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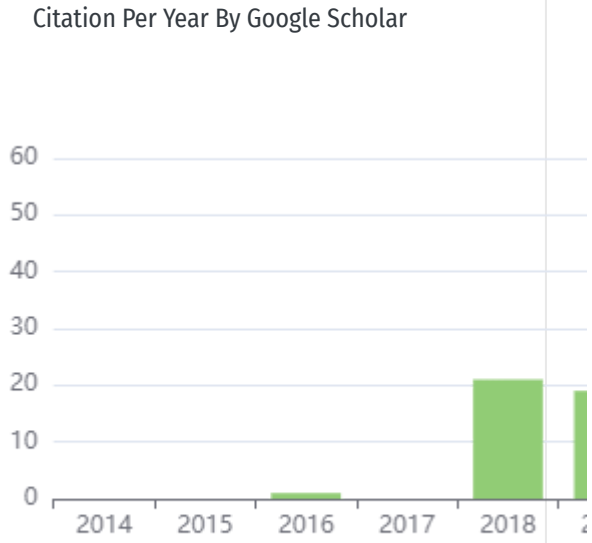

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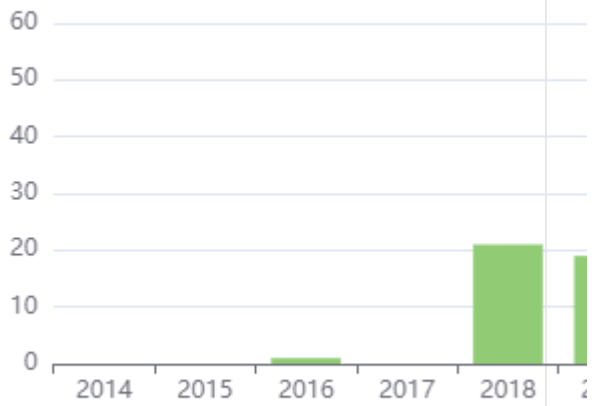

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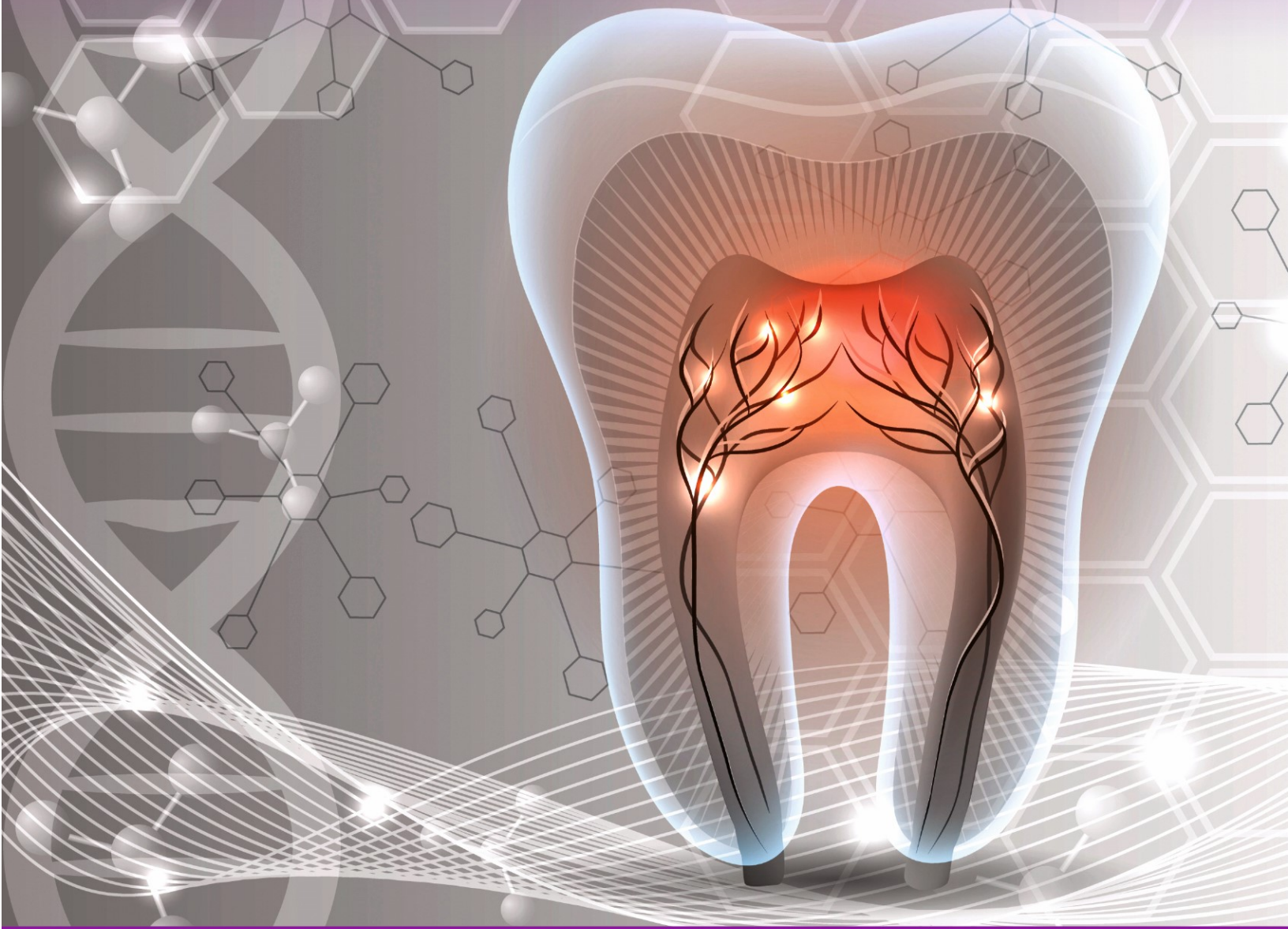

