# A SURVEY ON THE OCCLUSAL MORPHOLOGY OF PREMOLARS IN A SAMPLE OF EGYPTIAN POPULATION

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### ABSTRACT

Major and minor differences of dental morphology among populations have a significant impact on anthropological, forensic research and dentists as well. Hence in this study we aimed at surveying various presented external morphologies of maxillary and mandibular premolars in an Egyptian population sample, regarding the analysis of occlusal pattern and occlusal outline. Two hundred healthy premolars were collected from archived teeth, fifty of each type of premolars. Then classified according to Arizona State University-Dento-anthropological System (ASUDAS) for occlusal pattern and traced for occlusal outline. We found that few accessory cusps were observed in surveyed maxillary premolars. However, an accessory lingual cusp was detected among some of the surveyed teeth in mandibular premolars. Different occlusal outlines were recorded and tabulated. Therefore, it was concluded that Presence of mesial accessory cusp had a higher prevalence in maxillary first premolar, while two lingual cusps in mandibular second premolars were the most common. Regarding occlusal outline the hexagonal outline was dominating in upper first premolar while the oval was dominating in upper second. for lower premolars, the lower first premolars were diamond and the lower second premolars were rounded and square.

**KEYWORDS**: occlusal morphology, maxillary premolars, mandibular premolars, occlusal outline, ASUDAS classification, accessory cusp.

## INTRODUCTION

Differences in tooth form and dimension among human populations are due to differential growth rates **(Kraus and Jordan., 1965),** suggested that there are time-related and rate of growth differences between the differentiation of cusps and ridges (soft and hard tissue differentiation). Moreover, the size and the position of the crown are genetically controlled, especially in the growth and development stage. This illustrates that dental characteristic like size, shape, presence, number, the pattern of cusps, and the size of the dental arches are genetically controlled and such characteristics vary

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among races and species due to natural selection and genetic changes.

Many dental morphological variations were recorded to differentiate specific species from others. Particularly, the occlusal anatomy of the posterior teeth which represents a dental phenotype that was called species-specific **(Moss et al., 1967).**

**(Turner., 1967, Scott., 1973 and Hillson., 1996)** divided the dental morphological variations into two categories. Firstly, the major variations: these involved the dental structure itself and abnormality in tooth morphology. Secondly, minor variations in the tooth crown or root.

A study of dental anatomy in the sense of external and internal morphology of the various teeth in the human dentition which includes shape, structure, root morphology, function of the teeth, and their relation to each other in the same or contralateral sides. This would help in proper dental treatment **(Ash and Nelson., 2010).**

Maxillary premolars have one common occlusal outline this may be an oval or rectangular crown outline and greater buccolingually than mesiodistally **(Robert and Biggerstaff, 1969).**

The buccal and lingual cusps of the maxillary premolars are separated by a sagittal sulcus. At either the mesial or distal margin of this sulcus, a small accessory cusp or tubercle may be present **(Carlsen, 1987).**

On the other hand, the occlusal morphology of mandibular premolars may be molar formed having three primary cusps or they may be two-cusped having an H-shaped or U-shaped groove configuration. The first mandibular premolars are usually a bicuspid type with a lingual surface presenting a variety of forms and a central groove placed lingually. However, second premolars have two forms bicuspid or tricuspid **(Robert and Biggerstaff., 1969).**

The mandibular premolar may have no lingual cusp or with multiple lingual cusps that are always smaller than the buccal cusps, this lingual cusp has a mesial placement relative to the buccal cusps **(Scott., 1973).**

The study of dental morphological features is important in anthropological research for identification of population and to be aware of teeth variations in crown or in root in different populations or within same population **(Amin et al., 2015).**

Current study aimed at evaluating the occlusal morphology of premolars of Egyptian populations. Our null hypothesis (m) is occlusal surfaces of premolars shows no accessory cusps and the occlusal of upper first premolar is hexagonal while that of upper second is oval, while the lower first premolars are diamond and the lower second premolars are either rounded or square.

