

## Variation of Dental Crown Dimension between Javanese Males and Females

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### Abstract

Determination of sex is one important aspect in the identification process. Teeth are part of the human body that showing the characteristics of sexual dimorphism.

Purpose: To determine the variation of dental crown dimension based on the diameter of mesiodistal, buccolingual, and diagonal of the Javanese Males and Females tooth crown from skull and dental cast.

Measurements were made in Javanese skull and dental cast using dental calipers. Number of skull and tooth models are 61 individual each sex, the number of skull is 26 pieces for males and 17 for females, and the number of dental cast of dental students are 35 for males and 44 for females. The tooth dimensions that measured were mesiodistal diameter, buccolingual, and diagonal tooth crown. The measurement results were tabulated and tested by statistical tests Independent T-Test.

Mesiodistal measurements were significantly different between the canines, premolars of maxillary, first and second molar. Buccolingual measurements were significantly different in the maxillary canines, second molar, and maxillary third molar. Diagonal measurements (mesiobuccal distolingual) were significantly different between the maxillary second incisor, canines, maxillary second premolars and maxillary second molar. Diagonal measurements (distobuccal mesiolingual) were significantly different in canines, maxillary molar, and mandibular second molar.

Tooth can be used to determine sex in humans, especially in Javanese. There are differences between the diameter of the mesiobuccal, buccolingual, and diagonal tooth crown between Javanese males and females.

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### Introduction

Sex determination from forensic point of view, is important part of human identification process. The determination of sex by using skull depends upon traits and measurements. The Sexual characteristic like counture of forehead, size of mastoid processus, and breadth of the palate These measurements can distinguish between male and female.<sup>1</sup> The smaller part of the skull like morphology and size of the teeth can also be used for identification purposes. This condition can occur because no two mouths are alike.<sup>2</sup> Odontometric is one of the useful

information that can be used for determination of sex in a population because they are easy, reliable, cheap, and easy to measure.<sup>3</sup>

Sex dimorphism appear in teeth because of genetic expression that influences by X and Y chromosome, beside of male and female hormonal influence. The effect of those influence tooth permanent crown size average, tooth root dentin size, tooth crown morphology, and developmental timing of the permanent teeth.<sup>4</sup> The determination of the sex using teeth are based on the size and shape, in which male teeth usually larger than female.<sup>3</sup>

Sexual differences in tooth size have been explored during the last half century by odontologist and anthropologist with the focus on measuring the width of mesiodistal and buccolingual width. This measurement is also known as linear measurement. More recently researchers use to measure the diagonal

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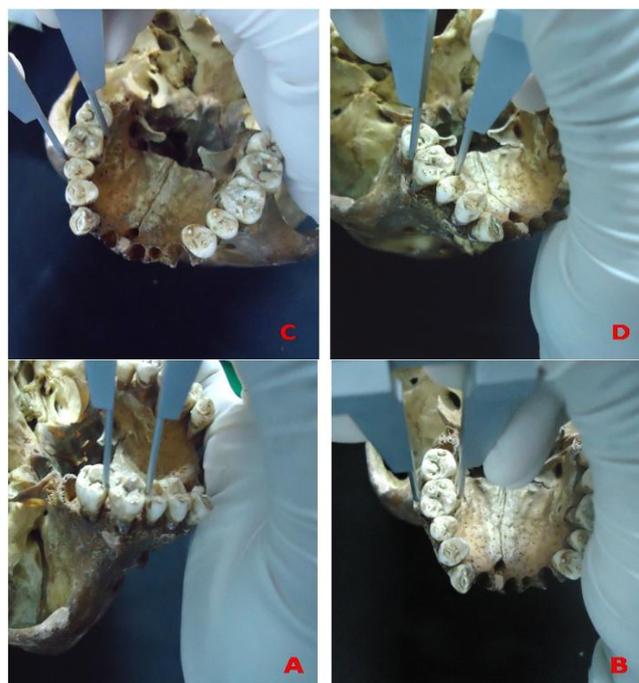
measurement of tooth crowns from corner to corner. This measurements carried out on crowded teeth and undergo rotation. However, this measurement is rarely performed because it is considered more complex than the linear measurement. Therefore, the diagonal will be needed combined with linear measurement.<sup>5</sup> Besides that, research in the field of dental anthropology hardly ever done in Indonesia, related to many variations in population and culture.

Purpose: To reveal whether the sex could be determined through the dimensions of the Javanese dental crown.