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Original Article

Correlation between Body Mass Index with Anterior Crowding and Enamel Hypoplasia of Sundanese Children in Bandung

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Abstract

Background: Nutrition affects the growth of bones and teeth. Malnutrition can cause teeth to become irregular and undergo enamel hypoplasia (EH). To assess malnutrition, the body mass index (BMI) can be used. **Objective:** This study aims to analyze the correlation of BMI with anterior crowding and EH in Sundanese children aged 9–12 years. **Method:** This analytic observational study with a cross-sectional design was done in four public elementary schools in Bandung taken by random cluster sampling. The study subjects comprised 208 children, with 90 boys and 118 girls. Data analysis used correlation coefficients with the Kolmogorov–Smirnov normality test. **Result:** The probability value of the correlation between BMI and anterior crowding was 0.24, which meets the significance level (α <0.05). The probability value between the BMI and EH was 0.102, which is not significant (α >0.05). **Conclusion:** There is a correlation between BMI and anterior crowding, but there is no correlation between BMI and EH.

Keywords: *Body mass index, crowding, enamel hypoplasia, malnutrition, nutrition, Sundanese*

Background

Physiological growth depends on the variety and amount of nutrients obtained from food consumed, digestion, absorption, and metabolism, which provide the body with the right substances, in the right place, and at the right time.[1] Nutrition is a component of food that helps to nourish the body, consisting of carbohydrates, fats, proteins, vitamins, minerals, and water.[2] Malnutrition is a multidimensional phenomenon wherein a nutritional deficiency results from the reduction of relative or absolute essential nutrients.[3,4] The prevalence of underweight in children aged 5–12 years is 11.2%, consisting of 4.0% very underweight and 7.2% underweight.[5] Malnutrition often occurs in groups of school-aged children (6–12 years old), especially with a lack of calories, protein, iodine, iron, and vitamins in their diet.[6]

Anthropometry is a growth status parameter that can be used to assess nutritional status by measuring physical dimensions and body composition, and it can provide information about the past nutritional status history.[7,8] Growth occurs because of the increase in body cells from one time to another.[9] The body mass index (BMI) is an easy method of measuring and calculating, and it is the most widely used diagnostic tool to identify the nutritional condition of a population; it can be used as a measurement scale for the assessment of malnutrition in children.[10,11]