## MATERIALS AND METHODS

### A- Materials

*Extracted teeth*

Two hundred premolar [maxillary first premolars (n=50), maxillary second premolars (n=50), mandibular first premolars (n=50) and mandibular second premolars (n=50)] were collected from oral surgery department, Faculty of dentistry Ain Shams University, different dental clinics, and different governmental hospitals in Egypt. Infection control guidelines were assured and examined for certain criteria.

*Inclusion criteria:*

1.  Partially intact crowns and fully developed apices.

2.  Acceptable attrition level.

*Exclusion criteria:*

1- Teeth with root canal fillings, posts, crown restorations, apical resorption, or fractured root, sever occlusal or proximal caries.

2- Teeth with severe attrition

**Sample size calculation**

A total number of 200 (50 in each group) is calculated using Epicalc program version 1.02 assuming a power of 80 % and alpha=0.05. the sample size is based on mean ±SD of prevalence of the two variants of mandibular second premolars in the Egyptian population. (0.35± 0.07) and (0.51 ± 0.12); respectively (Amin and Rabea, 2015).

**B) Methods**

**1) Occlusal morphology**

*a-occlusal pattern:*

The occlusal pattern was determined after tracing the grooves on the occlusal surface of extracted teeth using a graphite pencil, then the premolars were classified according to morphological triads of permanent teeth of Arizona State University-Dento-anthropological System (ASUDAS).

According to (ASUDAS) premolars were classified in to:

– According to the presence of accessory cusp in maxillary premolars: Classification A (Turner, 1967).

Grade 0: accessory cusp absent

Grade 1: well-defined mesial accessory cusp with palpable cusp tip

Grade 2: well-defined distal accessory cusp with palpable cusp tip

Grade 3: well-defined mesial and distal accessory cusps with palpable cusp tip.

According to number of lingual cusps in mandibular premolars: Classification B (Scott,1973)

Grade 0: lingual cusp has no free apex

Grade 1: single lingual cusp

Grade 2: two lingual cusps

Grade 3: three lingual cusps

*b- Occlusal outline:*

The occlusal outline was traced on the borders of extracted teeth by taking Photographs for them and importing these photos into the computer. All premolars occlusal outline were classified into

1- Oval outline.

2- Rectangular (lingual to buccal ridge) or Pentagonal

3- Hexagonal outline

4- Square (lingual to buccal ridge) or Pentagonal

5- Rounded outline

6- Diamond outline

**Statistical analysis**

Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

Chi-square (x2) test of significance was used to compare proportions between qualitative parameters. P-value <0.05 was considered significant. However, P-value >0.05 was considered insignificant.

**RESULTS**

**Occlusal morphology**

*A- Occlusal pattern*

Regarding Classification A for maxillary premolars (presence of accessory cusp)

Firstly, in maxillary first premolar; the Absence of accessory cusp (grade 0) was the most common pattern in maxillary first premolar (72%). followed by grade 1 (16%) with a mesial accessory cusp, then grade 3 (8%) with a mesial and distal accessory cusp and the little percentage of grade 2 with distal accessory cusps (4%).Fig (1)

Secondly, in maxillary second premolar; grade 0 was the most common pattern (88%) and with a small percentage for the rest of grades. 6% for grade 1, 4% for grade 2 and 2% for grade 3. Fig (2)

Comparing the occlusal pattern of two maxillary premolars showed no statistically significant difference. Table (1) chart (1)
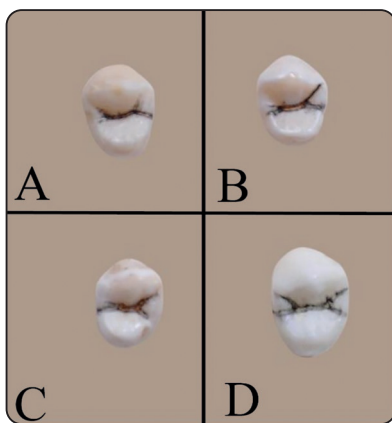


