; Scott & Irish, 2017; Scott & Turner, 1997).¹⁻⁹ Furthermore,

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dental morphology can be utilized as a data source for phonetic/biological distance analyses in both forensic anthropology and bioarchaeology (Irish, 2016; Irish & Scott 2016; Scott et al. 2018; Scott & Irish 2017; Pilloud et al., 2016).^{4,5,7,8,10} Dental non-metric traits have been utilized for many years as essential tools to quantify the biological relations between populations (Irish, 2016; Irish & Scott 2016; Scott et al. 2018; Scott & Irish, 2017; Scott & Turner, 1997).^{4,5,7-9} Dental morphological traits are suitable for measuring population distances as they are chiefly under genetic control and negligibly influenced by environmental factors (Scott et al. 2018; Scott & Irish, 2017; Corruccini et al., 1986; Dahlberg, 1986; Scott & Dahlberg, 1982).^{7,8,11-13} Sex and age have less effect on teeth than other skeletal components because after their growth is accomplished, they endure no further alterations in size and form apart from wear, traumas, and cultural modifications. Therefore, they offer an exceptional model in studies of development (Scott et al. 2018; Scott & Irish, 2017; Riga et al., 2014).^{7,8,14}

Many scholars have examined male-female differ-

ences in dental morphological traits, and the findings are not always consistent and seem to exhibit geographic variations between various populations. However, the distal accessory ridge of the upper and lower canines show consistent sexual dimorphism across diverse geographic groups (Scott et al. 2018; Deepa et al. 2017; Kaul & Prakash, 1981; Kieser & Preston, 1981; Scott, 1977; Scott et al., 1983).^{7,15-19} This trait aside, some scholars reported significant differences between sexes in the expression of some dental traits such as Carabelli trait (Kaul & Prakash, 1981; Kieser & Preston, 1981; Scott et al., 1983; Goose & Lee, 1971; Mizoguchi, 1985; Townsend & Brown, 1981)^{16,17,19-22} and shoveling of the upper central incisor (Harris, 1980; Rothhammer et al., 1968).^{23,24} Others scholars reported no male-female differences for the Carabelli trait (Scott, 1980; Garn et al., 1966; Townsend et al., 1992; Turner, 1969).²⁵⁻²⁷ and the shoveling trait (Mizoguchi, 1985; Aas & Risnes 1979).^{21,28}

The aim of the present study was to investigate the frequencies and sexual dimorphism of five dental morphological traits that are observable on upper and lower first molars on dental stone casts of the permanent dentition of the living Jordanian Arabs, and are among the standard dental traits used for population comparisons.

MATERIALS AND METHODS

Sample and technique

This retrospective study was performed at Prince Ali Bin Al- Hussain Military Hospital in Al-Karak (South of Jordan), where the Higher Research and Ethical Committee of Royal Medical Services approved it. The sample of the study was a part of a random sample attained in 2017 by choosing 760 maxillary and mandibular dental stone casts of the permanent teeth of 380 Jordanians (196 females and 184 males). The dental impressions were taken for clinical purposes and a consent form was signed by every patient or person with parental responsibility. It is worth-mentioning that the Dental Department at Prince Ali Bin Al- Hussain Military Hospital is one of the key referral centers for advanced and complex dental treatment in the South of Jordan, where about 300 thousand people live, according to the 2015 Population and Housing Census done by the Department of Statistics in Jordan. Besides, it is worth-mentioning that the clinical treatment at this center, although more expensive, is available to all referred patients regardless of their socio-economic status and this is primarily because all the costs are sponsored by the royal fund. Therefore, even the poverty-stricken individuals who live in Al- karak are well-informed about it, and have access to this dental care center. Consequently, the authors contemplate that the sample of the study was representative of the living South Jordanian population. In this regard,

it is worth-mentioning that it is important in similar studies, which assess dental morphological traits, to warrant that the used sample should include participants that are from a broad spectrum of socio-economic background to augment the representativeness of the sample to the population being assessed.