### Materials and methods

The subjects were teeth in maxilla and teeth in the mandible of the Javanese skull (collection of Department of Anatomy and Histology Faculty of Medicine Universitas Airlangga Surabaya and the Faculty of Social and Politic Universitas Airlangga Surabaya). The number of skull is 26 pieces for male and 17 for female, and the number of dental cast of dental students are 35 for male and 44 for female. The researcher using both sample to meet the number of sample. Measurements were performed by researchers with intraobserver method, in which the measurement is done twice at intervals of two weeks. Criteria for the subjects were aged 17-50 years of Javanese and the teeth are not damaged. Mesiodistal size teeth are the greatest distance between the mesial and distal surfaces of the tooth crown parallel to the occlusal surface of the tooth.<sup>2</sup> Buccolingual tooth size is the largest distance between the labial and lingual surfaces of the tooth crown parallel to the long axis of the tooth.<sup>2</sup> Diagonal size of the teeth is the greatest distance between the surface distobuccal/labial and mesiolingual/palatal or greatest distance between the surface of the mesiobuccal /labial and distolingual/palatal from the crown of the tooth.<sup>5</sup>

Measurements of the skull and dental cast done by using dental calipers with accurate 0,5 mm and tabulated according to gender. How to measure the diameter of mesiodistal, buccolingual, diagonal (mesiobuccal distolingual and distobuccal mesiolingual) tooth crown is shown in figure 1 and 2.



**Figure 1.** Measurement of Dimensions Teeth On Skull.

Description: A= Mesiodistal; B= Buccolingual; C= Diagonal (mesiobuccal distolingual); D= Diagonal (distobuccal mesiolingual).



**Figure 2.** Measurement of Dimensions Teeth On Dental Cast.

Description: A= Mesiodistal; B= Buccolingual; C= Diagonal (mesiobuccal distolingual); D= Diagonal (distobuccal mesiolingual).

The results of measurements then performed with Independent T-test to determine differences in the size of mesiodistal, buccolingual, and diagonal dental crowns dimension between male and female.

Measurements were made on one side of the jaw, in which if on that side there is abrasion of teeth, it can be measured on the other side, because there was no significant difference between the size of the right and left jaw.<sup>6</sup> This research has passed ethical clearance that organized by Health Ethical Comite of Medical Faculty of Airlangga University.

## Results

Tooth	Male			Female			P-Value
	N	Mean	SD	n	Mean	SD	
I1RA	49	8,43	0,99	52	8,19	0,65	0,159
I2RA	48	6,88	0,69	52	6,66	0,59	0,104
CRA	53	7,78	0,58	58	7,50	0,56	0,011*
P1RA	53	7,16	0,56	58	6,90	0,58	0,021*
P2RA	56	6,74	0,61	61	6,57	0,55	0,109
M1RA	55	10,58	0,73	60	10,16	0,75	0,004*
M2RA	52	9,71	0,72	60	9,28	0,77	0,003*
M3RA	30	9,23	0,72	24	8,98	1,17	0,334
I1RB	48	5,40	0,54	48	5,34	0,43	0,608
I2RB	50	6,88	0,69	50	6,66	0,59	0,322
CRB	51	6,85	0,58	52	6,63	0,50	0,045*
P1RB	51	7,08	0,59	51	7,03	0,77	0,720
P2RB	49	7,12	0,70	50	6,99	0,61	0,322
M1RB	42	11,10	0,87	49	10,77	0,58	0,036*
M2RB	51	10,60	0,83	52	10,00	0,77	0,000*
M3RB	23	10,59	1,16	18	10,42	1,14	0,642

Description: \* = significant in  $\alpha=0,05$ ; I1RA= maxillary first incisor, I2RA= maxillary second incisor, CRA= maxillary canine, P1RA= maxillary first premolar, P2RA= maxillary second premolar, M1RA= maxillary first molar, M2RA= maxillary second molar, M3RA= maxillary third molar, I1RB= mandibular first incisor, I2RB= mandibular second incisor, CRB= mandibular canine, P1RB= mandibular first premolar, P2RB= mandibular second premolar, M1RB= mandibular first molar, M2RB= mandibular second molar, M3RB= mandibular third molar.

**Table 1.** The Average of Mesiodistal Measurement of Maxilla and Mandible of Javanese Male and Female (mm).

The results of the average size of mesiodistal, buccolingual, and diagonal (mesiobuccal distolingual and distobuccal mesiolingual) on each tooth either maxilla and mandible of Javanese males and female presented on the table.