Fig (1) A: maxillary first premolar with grade 0 (absence of accessory cusps) B: maxillary first premolar with grade 1 (well defined mesial accessory cusp). C: maxillary first premolar with grade 2 (well defined distal accessory cusp). D: maxillary first premolar with grade 3 (well defined mesial and distal accessory cusp)
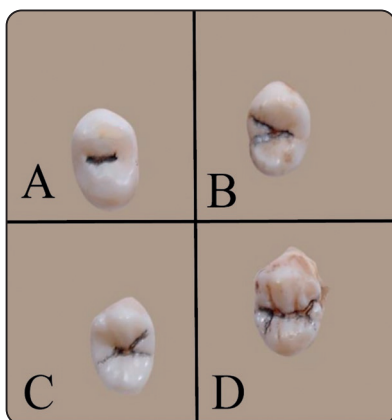


Fig (2) A: maxillary second premolar with grade 0 (absence of accessory cusp). B: maxillary second premolar with grade 1 (well-developed mesial cusp). C: maxillary first premolar with grade 2 (well defined distal accessory cusp). D: maxillary first premolar with grade 3 (well defined mesial and distal accessory cusp)

TABLE (1) Table showing occlusal pattern of maxillary premolars according to ASUDAS

| Occlusal pattern | Maxillary 1st (n=50) | Maxillary 2nd (n=50) | x2 | p-value |
|---|---|---|---|---|
| **Grade0** | 36 (72.0%) | 44 (88.0%) | 3.063 | 0.081 |
| **Grade1** | 8 (16.0%) | 3 (6.0%) | 1.634 | 0.201 |
| **Grade2** | 2 (4.0%) | 2 (4.0%) | 0.000 | 1.000 |
| **Grade3** | 4 (8.0%) | 1 (2.0%) | 0.842 | 0.359 |

*$x^2$: Chi-square test; p-value>0.05 NS.*

This table shows no statistically significant difference between Upper 4 and Upper 5 according to occlusal pattern.
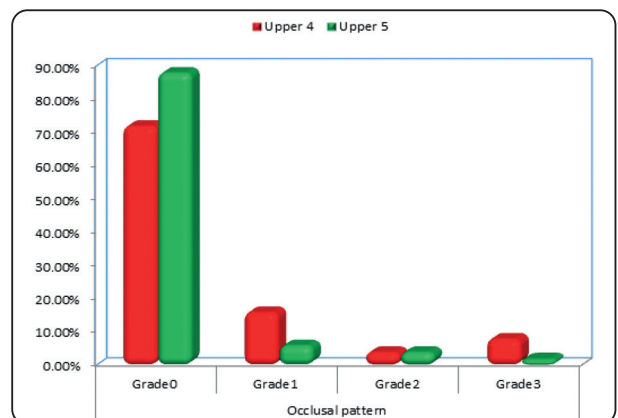


Chart (1) represents occlusal pattern of maxillary premolars Upper 4 refers maxillary first premolar, upper 5 refers to maxillary second premolar

Regarding Classification B for mandibular premolars (number of lingual cusps).

- The mandibular first premolars; showed 70% of grade 1 (with one lingual cusp) as a most common occlusal pattern. Followed by 22% of grade 2 and with equivalent percentage of grade 0 and 3 (4%). Fig (4)