The range of ages for the selected participants was from 16 to 22 years (standard deviation = 2.3), and the average age was 18.2 years. Only those subjects who satisfied the following inclusion criteria were incorporated in the sample; a) Healthy with no history of severe illnesses that could be detrimental to dental development, b) No congenital or hereditary diseases, c) Had fully emerged second molars, d) No crooked dental arches with no hyperdontia, and dental malformation e). No large restorations or fixed prosthodontics, and minimal signs of decay and/or attrition on the teeth utilized for examining the traits considered. Medical and dental records were inspected for each participant to reinforce the accuracy of the inclusion criteria. Informed written consent was obtained from each participant or from his legal guardian who voluntarily chose to be included in the study. Suitable ethical approval for this kind of study was attained from the authorized committee, the Ethical Committee of Royal Medical Services, prior to beginning the study.

Observation method

Five dental non-metric traits (Table 1) were observed and classified according to the standard ranking of the Arizona State University dental anthropology system (Turner et al., 1991)²⁹, and dichotomized according to Scott and Turner's criteria for the sake of inter-population comparisons (Scott & Turner, 1997).⁹ The individual count method was used to evaluate the rate of expression of the traits considered (Scott & Turner, 1997).⁹

Intraobserver reliability

Scoring of the traits considered was done, deliberated and agreed on at the time by two well-trained observers. Intra-observer reliability for scoring these traits was gauged according to the criteria of Nichol & Turner criteria (1986).³⁰ 60 casts (30 upper and 30 lower) out of the total sample of 760 upper and lower casts were randomly picked to be scored in the same way by the same two observers, and rescored in the same way by the same observers three months later. The ratios of sexes in the original sample of 380 individuals (196 females and 184 males) were reflected in the sub-sample of 60 casts. Percentages of discordance that are of two grades or more between the two sessions of scoring (>1 Grade Variant Scoring %) were calculated for the traits considered. The critical value of this method is 10% according to Nichol & Turner (1986).³⁰

Moreover, the Net Mean Grade Difference between the two sessions of scoring was calculated for the traits considered by the following formula: Net Mean Grade Difference = $(\frac{(X2-X1)}{n}) \times 100$, where X1 = the grade given for a trait on a cast in the first session of scoring; X2 = the grade given for the same trait on the same cast in the second session of scoring; and n = the number of casts that were scored in both of sessions. According to Nichol & Turner (1986), the critical value of Net Mean Grade Difference for each trait is > 5% multiplied by the highest possible grade on the standard plaque for that trait.³⁰

Statistical analysis

Rates of expression were calculated for the traits considered and these rates were dichotomized according to Scott & Turner's criteria (1997) for the sake of quantifying the relative occurrence of these traits among the living South Jordanian sample in comparison to other population groups. Statistical differences between rates of expression were assessed by Fisher's exact test for dichotomized scores (SPSS, Version 17.0, Inc., Chicago, IL) because the scores of dental non-metric traits are not proven to be normally distributed. The 0.05 level was used to determine statistical significance.

RESULTS

The percentages of disagreements between the two sessions of scoring (>1 Grade Variant Scoring %) for all the traits considered were found less than 10%. Also, the value of the Net Mean Grade Difference for each trait considered was found to be less than the critical value for the trait. These values show the scoring the traits considered is reliable, and that the intra-observer error is insignificant.

Table 1 shows the rates of expression of 5 non-metric dental traits, on the permanent teeth in both males and females among the living South Jordanian sample. By comparing the rates of expression of the 5 traits among this sample with the world ranges of these traits, it is obvious that the dental pattern of the living South Jordanians exhibits high rates of expression for Carabelli's tubercle and cusp forms, and cusp 5 (metaconule) on upper first molars (UM1); intermediate rates of expression of cusp 6 (tuberculum sextum) and cusp 7 on lower first molars (LM1); and low rates of expression for LM1 hypoconulid absence (4-cusped form).

Statistically significant male-female differences were found in three out of the five traits considered. These traits are Carabelli's tubercle/cusp and cusp 5 on UM1, and LM1 hypoconulid absence (4-cusped form). The first two traits exhibit higher rates of expression in males, meanwhile the third trait shows higher rate of expression in females (Table 1).

TABLE 1: FREQUENCIES OF FIVE DENTAL TRAITS AMONG THE LIVING JORDANIAN POPULATION (INDIVIDUAL COUNT, AFFECTED INDIVIDUALS/TOTAL NUMBER OF SUBJECTS IN PARENTHESES).

