

Determination of the influence of body mass percentile on mandibular canine calcification stages among 5-17 years old Northern Nigerian children

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Osaronse Anthony Aghimien¹, Osasumwen Aghimien-Osaronse²

ABSTRACT

BACKGROUND

Dental calcification is a biological phenomenon used to estimate the maturation status of growing children. The effect of body mass index percentile (BMI-percentile) on this process appears contentious among researchers.

AIMS AND OBJECTIVES

To determine the predictive effect of body mass percentile on mandibular canine calcification.

DESIGN

A prospective descriptive cross-sectional study.

METHODS

This was a prospective cross sectional descriptive study comprising of eighty four participants (5-17 years) who visited the Child Health Dental Clinic of Federal Medical Centre, Keffi, Nigeria between January and September, 2021. Mandibular canine calcifications of the study participants were staged using the Demirjian method while the World Health Organisation growth chart specific for age and gender was used to classify the BMI-percentile. The effect of BMI-percentile on the mandibular canine calcifications was determined using multinomial logistic regression.

RESULTS

Chronological age had a significant predictive effect on the mandibular canine calcification ($P=0.002$) as against gender and BMI-percentile. A one-percentile

increase in the BMI-percentile increases the likelihood of healthy children of having to present in stage D by 3.454 compared to obese children, but this effect was not statistically significant ($P= 1.000$).

CONCLUSIONS

Obese children have a tendency of having advanced mandibular canine calcification than healthy children. Female participants were likely to be in advanced mandibular canine calcification stage. Early intervention is therefore suggested for obese children.

Key words: Body mass percentile, mandibular canine, calcification.

INTRODUCTION

In 2006, the World Health Organisation (WHO) released standard growth charts for describing growth of healthy children in ideal conditions.¹ These charts were used to assess the nutritional status of children globally. Children and adolescents were categorized as either underweight, healthy, overweight or obese using body mass index percentile (BMI-percentile) scores of <5%, 5%-85%, 85%-95% and >95% respectively.

The prevalence of obesity is on the rise globally with increasing trend in developing countries like Nigeria.²⁻⁴ Continuous increase in the BMI-percentile of an individual can affect their general wellbeing by; predisposing them to increased blood pressure, coronary heart disease and increased risk of diabetic mellitus. It can also affect their dental development.⁵

Dental development is a biological phenomenon that is used to estimate the maturation of growing children. Orthodontists and paedodontists consider dental development as a crucial parameter that is usually evaluated before commencing treatment on their patients. Apart from dental eruption age, the dental formation stages (calcification/mineralization) of the teeth are more confidently used to estimate an individual's dental age because it has been reported to follow a more independent process and can be evaluated at any stage of its developmental process.^{6,7} The effects of changes in BMI-percentile on dental development have been studied by several researchers.⁸⁻¹⁷ Changes in the BMI-percentiles have been reported to either cause acceleration or a delay in tooth eruption.⁸⁻¹¹ Advancement in dental age among

Author affiliations:

1. Osaronse Anthony Aghimien: (*BDS, FWACS*), Federal Medical Centre, Keffi, Nasarawa State, Nigeria.
ORCID number: 0000-0002-6737-7959
2. Osasumwen Aghimien-Osaronse: (*BDS*), University of Benin Teaching Hospital, Benin City, Edo State, Nigeria.

Corresponding author:

Dr Osaronse Anthony Aghimien
Orthodontic unit, Dental Surgery Department,
Federal Medical Centre, Keffi, Nasarawa State.
E-mail: osaronse@yahoo.com
Phone number: +23 4703 0857 943

Author contributions:

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2. Osasumwen Aghimien-Osaronse: 40%.

overweight and obese children as against normal healthy individuals have also been reported in different population.¹²⁻¹⁷ Recently, it was reported that black South Africans overweight children aged 5-20 years were observed to be significantly advanced in their dental development when compared to underweight children.¹⁸ If nutritional status as classified by the BMI-percentile have influences on dental development, it cannot be said to absolutely follow an independent process of growth.¹⁸ The effect of BMI-percentile on dental maturation have been observed to be dichotomous among researchers.⁸⁻²² While some researchers observed BMI-percentile to have a statistically significant explanatory effect on dental maturation,¹⁸⁻²⁰ some others have reported non-statistically significant explanatory effects.^{21,22}

The effect of increased BMI-percentile on orthodontic tooth movement is still considered controversial among researchers.²³