- The mandibular second premolar; the common occlusal pattern of mandibular second premolars were grade 1 with percentage (54%), followed by the second common pattern was grade 2 (44%). A small percentage of grade 3 about (2%), and no incidence of grade 0 (0%). Fig(5).
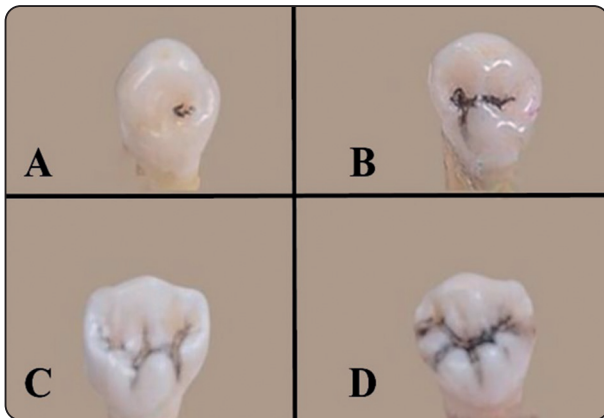
Fig (3) A: mandibular first premolar with grade 0 (no lingual cusp). B: mandibular first premolar with grade 1 (one lingual cusp C: mandibular first premolar with grade 2 (two lingual cusps). D: mandibular first premolar with grade 3 (three lingual cusps)
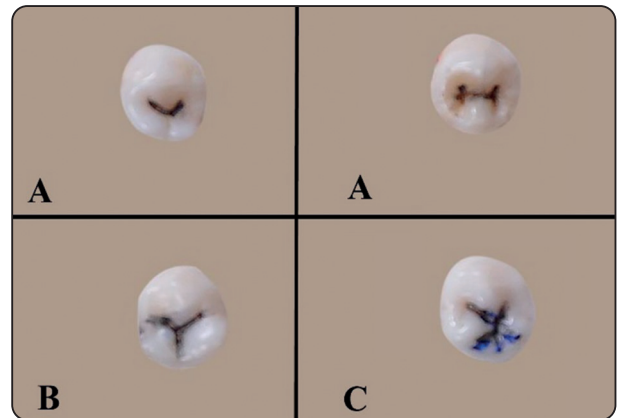


Fig (4) A: mandibular second premolar with grade 1 (one lingual cusp) B: mandibular second premolar with grade 2 (two lingual cusp) C: mandibular second premolar with grade 3 (three lingual cusps)

Comparing the occlusal pattern of two mandibular premolars showed a statistically significant difference in grade 2 table (2), chart (2).

TABLE (2) table showing occlusal pattern of mandibular premolars according to ASUDAS

| Occlusal pattern | Mandibular 1st(n=50) | Mandibular 2nd (n=50) | x2 | p-value |
|---|---|---|---|---|
| **Grade0** | 2 (4.0%) | 0 (0.0%) | 0.510 | 0.475 |
| **Grade1** | 35 (70.0%) | 27 (54.0%) | 2.080 | 0.149 |
| **Grade2** | 11 (22.0%) | 23 (46.0%) | 5.392 | 0.021* |
| **Grade3** | 2 (4.0%) | 0 (0.0%) | 0.510 | 0.475 |

*$x^2$: Chi-square test; p-value>0.05 NS.*

This table shows statistically significant difference at grade 2.

**B- Occlusal outline:**

***Occlusal outline of maxillary premolars:***

There were three forms of outlines was detected related to maxillary premolars. Hexagon, oval and rectangle.

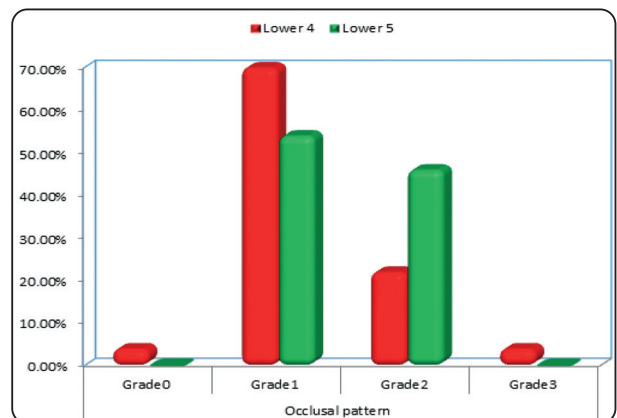The maxillary first premolars showed 60% of hexagonal outline which was the most common



Chart (2) represents occlusal pattern of mandibular premolars lower 4 refers mandibular first premolar, lower 5 refers to mandibular second premolar

outline. Followed by 28% of rectangular outline and 12% oval outline fig (5).