Nutritional deficiencies during the period of growth can cause enamel hypoplasia (EH) and disruption of jaw bone growth, resulting in tooth crowding.[8] EH is a structural abnormality in teeth characterized by a disturbance in the process of forming the enamel matrix by forming pits, grooves or surface of the enamel that is lost.[12] Crowding is a discrepancy between the clinical length of the dental arch and the amount of mesiodistal width in the teeth.[13] Research conducted by Thomaz and Valenca revealed an association between body weight

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based on age and an increased prevalence of crowding in children aged 3–5 years.[14] Research conducted by Schlegel and Satravaha on 110 Sundanese boys and girls found that the prevalence of tooth crowding was 85%.[15] Moreover, research conducted by Murniwati on minang tribes (Deutero-malayan racial group) at the Faculty of Dentistry of Andalas University found that crowding occurred in 49.2% of cases.[16] Malnutrition can inhibit the growth and development of facial bones and result in reduced space available for erupted permanent teeth.[17-19]

EH is the most common disorder of enamel development, and it is usually seen in children with nutritional deficiencies.[6,20] Research conducted by Kaushal *et al*. aimed at evaluating the relationship of malnutrition with malocclusion, dental caries, EH, and salivary flow in 120 children in India showed that 88 children with underweight had EH.[21]

Malocclusion is an oral health problem ranked third after caries and periodontal diseases.[22,23] Malocclusion examination needs to be conducted during the prepubertal stage so that, if any malocclusions are found, early treatment can be initiated. If malocclusion is neglected, an increasing severity of malocclusion can cause emotional problems and undermine a child's confidence.[24] Susilowati's study of 157 children obtained prevalence rates of anterior dental malocclusion of 26.75% for crowding, 9.55% for protrusion, and 6.37% for diastema.[25]

The Sundanese population comprises more than 34 million people, representing the second largest ethnic group in Indonesia.[26] Growth problems among school-aged children in West Java have a prevalence of boys in the underweight category of 10.9% and in girls of 8.3%, which is higher compared to Bali and North Sulawesi.[27] In 2018, reported that the proportion of nutritional status is very short and short in toddlers in West Java province reaches 30.8%, and this province ranks 17th out of 34 provinces in Indonesia.[28] In 2013, the prevalence of underweight in infants was 10.9% in West Java.[29] Thus, the objective of this study is to analyze the correlation of BMI with anterior crowding and EH in Sundanese children aged 9–12 years.

Materials and Methods

This analytic, observational study with a cross-sectional data design was conducted in state owned elementary school in the municipality of Bandung, Indonesia. The inclusion criteria for subjects were as follows: Sundanese children (two bloodlines, where the children had Sundanese fathers, mothers, and all four grandparents) aged 9–12 years; willingness to be the subjects of research, where parents/guardians signed a consent statement; and not currently being treated with orthodontics (removable/fixed). Subject exclusion criteria were children with persistent mandibular anterior teeth and children with supernumerary teeth, fusion, caries, and conical tooth shape. The subjects were state owned elementary school children of Sukawarna, Caringin, Warung Jambu, and Griya Bumi Antapani who met the inclusion and exclusion criteria. Cluster random sampling was used for recruiting the subjects.

Anterior crowding in the study subjects was determined by assessing six anterior teeth of the mandibular permanent teeth, the first left and right central incisors, left and right lateral incisors, and left and right canines. Each mandibular anterior tooth was calculated based on its rotation and deviation. The six tooth scores are added together and if the number is the same or more than 5, it is included in anterior crowding. The measurement of the severity of EH is carried out by clinical examination, and the subjects were divided into three categories – mild, moderate, and severe. Mild severity was characterized by single/plural pits and little loss of shallow enamel. Moderate severity grooves were defined as loss of enamel with a depth <2 mm. Finally, severe cases involve the loss of part or all of the crown enamel.

The number of subjects in this study was calculated using a correlative formula and a minimum number of research subjects was obtained as many as 196 people.[31] Data collection was carried out after the proposal was approved by the Ethics Committee of the Faculty of Dentistry, Trisakti University, Jakarta (approval number 247/S2/KEPK/FKG/3/2019). Parents were given informed consent forms and questionnaires to be filled out. In this research, no intervention was performed on the research subjects. The data collected came from questionnaires and examinations in children. To meet the principles of research ethics, the following measures were incorporated: subject confidentiality, parental consent, and not mentioning the identity of parents or research subjects.