In Table 1 showed that the mesiodistal measurement results significantly different in canines teeth of maxilla and mandible, maxillary first premolars, molars of maxilla and mandible, and maxillary second molar of the mandible. At this table showed that the average diameter of mesiodistal from maxillary first incisors to the maxillary third molars and mandibular first incisors to the mandibular third molar is greater in male than female.

Tooth	Male			Female			P-Value
	N	Mean	SD	N	Mean	SD	
I1RA	49	6,84	0,89	52	6,76	0,88	0,665
I2RA	48	6,33	0,91	52	6,12	0,90	0,234
CRA	53	7,88	0,88	58	7,49	0,71	0,012*
P1RA	53	9,73	0,65	58	9,55	0,66	0,165
P2RA	56	9,66	0,58	61	9,44	0,73	0,078
M1RA	55	11,32	0,66	60	11,08	0,63	0,055
M2RA	52	11,35	0,78	60	10,83	0,73	0,001*
M3RA	30	11,12	0,79	24	10,35	0,94	0,002*
I1RB	48	5,54	0,65	48	5,53	0,73	0,942
I2RB	50	5,83	0,64	50	5,76	0,73	0,612
CRB	51	7,07	0,87	52	6,93	0,74	0,399
P1RB	51	8,02	0,56	51	8,06	0,58	0,730
P2RB	49	8,44	0,52	50	8,47	0,60	0,784
M1RB	42	10,71	0,64	49	10,66	0,55	0,686
M2RB	51	10,48	0,73	52	10,19	0,65	0,030*
M3RB	23	10,33	0,82	18	9,97	0,83	0,181

Description: \* = significant in  $\alpha=0,05$ ; I1RA= maxillary first incisor, I2RA= maxillary second incisor, CRA= maxillary canine, P1RA= maxillary first premolar, P2RA= maxillary second premolar, M1RA= maxillary first molar, M2RA= maxillary second molar, M3RA= maxillary third molar, I1RB= mandibular first incisor, I2RB= mandibular second incisor, CRB= mandibular canine, P1RB= mandibular first premolar, P2RB= mandibular second premolar, M1RB= mandibular first molar, M2RB= mandibular second molar, M3RB= mandibular third molar.

**Table 2.** The Average of Buccolingual Measurement of Maxilla and Mandible of Javanese Male and Female (mm).

Tooth	Male			Female			P-Value
	n	Mean	SD	n	Mean	SD	
I1RA	49	8,10	0,87	52	7,89	0,67	0,184
I2RA	48	6,70	0,71	52	6,29	1,04	0,023*
CRA	53	7,75	0,80	58	7,39	0,60	0,008*
P1RA	53	8,77	0,68	58	8,66	0,70	0,371
P2RA	56	8,86	0,69	61	8,54	0,70	0,017*
M1RA	55	12,86	1,00	60	12,42	0,70	0,006*
M2RA	52	11,96	0,86	60	11,47	0,78	0,002*
M3RA	30	11,20	1,08	24	10,65	1,32	0,097
I1RB	48	5,23	0,50	48	5,06	0,40	0,078
I2RB	50	5,82	0,52	50	5,77	0,49	0,625
CRB	51	6,75	0,78	52	6,62	0,58	0,346
P1RB	51	7,68	0,57	51	7,69	0,56	0,931
P2RB	49	8,10	0,80	50	8,03	0,71	0,637
M1RB	42	12,13	0,60	49	11,90	0,67	0,089
M2RB	51	11,72	1,62	52	11,25	0,70	0,062
M3RB	23	11,43	2,47	18	10,89	0,94	0,382

Description: \* = significant in  $\alpha=0,05$ ; I1RA= maxillary first incisor, I2RA= maxillary second incisor, CRA= maxillary canine, P1RA= maxillary first premolar, P2RA= maxillary second premolar, M1RA= maxillary first molar, M2RA= maxillary second molar, M3RA= maxillary third molar, I1RB= mandibular first incisor, I2RB= mandibular second incisor, CRB= mandibular canine, P1RB= mandibular first premolar, P2RB= mandibular second premolar, M1RB= mandibular first molar, M2RB= mandibular second molar, M3RB= mandibular third molar.