Trait name	Tooth observed	Break-point	World range (%)	Males (%)	Females (%)	P-value	Sexes pooled (%)
Carabelli's trait	UM1	Grades 5-7	1.9	48.4 (89/184)	36.2 (71/196)	0.036*	42.1 (160/380)
Cusp 5	UM1	Grades 1-5	10.4	70.1 (129/184)	59.2 (116/196)	0.042*	64.4 (245/380)
4-cusped	LM1	Grade 0	0.0	1.6 (3/184)	4.1 (8/196)	0.023*	2.9 (11/380)
Cusp 6	LM1	Grade 1-5	4.7	15.2 (28/184)	19.4 (38/196)	0.621	17.4 (66/380)
Cusp 7	LM1	Grade 1-4	3.1	21.7 (40/184)	15.8 (31/196)	0.874	18.7 (71/380)

* The difference is statistically significant at the 0.05 probability level (2-tailed).

Abbreviations: UM1, upper first molar; LM1, lower first molar.

DISCUSSION

Male-female difference among the living South Jordanians was found to be statistically significant in three out of the five dental traits described: Carabelli's tubercle/cusp and cusp 5 on UM1 in favour of males, and hypoconulid absence (4-cusped form) on LM1 in favour of females. Many investigators found significant differences between sexes in the expression of Carabelli's trait (Kaul & Prakash, 1981; Kieser & Preston, 1981; Scott et al., 1983; Goose & Lee, 1971; Mizoguchi, 1985; Townsend & Brown, 1981).^{16,17,19-22} Meanwhile, others found no male-female differences for this trait (Scott, 1980; Garn et al., 1966; Townsend et al., 1992; Turner, 1969).^{6,25,27} Besides, Turner syndrome (XO or 45,X) patients were found to have less incidences and expressions of the LM1 hypoconulid, and UM1 Carabelli's trait than their relatives (Kirveskari & Alvesalo, 1982).³¹ Though not well-confirmed and not always consistent across diverse world populations, it seems that there is a tendency toward morphological simplification of the crown non-metric traits in females comprising not only auxiliary tubercles and cusps such as Carabelli's trait and cusp 5 on UM1; but also major cusps of molar teeth such as the LM1 hypoconulid. These results propose a role for the X chromosome in supporting morphological reduction of the tooth crown in females and that such effect is likely opposed by the Y chromosome.

The findings of this research were compared to the dental morphological pattern of the Western Eurasian category including three major non-Middle Eastern subcategories (North Africa, Western Europe and Northern Europe). This comparison revealed that the living South Jordanians have high frequencies of Carabelli's tubercle and cusp forms, and cusp 5 (metaconule) on UM1; intermediate frequencies of cusp 6 (tuberculum sextum) and cusp 7 on LM1; and low frequency hypoconulid absence (4-cusped form) on LM1. In addition, the South Jordanian dental pattern appears to be distinct from the most common Western Eurasian dental pattern (as observed in Western Europeans, Northern Europeans, and North Africans), as South Jordanians show relatively higher frequencies of Carabelli's tubercle/cusp and cusp 5 on UM1, and of cusp 6 and cusp 7 on LM1; and distinctly lower frequency of hypoconulid absence (4-cusped form) on LM1 (Scott & Turner, 1997).⁹ In summary, the dental morphological pattern of living South Jordanian Arab seems to exhibit more trait complexity than that of most Western Eurasians, which is regarded by many workers to be characterized more by trait scarcity or nonexistence (Scott et al. 2018; Scott & Turner, 1997; Mayhall et al., 1982).^{7,9,32}

CONCLUSIONS

The present research showed that the expression frequencies of the five dental morphological traits examined amongst the living South Jordanians are in the direction of more trait complexity when compared with the non-Middle Eastern Western Eurasian groups who were reported to be distinguished by trait by trait scarcity or nonexistence. Statistically significant male-female differences were found in the incidence of three out of the five dental traits studied in the living South Jordanian Arab population, and they are all in the direction of morphological reduction of the tooth crown in females.

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CONTRIBUTIONS BY AUTHORS
All authors contributed substantially