Statistical analysis

The correlations between the BMI variable and anterior crowding and EH were tested using the Spearman correlation test performed using the Statistical Package for the Social Sciences (IBM, NY, USA).

Results

The frequency distribution of BMI based on age is shown in Table 1. Table 1 shows the BMI with an underweight category in the age group of 9.10, and 11 years showed the highest value compared to the normal and overweight categories. The 10-year age

Table 1: Frequency distribution of body mass index

Age	BMI (%)			Total
	Underweight	Normal	Overweight	
Age 9	16 (69.56)	7 (30.44)	0	23
Age 10	67 (81.71)	15 (18.29)	0	82
Age 11	63 (76.83)	18 (21.95)	1 (1.22)	82
Age 12	10 (47.62)	10 (47.62)	1 (4.76)	21
Total	156 (75)	50 (24.04)	2 (0.96)	208

BMI: Body mass index

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group showed the highest underweight category of all age groups, 67 children (81.71%). Table 2 shows that more subjects had crowding than did not have crowding in 9, 10, 11, and 12 years' age groups. The 10-year age group showed the highest anterior crowding, with 61 children (74.39%).

The results of the EH measurements are shown in Table 3. It was found that 54 children (25.96%) had mild hypoplasia of all categories in the age group, 8 children (3.85%) had moderate hypoplasia.

The correlation of BMI based on the underweight, normal weight, and overweight categories and anterior crowding is shown in Table 4. The BMI of the underweight category showed the highest average value of 4.769, with a standard deviation of 1.965, and the overweight category showed the lowest average value of 3.5, with a standard deviation of 2.1. The correlation of BMI with enamel hypoplasia is shown in Table 5. The BMI of the overweight category showed an average value of 1, with a standard deviation of 1.00, and the underweight and normal categories both exhibited an average value of 0.33, with standard deviations of 0.549 and 0.557, respectively.

The correlation coefficient (r) for anterior crowding showed a result of − 0.138, $P = 0.024$, and the correlation coefficient for EH was 0.089, $P = 0.102$. The correlation coefficient values of BMI based on anterior crowding and EH are shown in Table 6. As shown in Table 6, the probability value of anterior crowding was 0.024, which is meets the level of significance level ($P < 0.05$), meaning there was a correlation between BMI and nonsignificanct ($P > 0.05$), meaning that there was no correlation between BMI and EH.

Discussion

The assessment of nutritional status in research subjects uses the BMI, which is the best assessment used to identify nutritional problems in children. Table 1 shows that the subjects aged 9 − 11 years had the highest BMI for the underweight category, while at 12 years, the underweight and normal weight categories had the same number of 10 children, (47.62%). Consumption of food with a balanced nutritional content has an important role in school-aged children for promoting optimal growth, development, and health. Low nutritional status is influenced by several factors, including lack of food availability, poverty, lack of knowledge about balanced nutrition. Children often consume more food outside the home. There are 2 state owned elementary school where the study was conducted does not yet have a school canteen, so the school children generally have snacks around the school, and there is no special food supervision. Economic factors also affect the availability of balanced nutrition.[1,7-9]

Crowding can occur due to an imbalance between the size of the dental arch with the jaw arch. Anterior crowding was found in all age groups, as shown in Table 2. The highest prevalence was found at the age of 10 years in 61 children (74.39%). As shown in Table 6, the correlation coefficient (r) for anterior crowding showed a value of −0.138, $P = 0.024$. This means that the BMI was correlated with anterior crowding, although the correlation was weak.