**Table 3.** The Average of Diagonal (Mesiobuccal Distolingual) Measurement of Maxilla and Mandible of Javanese Male and Female (mm).

In Table 2 buccolingual measurements given significantly different results in maxillary canine; maxillary and mandibular second molar; and maxillary third molar. In this table, there were two teeth which have an average diameter greater in female than male. There were mandibular first premolars with average diameter 8.02 mm in male and average diameter 8.06 mm in female with the difference is 0.04 mm, as well as mandibular second premolars with average diameter 8.44 mm in male and average diameter 8.47 mm in female with the difference is 0.03 mm.

Diagonal measurement (mesiobuccal distolingual) in table 3 given significantly different results on maxillary second incisors, canines, maxillary second premolars and second molars. The whole average diagonal diameter (mesiobuccal distolingual) was greater in male than female, except in the mandibular first premolars with an average male crown diameter of 7.68 mm and female diameter of 7.69 mm with difference of 0.01 mm.

Tooth	Male			Female			P-Value
	n	Mean	SD	n	Mean	SD	
I1RA	49	8,07	0,74	52	8,02	0,57	0,693
I2RA	48	6,81	0,70	52	6,81	0,74	0,974
CRA	53	7,64	0,56	58	7,32	0,53	0,003*
P1RA	53	8,84	0,70	58	8,74	0,63	0,442
P2RA	56	8,68	0,62	61	8,57	0,59	0,357
M1RA	55	11,49	0,85	60	11,19	0,71	0,044*
M2RA	52	10,83	0,67	60	10,68	1,43	0,510
M3RA	30	10,40	0,75	24	10,00	1,02	0,105
I1RB	48	5,19	0,46	48	5,18	0,51	0,917
I2RB	50	5,73	0,50	50	5,56	0,48	0,089
CRB	51	6,60	0,64	52	6,34	0,53	0,028*
P1RB	51	7,39	0,51	51	7,30	0,50	0,382
P2RB	49	7,98	0,62	50	8,03	0,63	0,690
M1RB	42	11,85	0,68	49	11,70	0,61	0,302
M2RB	51	11,51	0,63	52	11,19	0,74	0,022*
M3RB	23	11,30	0,93	18	11,00	0,95	0,313

Description: \* = significant in  $\alpha = 0,05$ ; I1RA= maxillary first incisor, I2RA= maxillary second incisor, CRA= maxillary canine, P1RA= maxillary first premolar, P2RA= maxillary second premolar, M1RA= maxillary first molar, M2RA= maxillary second molar, M3RA= maxillary third molar, I1RB= mandibular first incisor, I2RB= mandibular second incisor, CRB= mandibular canine, P1RB= mandibular first premolar, P2RB= mandibular second premolar, M1RB= mandibular first molar, M2RB= mandibular second molar, M3RB= mandibular third molar.

**Table 4.** The Average of Diagonal (Distobuccal Mesiolingual) Measurement of Maxilla and Mandible of Javanese Male and Female (mm)

Tooth	Male			Female			Sexual dimorphism		
	n	Mean (mm)	SD	n	Mean (mm)	SD	P-Value	X	%
CMDRA	53	7,78	0,58	58	7,50	0,56	0,011*	0,28	3,77
P1MDRA	53	7,16	0,56	58	6,91	0,58	0,021*	0,25	3,69
M1MDRA	55	10,58	0,73	60	10,17	0,75	0,004*	0,41	4,08
M2MDRA	52	9,71	0,72	60	9,28	0,77	0,003*	0,43	4,70
CMDRB	51	6,85	0,58	52	6,63	0,50	0,045*	0,22	3,29
M1MDRB	42	11,10	0,87	49	10,77	0,58	0,036*	0,33	3,06
M2MDRB	51	10,60	0,83	52	10,00	0,77	0,000*	0,60	5,98
CBLRA	53	7,88	0,88	58	7,49	0,71	0,012*	0,39	5,15
M2BLRA	52	11,35	0,78	60	10,83	0,73	0,001*	0,52	4,73
M3BLRA	30	11,12	0,79	24	10,35	0,94	0,002*	0,77	7,36
M2BLRB	51	10,48	0,73	52	10,19	0,65	0,030*	0,29	2,82
I2MBDLRA	48	6,70	0,71	52	6,29	1,04	0,023*	0,41	6,51
CMBDLRA	53	7,75	0,80	58	7,39	0,60	0,008*	0,36	4,96
P2MBDLRA	50	8,86	0,69	61	8,54	0,70	0,017*	0,32	3,70
M2MBDLRA	52	11,96	0,86	60	11,48	0,78	0,002*	0,48	4,23
CDBMLRA	53	7,64	0,56	58	7,32	0,53	0,003*	0,32	4,40
M1DBMLRA	55	11,49	0,85	60	11,19	0,71	0,044*	0,30	2,67
CDBMLRB	51	6,60	0,64	52	6,34	0,53	0,028*	0,26	4,12
M2DBMLRB	51	11,51	0,63	52	11,19	0,74	0,022*	0,32	2,83