There is no doubt that fluctuation in BMI-percentile can influence dental development. However, there appears to be scarcity of researches on the influence of BMI-percentile on dental development among Nigerians, despite the increasing prevalence of overweight and obesity among the Nigerian population.²⁴ This study was conducted to determine the influence of BMI-percentile on the developmental stages of the right mandibular canine in Northern Nigerian children using the Demirjian method.²⁵ It was hypothesized that there was no statistically significant correlation between BMI-percentile and the developmental stages of the right mandibular canine. Secondly, that BMI-percentile has no statistically significant explanatory effect on the developmental stages of the right mandibular canine. The outcome of this study will guide clinicians especially those in the fields of Orthodontists and paedodontists on proper timing of implementation of treatment procedures.

MATERIALS AND METHODS

Study population

This was a prospective cross-sectional study. It included 84 children and adolescents that visited the Child Health Dental Clinic, Federal Medical Centre, Keffi, Nigeria (between January 2021 and September, 2021). Data were extracted from records of patients that visited for routine treatment.

Ethical consideration

Ethical approval was obtained from the institution's Health Research Ethical Committee (FMC/KF/HREC/2571/21) prior to collection of the data, informed consent was obtained from parents/guardians of the participants while verbal consent was obtained from the children.

Inclusion and exclusion criteria.

Participants recruited for the study included patients between aged 5 to 17 years with no previous orthodontic treatment and the absence of congenital or developmental defects. Participants with serious childhood illness, multiple extractions, congenital anomalies affecting the teeth in the form of supernumeraries and; dilacerations

as well as those who refused consent and assent were not recruited for the study. Participants with distorted peri-apical radiographs were also excluded from the study

Data collection

Digital peri-apical radiographs of the mandibular canine were obtained using the bisecting angle technique. The Demirjian method²⁵ was used to grade the developmental stages of the right mandibular canine calcification.

Mandibular canine calcification stages using the Demirjian method

- **Stage D:** Crown formation is complete down to CEJ. Superior border of pulp chamber is curved and concave towards the cervical region. The beginning of root formation is in the form of a spicule.
- **Stage E:** The walls of the pulp chamber form straight lines. The root length is less than the crown height.
- **Stage F:** The walls of the pulp chamber form a more or less isosceles triangle, with the apex ending in a funnel shape. The root length is equal to or greater than the crown height.
- **Stage G:** The walls of the root canal are parallel and its apical end is still partially open.
- **Stage H:** The apical end of the root canal is completely close. The periodontal membrane has a uniform width around the root and the apex.

Measurement of body mass index (BMI) and body mass index-percentile

Weight (in kilogram) and height (in meters) were measured using a stadiometer with a weighing scale at the base. Body mass index was calculated by dividing the weight in kilogram (kg) by the square of the height in meters (m²).

BMI percentile for each participants was obtained from BMI scores with reference to the growth charts specific for age and gender. The WHO growth chart specific for age (2-20 years) and gender was used for this participants. A BMI-percentile less than 5%, between 5%-85%, between 85%-95% and greater than 95% were scored as either underweight, healthy, overweight or obese respectively.

Description of equipment and machines

The Carestream peri-apical x-ray machine model CS2100 with a standard wall-mounted unit was used to take radiographs in for this study. It has exposure dose of 60KV-7mA at a distance of 20cm from the x ray tube focal spot to the skin. Carestream digital sensor, RVG 142 size 1 (24mm x 40mm) was used to obtain the peri-apical radiographs of the study participants.

Intra-investigator reliability

Before the commencement of the study, a reliability survey was conducted to assess the level of intra-investigator error of the mandibular calcification stages. Eight (8) digital peri-apical radiographs of the participants were randomly selected and assessed at two different sections of 2 weeks interval to determine intra-class reliability. Intra-class coefficient (ICC) showed

excellent intra-investigator reliability to be 0.948 for the mandibular canine calcification stages, $p < 0.001$.

Data analysis

Data collected were coded and entered into the computer system and analyzed using Statistical Package for Social Sciences (SPSS) version 22.

Unpaired t-test was used to compare the mean of the chronological age, height, weight and Body Mass Index (BMI) according to gender. The mean chronological age and mean BMI of the various groups of BMI-percentile and the various stages of mandibular canine calcifications were compared according to gender using the unpaired t-test. Spearman's correlation was used to determine the association of BMI-percentile and the mandibular canine calcifications stages. Multinomial

logistic regression was thereafter used to determine the effect of some explanatory independent variables (chronological age, gender and BMI percentile) on the dependent variable (mandibular canine calcifications stages) with stage F of the mandibular canine calcifications stages as the reference category.