Nutrition affects the growth and development of children; nutritional deficiencies can cause problems with the oral structure, inhibited tooth eruption, and decreased radicular osteo cementum. Nutritional deficiency can cause underdevelopment of the mandible and maxilla, disruption of collagen fiber formation, and odontoblast atrophy, as well as thickening of the mandibular process. It plays an important role in the growth and development of the jaw. Poor nutrition can cause interference with the formation of the jaw, such that it becomes narrow and underdeveloped. Incorrect jaw arches will cause the teeth to become irregular.[30,31] Tooth crowding can be caused because the available size of the jaw arch is smaller than the size of the teeth; Malnutrition can inhibit jaw growth. The effects of malnutrition can influence the growth and development of facial bones and the development of muscles.[32-34]

Research conducted by Thomaz and Valenca indicated an association between body weight based on age and an increased prevalence of crowding in children aged 3−5 years.[15] The correlation coefficient for EH was 0.089,

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Table 2: Anterior crowding frequency distribution based on age groups

Ages	Anterior crowding (%)		Total
	Yes	No	
Age 9	15 (65.22)	8 (34.78)	23
Age 10	61 (74.39)	21 (25.61)	82
Age 11	54 (65.85)	28 (34.15)	82
Age 12	15 (71.43)	6 (28.57)	21
Total	145 (69.71)	63 (30.29)	208

Table 3: Frequency distribution of enamel hypoplasia

Ages	EH (%)				Total
	None	Mild	Moderate	Severe	
Age 9	21 (91.30)	1 (4.35)	1 (4.35)	0	23
Age 10	65 (79.27)	12 (14.63)	5 (60.97)	0	82
Age 11	50 (60.97)	31 (37.81)	1 (1.22)	0	82
Age 12	10 (47.62)	10 (47.62)	1 (4.76)	0	21
Total	146 (70.19)	54 (25.96)	8 (3.85)	0	208

EH: Enamel hypoplasia

Table 4: Correlation of body mass index with anterior crowding

BMI	Anterior crowding	
	Average	SD
Underweight	4.769	1.965
Normal	3.82	0.983
Overweight	3.5	2.1

BMI: Body mass index, SD: Standard deviation

Table 5: Correlation of body mass index with enamel hypoplasia

BMI	EH	
	Average	SD
Underweight	0.33	0.549
Normal	0.33	0.557
Overweight	1	1.00

EH: Enamel hypoplasia, BMI: Body mass index, SD: Standard deviation

Table 6: Correlation coefficient of body mass index based on anterior crowding and enamel hypoplasia

	Anterior crowding		EH	
	Correlation coefficient	*P*	Correlation coefficient	*P*
BMI	−0.138*	0.024	0.089	0.102

*Significant. BMI: Body mass index, EH: Enamel hypoplasia

$P = 0.102$. This means that the BMI had a correlation with EH, although the correlation strength is very weak. $P = 0.102$ was greater than the level of significance ($\alpha < 0.05$), which means there is no correlation between BMI and EH. Disturbances during tooth growth and development that result in abnormalities in the enamel structure occurring during the formation of the enamel matrix can arise due to both local and systemic factors affecting enamel formation.[34,35] As a result of such factors, the formation of the enamel matrix becomes imperfect.[33] Systemic factors include trauma at birth, nutritional disorders, exanthematous disease, congenital syphilis, and infection.[35,36] Local factors, such as trauma and apical infections of primary teeth, result in damage to the epithelium lining of the permanent tooth replacement.[35]

Conclusion

There is a correlation of BMI with anterior crowding but no correlation between BMI and EH. Further research can be done on other factors such as genetic factors, habit factors that can influence crowding.

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Conflicts of interest

There are no conflicts of interest.

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Original Article

Correlation between Body Mass Index with Anterior Crowding and Enamel Hypoplasia of Sundanese Children in Bandung

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Background: Nutrition affects the growth of bones and teeth. Malnutrition can cause teeth to become irregular and undergo enamel hypoplasia (EH). To assess malnutrition, the body mass index (BMI) can be used. **Objective:** This study aims to analyze the correlation of BMI with anterior crowding and EH in Sundanese children aged 9–12 years. **Method:** This analytic observational study with a cross-sectional design was done in four public elementary schools in Bandung taken by random cluster sampling. The study subjects comprised 208 children, with 90 boys and 118 girls. Data analysis used correlation coefficients with the Kolmogorov–Smirnov normality test. **Result:** The probability value of the correlation between BMI and anterior crowding was 0.24, which meets the significance level (α <0.05). The probability value between the BMI and EH was 0.102, which is not significant (α >0.05). **Conclusion:** There is a correlation between BMI and anterior crowding, but there is no correlation between BMI and EH.