Description: \* = significant in  $\alpha = 0,05$ ; I1RA= maxillary first incisor, I2RA= maxillary second incisor, CRA= maxillary canine, P1RA= maxillary first premolar, P2RA= maxillary second premolar, M1RA= maxillary first molar, M2RA= maxillary second molar, M3RA= maxillary third molar, I1RB= mandibular first incisor, I2RB= mandibular second incisor, CRB= mandibular canine, P1RB= mandibular first premolar, P2RB= mandibular second premolar, M1RB= mandibular first molar, M2RB= mandibular second molar, M3RB= mandibular third molar.

**Table 5.** The Sexual Dimorphism Degree of Maxillary and Mandible of Javanese Male and Female.

Diagonal measurement (distobuccal mesiolingual) in table 4 given significantly different results on the maxillary and mandibular canines, maxillary first molar, and mandibular second molars. The diameter average of the diagonal (distobuccal mesiolingual) tooth crown was greater in male than female, except for mandibular second premolars with male average crown diameter was 7.98 mm and average crown diameter was 8, 03 mm with difference of 0.05 mm.

The percentage of sexual dimorphism in the tooth measurements that showed significant differences seen in Table 5. The largest percentage of sexual difference in the measurement of buccolingual was maxillary third molars. It appeared that the male has a higher value was 7.36%. While the percentage of sexual differences in smallest diagonal measurement (distobuccal mesiolingual) mandible second molar was 2.67%. The biggest difference in mesiodistal measurement in mandibular second molars with a value of 5.98%. The biggest difference was the buccolingual measurement of maxilla third molars with a value of 7.36%. The biggest difference in the diagonal measurement (mesiobuccal distolingual) was maxillary second incisors with a value of 6.51%. The biggest difference in the diagonal measurement (distobuccal mesiolingual) was the maxillary canines with a value of 4.40%. The data in Table 5.5 shows the difference of the average diameter of male and female crown dimension was between 0.22 mm to 0.76 mm.

Based on the Independent T-test showed  $p < 0,05$ , which means there were significant differences in mesiodistal, buccolingual, and diagonal (mesiobuccal distolingual and distobuccal mesiolingual) teeth dimension of Javanese male and female. The significant result of mesiodistal measurement were maxillary and mandibular canine, maxillary first premolars, maxillary and mandibular first molars, maxillary, and mandibular second molars; buccolingual maxillary canines, maxillary and mandibular second molars, and maxillary third molar, and maxillary second incisive; diagonal (mesiobuccal distolingual) maxillary and mandibular canine, maxillary second premolars, maxillary second molars molar; diagonal (distobuccal mesiolingual) maxillary and mandibular canine, maxillary first molars and mandibular second molars.

## Discussion

Measuring the diameter of the tooth crown has been done over the years in various populations in the world. Teeth can provide reliable information with lower observer error rate. The permanent teeth of maxilla and mandible of the skull and dental cast of Javanese can be used to determine the sex. The different measurement significantly between male and female are in maxillary second incisors, maxillary canines, maxillary first and second premolars, first molar, maxillary second and third molars, mandibular canines, mandibular first and second molars.

Some studies show that male have greater tooth crown diameter than female.<sup>7,8</sup> The average of the male crown is bigger than female although the degree of dimorphism varies in each population.<sup>9</sup> These results are consistent with the results of this study that showed significant differences between male and female. Mesiodistal and buccolingual diameter of the tooth crown is the most widely studied and used in the determination of the sex. The results from this study area the average diameter of mesiodistal tooth crown from the maxillary and mandibular incisor until maxillary and mandibular third is greater in male than in the female. For the measurement of buccolingual diameter produced on average larger in males than females except on the mandibular first and second premolars. This is consistent with previous research which states that the diameter of the tooth crown mesiodistal on males is consistently higher than female's crown.<sup>8,10</sup> The other research resulted in significant differences between male and female in buccolingual measurement.<sup>10</sup> Beside mesiodistal and buccolingual, the diagonal diameter also gives the significant different result, whether males exceeded that of females.<sup>5</sup> These results are consistent with this study that are significant differences in crown diameter of maxillary second incisor; maxillary and mandibular canine; maxillary first molar; mandibular second molar.