RESULTS

Table I shows the comparison of the mean values of chronological age, height, weight and Body Mass Index (BMI) according to gender using unpaired t-test. Female participants had higher heights (1.40 ± 0.14 m), larger weights (35.00 ± 11.23 kg) and BMI (17.56 ± 2.99 kg/m²). However, but they were not statistically significant, with p values of 0.979, 0.584 and 0.442 respectively. The mean BMI of the healthy females was significantly higher than the males ($p = 0.015$). Overweight and obese

Table I: Mean chronological age, height, weight and body mass index (BMI) using unpaired t-test

Variables	Gender	N(%)	Mean \pm SD	MD	95% CI		P value
					Lower	Upper	
Chronological age (years)	Male	47 (56.0)	10.51 \pm 2.80	0.186	-1.139	1.512	0.777
	Female	37 (44.0)	10.32 \pm 3.19				
	Total	84 (100.0)	10.43 \pm 2.96				
Height (m)	Male	47 (56.0)	1.39 \pm 0.14	-0.001	-0.062	0.061	0.979
	Female	37 (44.0)	1.40 \pm 0.14				
	Total	84 (100.0)	1.39 \pm 0.14				
Weight (kg)	Male	47 (56.0)	33.53 \pm 12.83	-1.468	-6.782	3.846	0.584
	Female	37 (44.0)	35.00 \pm 11.23				
	Total	84 (100.0)	34.18 \pm 12.10				
BMI (kg/m ²)	Male	47 (56.0)	16.93 \pm 4.21	-0.633	-2.262	0.997	0.442
	Female	37 (44.0)	17.56 \pm 2.99				
	Total	84 (100.0)	17.21 \pm 3.72				

MD, Mean difference; CI- Confidence interval

Table II: Comparison of the mean chronological age of the BMI-percentile and also the comparison of the mean BMI of the BMI-percentile according to gender using unpaired t-test.

BMI-					95% Confidence interval		P-Value
Percentile n (%)		Male N (%)	Female N (%)	MD	Lower	Upper	
Underweight 14 (16.3%)	CA Mean SD	9(10.7) 11.76 4.09	5(6.0) 10.20 2.39	1.467	-2.926	5.860	0.481
	BMI Mean SD	13.70 1.80	13.47 1.11	0.236			
Healthy 58 (69.0%)	CA Mean SD	31(36.9) 10.32 2.47	27(32.1) 10.56 3.40	-0.233	-1.782	1.316	0.764
	BMI Mean SD	16.36 1.69	17.78 2.58	-1.414			
Overweight 9 (10.7%)	CA Mean SD	5(6.0) 9.80 1.64	4(4.8) 10.25 2.06	0.450	-3.360	2.460	0.725
	BMI Mean SD	20.72 1.55	20.58 2.38	0.147			
Obese 3 (3.6%)	CA Mean SD	2(2.4) 10.00 4.24	1(1.2) 5.00 0.00	10.580	-172.524	193.684	0.597
	BMI Mean SD	30.72 11.76	20.14 0.00	5.000			

*- $P < 0.05$; CA-Chronological age; BMI-Body mass index; SD-Standard deviation; MD-Mean difference

males participants ($20.72 \pm 1.55 \text{ kg/m}^2$ and $30.72 \pm 11.76 \text{ kg/m}^2$ respectively) had higher mean BMI when compared to females ($20.58 \pm 2.38 \text{ kg/m}^2$ and 20.14 kg/m^2 respectively) but no statistical significance was observed. The mean ages of obese participants was observed to be 10 years for males and 5 years for female participants, $p=0.597$ (see table II).

Table III shows that Stage F of mandibular canine calcification was mostly represented among the various stages of the tooth development with 26.2% while stage D was least represented with 6.0%. The mandibular canine calcification stages among the male participants were majorly categorized as stage F (17.9%) while stage G had the highest representation among females (13.1%). The mean chronological age of the various developmental stages of the mandibular canine were consistently earlier among females than in males. Statistical significant difference was only observed at stage F where the mean chronological age was 8.57 years for females and 10.13 years for males, ($p=0.046$). Mean BMI for each stage were lower among the males compared to females in stages D, E, G and H but higher in stage F. Statistical difference was only

observed in stage D, ($p = 0.026$). As the mandibular canine calcification stages advanced from stage to stage, the mean BMI also steadily increased among the males.