Keywords: *Body mass index, crowding, enamel hypoplasia, malnutrition, nutrition, Sundanese*

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Background

Physiological growth depends on the variety and amount of nutrients obtained from food consumed, digestion, absorption, and metabolism, which provide the body with the right substances, in the right place, and at the right time.[1] Nutrition is a component of food that helps to nourish the body, consisting of carbohydrates, fats, proteins, vitamins, minerals, and water.[2] Malnutrition is a multidimensional phenomenon wherein a nutritional deficiency results from the reduction of relative or absolute essential nutrients.[3,4] The prevalence of underweight in children aged 5–12 years is 11.2%, consisting of 4.0% very underweight and 7.2% underweight.[5] Malnutrition often occurs in groups of school-aged children (6–12 years old), especially with a lack of calories, protein, iodine, iron, and vitamins in their diet.[6]

Anthropometry is a growth status parameter that can be used to assess nutritional status by measuring physical dimensions and body composition, and it can provide information about the past nutritional status history.[7,8] Growth occurs because of the increase in body cells from one time to another.[9] The body mass index (BMI) is an easy method of measuring and calculating, and it is the most widely used diagnostic tool to identify the nutritional condition of a population; it can be used as a measurement scale for the assessment of malnutrition in children.[10,11]

Nutritional deficiencies during the period of growth can cause enamel hypoplasia (EH) and disruption of jaw bone growth, resulting in tooth crowding.[8] EH is a structural abnormality in teeth characterized by a disturbance in the process of forming the enamel matrix by forming pits, grooves or surface of the enamel that is lost.[12] Crowding is a discrepancy between the clinical length of the dental arch and the amount of mesiodistal width in the teeth.[13] Research conducted by Thomaz and Valenca revealed an association between body weight

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based on age and an increased prevalence of crowding in children aged 3–5 years.[14] Research conducted by Schlegel and Satravaha on 110 Sundanese boys and girls found that the prevalence of tooth crowding was 85%.[15] Moreover, research conducted by Murniwati on minang tribes (Deutero-malayan racial group) at the Faculty of Dentistry of Andalas University found that crowding occurred in 49.2% of cases.[16] Malnutrition can inhibit the growth and development of facial bones and result in reduced space available for erupted permanent teeth.[17-19]

EH is the most common disorder of enamel development, and it is usually seen in children with nutritional deficiencies.[6,20] Research conducted by Kaushal *et al*. aimed at evaluating the relationship of malnutrition with malocclusion, dental caries, EH, and salivary flow in 120 children in India showed that 88 children with underweight had EH.[21]

Malocclusion is an oral health problem ranked third after caries and periodontal diseases.[22,23] Malocclusion examination needs to be conducted during the prepubertal stage so that, if any malocclusions are found, early treatment can be initiated. If malocclusion is neglected, an increasing severity of malocclusion can cause emotional problems and undermine a child's confidence.[24] Susilowati's study of 157 children obtained prevalence rates of anterior dental malocclusion of 26.75% for crowding, 9.55% for protrusion, and 6.37% for diastema.[25]

The Sundanese population comprises more than 34 million people, representing the second largest ethnic group in Indonesia.[26] Growth problems among school-aged children in West Java have a prevalence of boys in the underweight category of 10.9% and in girls of 8.3%, which is higher compared to Bali and North Sulawesi.[27] In 2018, reported that the proportion of nutritional status is very short and short in toddlers in West Java province reaches 30.8%, and this province ranks 17th out of 34 provinces in Indonesia.[28] In 2013, the prevalence of underweight in infants was 10.9% in West Java.[29] Thus, the objective of this study is to analyze the correlation of BMI with anterior crowding and EH in Sundanese children aged 9–12 years.

Materials and Methods

This analytic, observational study with a cross-sectional data design was conducted in state owned elementary school in the municipality of Bandung, Indonesia. The inclusion criteria for subjects were as follows: Sundanese children (two bloodlines, where the children had Sundanese fathers, mothers, and all four grandparents) aged 9–12 years; willingness to be the subjects of research, where parents/guardians signed a consent statement; and not currently being treated with orthodontics (removable/fixed). Subject exclusion criteria were children with persistent mandibular anterior teeth and children with supernumerary teeth, fusion, caries, and conical tooth shape. The subjects were state owned elementary school children of Sukawarna, Caringin, Warung Jambu, and Griya Bumi Antapani who met the inclusion and exclusion criteria. Cluster random sampling was used for recruiting the subjects.