In case of maxillary second premolars, 70% of oval outline was the most common outline .24% were hexagonal outline and 6% for rectangular outline fig (6).

Table (3) and chart (3) demonstrated that there is a significant difference between two maxillary premolars regarding the three occlusal outline forms.
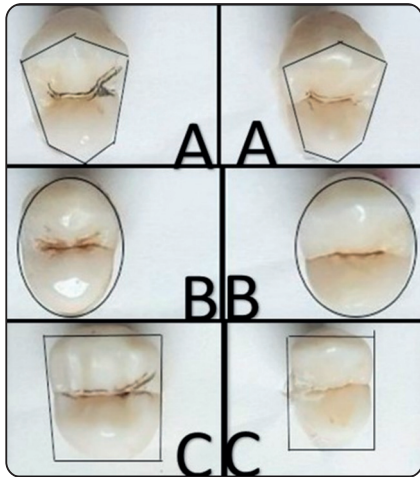
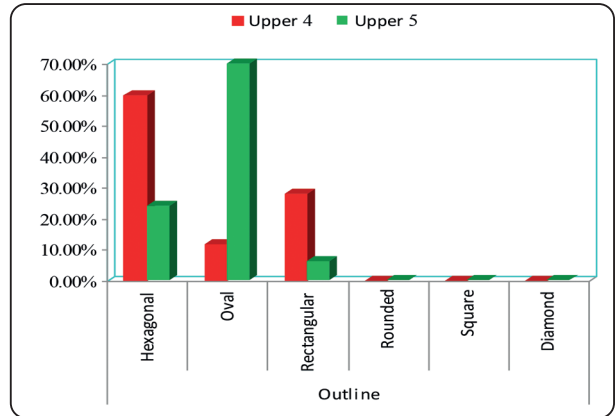Fig (5): Outline of maxillary first premolar A-Hexagonal B-Oval C- Rectangular


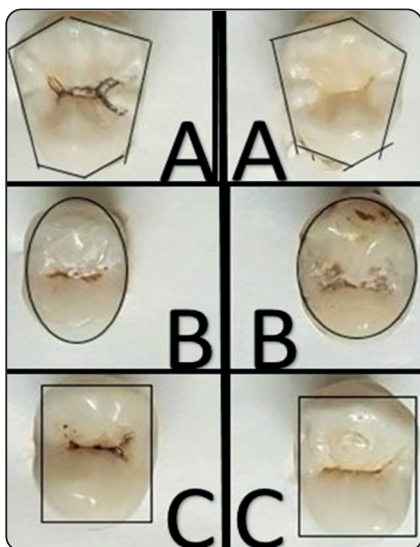
Fig (6): Outline of upper second premolar A- Hexagonal  B-Oval  C – Rectangle

Table (3) Table showing the percentage of each premolars regarding occlusal outline and demonstrating that there was statistically significant difference between them using

| Outline | Upper 4 (n=50) | Upper 5 (n=50) | x2 | p-value |
|---|---|---|---|---|
| **Hexagonal** | 30 (60.0%) | 12 (24.0%) | 11.864 | 0.006* |
| **Oval** | 6 (12.0%) | 35 (70.0%) | 32.410 | <0.001** |
| **Rectangular** | 14 (28.0%) | 3 (6.0%) | 7.087 | 0.008* |

*$x^2$: Chi-square test*
**P-value>0.05 NS; *p-value <0.05 S; **p-value <0.001 HS**



Chart (3) Bar chart showing the occlusal outline of maxillary premolars

*Occlusal outline of mandibular premolars:*

In case of mandibular premolars, table (4). They showed another three forms differ than the maxillary premolars. The whole sample of mandibular first premolars was diamond outline (100%) as shown in (fig 7), but in mandibular second premolars showing two types of occlusal outline as 70% was rounded outline and 30% was square outline (lingual to the buccal ridge) or pentagonal fig (8)