Table IV shows that the average correlation of the mandibular canine calcification stages with the BMI-percentile was positive but weak and not statistically significant, ($p = 0.769$). Table IV also shows that age has significant ($p < 0.001$) positive and moderate correlation while gender had weak correlation with the mandibular canine calcification stages ($p = 0.077$).

Multinomial logistic regression was used to determine the influence of age, gender and BMI percentile on the dependent variable (mandibular canine calcification stages) with stage F of the mandibular canine calcification stages as the reference category as shown in Table V. There was an increase in the likelihood of males to present with stage D of mandibular canine calcification by 2.233 than females. This shows that females are more likely to be in advanced stage F. However the effect of gender on the canine calcification was observed not to be statistically significant ($p = 0.199$).

Table III: Comparison of the mean chronological age of the mandibular canine calcification stages (MCCS) and the mean BMI of the mandibular canine calcification stages (MCCS) according to gender using unpaired t-test.

MCCS N(%)		Male N(%)	Female N(%)	MD	95% CI		P-Value
					Lower	Upper	
Stage D 5 (6.0%)	CA	3 (3.6)	2 (2.4)				
	Mean SD	8.00 2.00	5.00 0.00	3.000	-1.744	7.744	0.138
	BMI						
	Mean SD	13.81 0.58	16.25 0.78	0.236	-4.343	-0.544	0.026
Stage E 21 (25.0%)	CA	14 (16.7)	7 (8.3)				
	Mean SD	8.21 0.89	7.71 1.60	0.500	-0.629	1.629	0.365
	BMI						
	Mean SD	15.61 2.87	16.15 2.12	-0.541	-3.116	2.034	0.665
Stage F 22 (26.2%)	CA	15 (17.9)	7 (8.3)				
	Mean SD	10.13 1.77	8.57 1.13	1.562	0.305	3.093	0.046
	BMI						
	Mean SD	16.92 2.44	16.20 1.89	1.721	-1.463	2.901	0.499
Stage G 18 (21.4%)	CA	7 (8.3)	11 (13.1)				
	Mean SD	12.00 1.29	10.64 1.57	1.363	-0.142	2.870	0.073
	BMI						
	Mean SD	18.08 2.99	17.26 3.19	0.819	-2.372	4.010	0.594
Stage H 18 (21.4%)	CA	8 (9.5)	10 (11.9)				
	Mean SD	14.88 1.96	14.10 2.33	0.775	-1.413	2.963	0.464
	BMI						
	Mean SD	19.41 8.10	20.10 2.91	-0.681	-6.499	5.137	0.807

*- $P < 0.05$; MCCS- Mandibular canine calcification stages; CA-Chronological age; BMI-Body mass index; SD-Standard deviation; MD-Mean difference.

Table IV: Measure of relationship with mandibular canine calcification stages (MCCS)

		Pubertal growth spurt	
		Correlation coefficient	P value
BMI-percentile			
Male		*0.080	0.591
Females		*0.008	0.961
Total		*0.033	0.769
Age		**0.712	<0.001
Gender		***0.194	0.077

*-Spearman's correlation, **- kendaul tau-b correlation, ***- Rank biserial correlation

Table V: Multinomial logistic model of the mandibular canine calcification stages (MCCS), stage F as reference category.

Predictive variables	B	Df	OR	95% CI		P value
				Lower	Upper	
Gender (male)	2.233	1	9.327	0.309	218.436	0.199
Chronological Age	-2.805	1	0.061	0.011	0.348	0.002
BMI percentile (Healthy 5%-85%)	3.454	1	31.624	0.009	0.694	1.000

OR-Odd ratio; CI- Confidence interval.

Furthermore, a one-percentile increase in the BMI-percentile increased the likelihood of healthy children to present in stage D by 3.454 than in stage F as against obese children. This revealed that obese children tend to have advance mandibular canine development than healthy children. This effect was also not statically significant ($p= 1.000$).

An increase in chronological age by one year was observed to have significantly ($P = 0.002$) decreased the likelihood of presenting with stage d of mandibular canine calcification by 2.805. Thus showing that an increase in chronological age is accompanied by increase in developmental stages of the mandibular canine calcification stages.