Anterior crowding in the study subjects was determined by assessing six anterior teeth of the mandibular permanent teeth, the first left and right central incisors, left and right lateral incisors, and left and right canines. Each mandibular anterior tooth was calculated based on its rotation and deviation. The six tooth scores are added together and if the number is the same or more than 5, it is included in anterior crowding. The measurement of the severity of EH is carried out by clinical examination, and the subjects were divided into three categories – mild, moderate, and severe. Mild severity was characterized by single/plural pits and little loss of shallow enamel. Moderate severity grooves were defined as loss of enamel with a depth <2 mm. Finally, severe cases involve the loss of part or all of the crown enamel.

The number of subjects in this study was calculated using a correlative formula and a minimum number of research subjects was obtained as many as 196 people.[31] Data collection was carried out after the proposal was approved by the Ethics Committee of the Faculty of Dentistry, Trisakti University, Jakarta (approval number 247/S2/KEPK/FKG/3/2019). Parents were given informed consent forms and questionnaires to be filled out. In this research, no intervention was performed on the research subjects. The data collected came from questionnaires and examinations in children. To meet the principles of research ethics, the following measures were incorporated: subject confidentiality, parental consent, and not mentioning the identity of parents or research subjects.

Statistical analysis

The correlations between the BMI variable and anterior crowding and EH were tested using the Spearman correlation test performed using the Statistical Package for the Social Sciences (IBM, NY, USA).

Results

The frequency distribution of BMI based on age is shown in Table 1. Table 1 shows the BMI with an underweight category in the age group of 9.10, and 11 years showed the highest value compared to the normal and overweight categories. The 10-year age

Table 1: Frequency distribution of body mass index

Age	BMI (%)			Total
	Underweight	Normal	Overweight	
Age 9	16 (69.56)	7 (30.44)	0	23
Age 10	67 (81.71)	15 (18.29)	0	82
Age 11	63 (76.83)	18 (21.95)	1 (1.22)	82
Age 12	10 (47.62)	10 (47.62)	1 (4.76)	21
Total	156 (75)	50 (24.04)	2 (0.96)	208

BMI: Body mass index

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group showed the highest underweight category of all age groups, 67 children (81.71%). Table 2 shows that more subjects had crowding than did not have crowding in 9, 10, 11, and 12 years' age groups. The 10-year age group showed the highest anterior crowding, with 61 children (74.39%).

The results of the EH measurements are shown in Table 3. It was found that 54 children (25.96%) had mild hypoplasia of all categories in the age group, 8 children (3.85%) had moderate hypoplasia.

The correlation of BMI based on the underweight, normal weight, and overweight categories and anterior crowding is shown in Table 4. The BMI of the underweight category showed the highest average value of 4.769, with a standard deviation of 1.965, and the overweight category showed the lowest average value of 3.5, with a standard deviation of 2.1. The correlation of BMI with enamel hypoplasia is shown in Table 5. The BMI of the overweight category showed an average value of 1, with a standard deviation of 1.00, and the underweight and normal categories both exhibited an average value of 0.33, with standard deviations of 0.549 and 0.557, respectively.

The correlation coefficient (r) for anterior crowding showed a result of − 0.138, $P = 0.024$, and the correlation coefficient for EH was 0.089, $P = 0.102$. The correlation coefficient values of BMI based on anterior crowding and EH are shown in Table 6. As shown in Table 6, the probability value of anterior crowding was 0.024, which is meets the level of significance level ($P < 0.05$), meaning there was a correlation between BMI and nonsignificanct ($P > 0.05$), meaning that there was no correlation between BMI and EH.