There is no comparison between lowers premolars regarding occlusal outline as they didn't have a common outline.
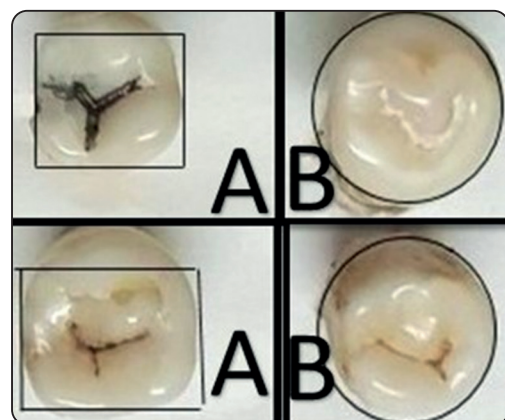


Fig (7) Showing occlusal outline of mandibular first premolar (diamond) A-Square   B- Rounded

Fig (8) showing occlusal outline of mandibular second premolar

TABLE (4) Showing the percentage of occlusal outline of mandibular premolars

| Outline | Lower 4 (n=50) | Lower 5 (n=50) |
|---|---|---|
| **Diamond** | 50 (100.0%) | 0 (0.0%) |
| **Square** | 0 (0.0%) | 15 (30.0%) |
| **Rounded** | 0 (0.0%) | 35 (70.0%) |

## DISCUSSION

It has been observed that there are variations of teeth in dentitions of different populations and races. There are a lot of factors that determine the tooth form as developmental process, genetic and environmental factors. The combination between these factors, determine the occlusal morphology (cusp number, occlusal pattern and occlusal outline). There are different occlusal Patterns for premolars with different numbers of cusps.
The occlusal pattern of the posterior teeth has been a matter of interest for dental anthropologists for a long time *(Hasund and Bang, 1985)*.

There is a little data about geographic distribution related to marginal accessory cusps of the maxillary premolars comprising part of the Arizona State University Dental Anthropology System *(ASUDAS; Turner et al., 1991), (Hanihara, 2008).*

Regarding maxillary first premolars, our results are quite compatible with investigations on American populations (15.9%).in north and South American Indian groups ranging between (3.4 and 7.7%). As the mesial accessory cusp of maxillary first premolar had the highest prevalence *(Turner 1985; Powell 1993; Cavalli-Sforza et al.,1994).*

*Bailey (2002)* noted that these cusps occurred in a high frequency in Neanderthals, especially on the first premolar, with higher frequency of distal accessory cusps than mesial one. Then, he compared them with modern humans and found that mesial accessory cusps had higher rates.

Moreover, **Hanihara`s** study **(2008),** found that East Asians exhibiting the highest frequencies of mesial accessory cusps on the maxillary first premolar while Micronesian and pacific populations have the highest frequencies on the maxillary second premolar.

Because of Genetic inheritance patterns and complex migration histories, there was difference in percentage at Australia and New Guinea. *(Scott and Schomberg, 2016)* found that mesial accessory cusp of maxillary first premolars at Australians were 5.4% and at New Guinea was 6.2%. However, the mesial accessory cusp of maxillary second premolars showed 15.1% of Australians and 16.2% of New Guinea.

The lowest frequencies for both mesial and distal accessory cusps of first and second maxillary premolars were found in African, Asian and European populations about (2%) *(Scott et al., 2018).*

The mesial accessory cusp of maxillary first premolars was found in higher frequencies (0%-35.4%) than the distal accessory cusp of maxillary first premolars (0%-15.4%) *(Adams et al., 2019).* He also demonstrated that distal accessory cusp occurred in lower frequencies than mesial accessory cusp at most populations and any differences found due to genetic drift.