This result shows that gender and BMI-percentile were not statistical significant predictors of mandibular canine calcification stages.

DISCUSSION

In this current study, it was observed that the correlation of the mandibular canine calcification with the BMI-percentile was positive but weak irrespective of gender. This findings is consistent with results of a previous study conducted in an Iranian population.¹⁴ While the present study recorded a non-statistically significant correlation among males and females, Anbiaee et al¹⁴ only reported a non-statistically significant correlation among the males.

The present study also confirms that age has a significant predicting effect on the calcification stages of mandibular canine. These findings corroborate previous observations. Hedayati & Khalafinejad in a study conducted among an Iranian population observed that gender was not a statistical significant predictor of mandibular canine calcification.¹⁵ The findings in the present study corroborate the observation made by the authors.¹⁵

Findings in the current study differ from previous reports made by Mack et al¹⁹ and Erhamza et al²² where it was observed that gender played a significant predicting role in determining the outcome of the dental development.

Although this present study shows that an increase in the BMI-percentile increases the tendency towards advanced dental calcification, the effect was however not statistically significant. There is general consensus among several authors that there is a tendency towards advanced dental development when there is an increase in the BMI-percentile on the contrary, they differ with regard to the level of statistical significance of the predictive effects.^{14,15,19,22,26} While finding in the present study is consistent with the observations made by some authors,^{21,22,26} it is at variance with other researchers that reported BMI-percentile as a significant predictor of dental maturation.^{13,18-20} This present study apart from having lower study participants focused majorly on the calcification stages of the right mandibular canine while the study conducted by Mack et al¹⁹ and DuPlessis et al²⁰ calculated the actual dental maturity score and the corresponding dental age of the participants using the Demirjian method which involve the use of seven teeth. These differences could have accounted for the difference on the predictive effect of BMI-percentile.

The study conducted in a black South African population focused majorly on stage H of the left seven teeth.¹⁸ The exclusion of other developmental stages of the teeth could have probably magnify the predictive effect of the BMI-percentile on stage H that was evaluated. Although Zangouei-Booshehri et al¹³ reported a tendency towards accelerated dental development which is corroborated by observations made in this present study. The significant predictive effect of BMI-percentile reported by the author is at variance with the findings in the current study. The BMI-percentile was either classified as normal or above normal by the authors¹³, therefore obviating the separate effects of the 4 groups

of BMI-percentile used in the current study. Also, only the coefficient ratio of BMI-percentile was reported while the parameter estimate of the logistic model was reported in this current study. Coefficient ratio only reports the overall effect without considering individual contribution of the various groups of the BMI-percentile.

The differences in methodology, ethnic difference and possibly racial variation could have accounted for the difference observed between the present study and the studies that reported significant effect of BMI-percentile on dental development. Obese patients have also been reported to have significantly more erupted teeth than normal non-obese individuals in a study conducted among a North American population,⁸ but the mixed model analysis failed to show that obesity had a statistically significant effect on the eruption pattern which is further corroborated by the results of this current study which shows a non-significant effect of BMI-percentile on mandibular canine calcification. The quadratic mixed-effects model used in the longitudinal study conducted by Nicholas et al⁹ also showed that BMI-percentile had no statistical significant effect on changes in the dental of the study participants. This is in agreement with results from the current study.

Since findings from this current study have shown that there is a tendency towards advanced dental development among individuals with increased BMI-percentile, special considerations should be given to overweight and obese individuals visiting the paediatric and orthodontic dental clinics. These individuals may require earlier treatment intervention than individuals within the normal range of healthy BMI-percentile among Nigerian children.

CONCLUSION

1. A one-percentile increase in the BMI-percentile increased the likelihood of healthy children to present be in stage D by 3.454 than in stage F as against obese children. However, the effect of an increase in BMI-percentile on the mandibular canine calcification was not statically significant ($P=1.000$). This revealed that obese children tend to have advance mandibular canine development than healthy children.
2. Chronological age was observed to be a statistical significant predictive factor ($P=0.002$) of mandibular canine calcification stages. A statistically significant and strong positive correlation ($p<0.001$) was also observed between chronological age and mandibular canine calcification stages.
3. The effect of gender on mandibular canine calcification stages was not statistically significant ($P=0.199$). The correlation between gender and mandibular canine calcification stages was also not statistically significant ($P = 0.077$).

Conflict of interest

The authors declare that there is no conflict of interest.

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