The percentage of sexual difference (sexual dimorphism) between male and female is not too large, which ranged between 2.67% - 7.36%. The smallest difference was on the diagonal (distobuccal mesiolingual) maxillary first molar and the biggest difference in the buccolingual maxillary third molar. The results of

this study also showed average tooth crown greater in female than male. There are in buccolingual measurement of mandibular first and second premolars and mesiobuccal distolingual measurement of mandibular first premolar. This is a condition of overlap that may occur due to human beings have no special difference in teeth.<sup>11</sup>

Ninety percent of the enamel organic components are amelogenin. Amelogenin is a protein consisting of proline, amino acid, glutamic acid, leucine, and histidine. During the maturation process, the rapid mineralization of enamel happened. Human amelogenin produced by a single gene with two copies, one in X chromosome and one in Y chromosome (AMGX and AMGY). The second copy of the gene is expressed though 90% amelogenin that came from AMGX. The differences between AMGX and AMGY bring differences in the amino acid that produces a row of amelogenin. The amelogenin and product fractions showed sexual characteristics.<sup>12</sup> Amelogenin is the most enamel protein. Amelogenin was expressed from a gene on X chromosome and Y chromosome, with about 90 percent of all RNA transcripts derived from the X chromosome. X chromosome and Y chromosome amelogenin gene copy does not undergo homologous recombination, therefore amelogenin gene is a genetic marker that is preferred in the determination of sex in the field of forensics.<sup>12</sup> The Y chromosome affects the timing and speed of growth of the body. The Y chromosome cause slower and wider enamel maturation process than the X chromosome.<sup>13</sup>

Sex determination have been reported seen in the complex volume of enamel, dentin, and pulp. Sexual hormones also affect the functioning of odontoblasts. Antigen estrogen receptors have been identified at odontoblast in predentin lining and blood vessels of pulp extracted teeth.<sup>14</sup> There is a combination of environmental and genetic factors that control the mesiobuccal and buccolingual diameter. The Y chromosome contributed the most to the size of the tooth by controlling the thickness of the dentin, where the X chromosome responsible for the thickness of the enamel. The Y chromosome gives a direct effect on the size of the teeth that may be related to many non-specific effects on cellular activity. The difference in size of teeth diameter crown between male and female has been described as part of the genetic expression

of the male who have sizes tend to be larger than females. The Y chromosome intervenes tooth size from the thickness of the enamel and dentin, while the X chromosome plays a role only regulate the thickness of the enamel.<sup>4</sup>

Permanent dental crown is formed at tooth formation stage and its dimensions have not changed during tooth growth and development, except in case of functional disorders, pathological, and nutrients that can affect the normal dimensions of the teeth. Sex differences referring to the number of primary and secondary dentin that formed more in males than females. In males teeth, the dentine area is greater than females teeth. It could be concluded that males teeth have more dentine than females teeth, so this condition affected the diameter of the tooth crown in both sexes.<sup>15</sup>

Cusp on tooth development process began to take shape during the early bell stage, before calcification of teeth starts. Cells from the internal epithelium proliferate and produce activators and inhibitors when these cells are deposited on a layer of the tooth. Activators produce enamel knots primer until the concentration reaches a threshold which induces inhibitor that neutralizing the activator. After developing enamel knots primer, then enamel knots primer disappeared and secondary enamel knots appear. The gene that encodes and controls the expression of activators and inhibitors modulate the rhythm and the quantity of enamel deposition. The enamel knots primer formed the occlusal of premolars and molars while the secondary enamel knots forming cusps during amelogenesis.<sup>16</sup> This is the basic that explaining why not all of the tooth diameter differences between male and female.

## Conclusions

Teeth can be used to determine the sex in humans, especially in Javanese. There are significant differences between some mesiobuccal, buccolingual, and diagonal crown diameter between Javanese male and female. Significant differences were found in maxillary second incisors; maxillary canines; maxillary first and second premolar; maxillary first, second, and third molar; mandibular canines; mandibular first and second molars.

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## Declaration of Interest

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