About the mandibular premolars, they always display a well-developed buccal cusp. However, considerable variability takes place in the expression of the lingual cusp (or cusps) *(Scoot, 2008)*. The mandibular second premolar has diverse morphological features existing in different populations. So, this is very important from the clinical point of view to differentiate it from the second deciduous molar *(Coro et al., 2016)*. Mandibular second premolars with extra cusps are larger mesio-distally than others. So, this leads to change lee way space.

**Pedersen** in **1949,** reported that the East Greenland Eskimos expressed only a single lingual cusp on mandibular first premolars. In Southeast Asia **Manabe et al.** in **1997,** found that the frequency of expression of two lingual cusps on mandibular first premolar was 17.7%.

Mandibular first premolars with multiple lingual cusps were expressed at Australasian and New Guineans (43.8%), Europeans (40.0%), Indians (20%), and Northeast Asian (9.1%). **Bailey (2002).**

Onther study revealed that the frequency of expression of two lingual cusps on the mandibular first premolar is relatively low among the Jordanian population, accounting for 11.4 % *(Khraisat et al, 2013)*. In Koreans, one lingual cusp of mandibular first premolars was the most common and the absence of lingual cusp was relatively less about (3%) *(Hong et al., 2015)*.

Regarding mandibular second premolars, **Ludwig** in **1957,** reported the following frequencies for the expression of lingual cusps at Negroid 52.8% for one lingual cusp, 41.7 for two lingual cusps and 5.5% for three lingual cusps. Caucasus Mongoloid had 65.2% for one lingual cusp. 34.8% for two lingual cusps and 0.0% for three lingual cusps. *Loh, in 1993* reported in Chinese population with single lingual cusp was the dominant (66.3%) and 25.4% with two lingual cusps

*Bailey (2002)* reported the following frequencies for the expression of multiple lingual cusps on mandibular second premolars as following Australasian (87.5%), Europeans (55.9%), Northeast Asian (50.0%), and Indians (20.0%). Another study revealed that the expression of two lingual cusps on mandibular second premolar was relatively high among Jordanian population 61.4 % *(Khraisat, 2013)*.

In this study, showed that maxillary first premolars had hexagonal outline which is the common outline 60%, 28% rectangular outline and 12% oval outline. But the maxillary second premolars had 70% oval outline, 24% hexagonal outline and 6% rectangular outline. These records are like *(Scheid and Weiss, 2010)* recommended that the hexagonal is the most common outline for maxillary first premolar and with a small percentage of oval and rectangular outline. The oval is the most common outline for the maxillary second premolar and with a small percentage of oval or rectangular outline. According to *(Ash and Nelson, 2010)*.

Our results about mandibular premolars were 100% diamond outline for lower first premolars, 70% were rounded outline for mandibular second premolars and 30% were square outline. These results are compatible with *(Scheid and Weiss, 2010)* and *(Ash and Nelson, 2010)*.

maxillary first premolar of Chinese had a symmetric angular outline (hexagonal) with a buccal portion wider than the lingual portion *(Liu et al., 2010)*.

The final tooth form results from combination of genetic factors and environmental factors. This leads to variations in tooth morphology in different populations due to different degrees of gene expression, frequency, and also geographic distribution *(Mosharraf et al., 2010)*.

## CONCLUSION

Accordingly, we can conclude that the null hypothesis stating absence of accessory cusps on occlusal surfaces of premolars is rejected. Wher the alternate hypothesis is proven as Maxillary first premolar showed higher prevalence of presence of mesial accessory cusp than maxillary second premolars. Also, Mandibular second premolars showed the most common pattern was presence of two lingual cusps, however, presence of one lingual cusp was the common pattern of mandibular first premolars.

On the other hand, the null hypothesis describing prevalent occlusal outlines in upper and lower premolars is accepted. where, the hexagonal outline was dominating in upper first premolar while the oval was dominating in upper second. Also, the lower first premolars were diamond and the lower second premolars were rounded and square.

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