Discussion

The assessment of nutritional status in research subjects uses the BMI, which is the best assessment used to identify nutritional problems in children. Table 1 shows that the subjects aged 9 − 11 years had the highest BMI for the underweight category, while at 12 years, the underweight and normal weight categories had the same number of 10 children, (47.62%). Consumption of food with a balanced nutritional content has an important role in school-aged children for promoting optimal growth, development, and health. Low nutritional status is influenced by several factors, including lack of food availability, poverty, lack of knowledge about balanced nutrition. Children often consume more food outside the home. There are 2 state owned elementary school where the study was conducted does not yet have a school canteen, so the school children generally have snacks around the school, and there is no special food supervision. Economic factors also affect the availability of balanced nutrition.[1,7-9]

Crowding can occur due to an imbalance between the size of the dental arch with the jaw arch. Anterior crowding was found in all age groups, as shown in Table 2. The highest prevalence was found at the age of 10 years in 61 children (74.39%). As shown in Table 6, the correlation coefficient (r) for anterior crowding showed a value of −0.138, $P = 0.024$. This means that the BMI was correlated with anterior crowding, although the correlation was weak.

Nutrition affects the growth and development of children; nutritional deficiencies can cause problems with the oral structure, inhibited tooth eruption, and decreased radicular osteo cementum. Nutritional deficiency can cause underdevelopment of the mandible and maxilla, disruption of collagen fiber formation, and odontoblast atrophy, as well as thickening of the mandibular process. It plays an important role in the growth and development of the jaw. Poor nutrition can cause interference with the formation of the jaw, such that it becomes narrow and underdeveloped. Incorrect jaw arches will cause the teeth to become irregular.[30,31] Tooth crowding can be caused because the available size of the jaw arch is smaller than the size of the teeth; Malnutrition can inhibit jaw growth. The effects of malnutrition can influence the growth and development of facial bones and the development of muscles.[32-34]

Research conducted by Thomaz and Valenca indicated an association between body weight based on age and an increased prevalence of crowding in children aged 3−5 years.[15] The correlation coefficient for EH was 0.089,

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Table 2: Anterior crowding frequency distribution based on age groups

Ages	Anterior crowding (%)		Total
	Yes	No	
Age 9	15 (65.22)	8 (34.78)	23
Age 10	61 (74.39)	21 (25.61)	82
Age 11	54 (65.85)	28 (34.15)	82
Age 12	15 (71.43)	6 (28.57)	21
Total	145 (69.71)	63 (30.29)	208

Table 3: Frequency distribution of enamel hypoplasia

Ages	EH (%)				Total
	None	Mild	Moderate	Severe	
Age 9	21 (91.30)	1 (4.35)	1 (4.35)	0	23
Age 10	65 (79.27)	12 (14.63)	5 (60.97)	0	82
Age 11	50 (60.97)	31 (37.81)	1 (1.22)	0	82
Age 12	10 (47.62)	10 (47.62)	1 (4.76)	0	21
Total	146 (70.19)	54 (25.96)	8 (3.85)	0	208

EH: Enamel hypoplasia

Table 4: Correlation of body mass index with anterior crowding

BMI	Anterior crowding	
	Average	SD
Underweight	4.769	1.965
Normal	3.82	0.983
Overweight	3.5	2.1

BMI: Body mass index, SD: Standard deviation

Table 5: Correlation of body mass index with enamel hypoplasia

BMI	EH	
	Average	SD
Underweight	0.33	0.549
Normal	0.33	0.557
Overweight	1	1.00

EH: Enamel hypoplasia, BMI: Body mass index, SD: Standard deviation

Table 6: Correlation coefficient of body mass index based on anterior crowding and enamel hypoplasia

	Anterior crowding		EH	
	Correlation coefficient	*P*	Correlation coefficient	*P*
BMI	−0.138*	0.024	0.089	0.102

*Significant. BMI: Body mass index, EH: Enamel hypoplasia

P = 0.102. This means that the BMI had a correlation with EH, although the correlation strength is very weak. P =0.102 was greater than the level of significance ($\alpha < 0.05$), which means there is no correlation between BMI and EH. Disturbances during tooth growth and development that result in abnormalities in the enamel structure occurring during the formation of the enamel matrix can arise due to both local and systemic factors affecting enamel formation.[34,35] As a result of such factors, the formation of the enamel matrix becomes imperfect.[33] Systemic factors include trauma at birth, nutritional disorders, exanthematous disease, congenital syphilis, and infection.[35,36] Local factors, such as trauma and apical infections of primary teeth, result in damage to the epithelium lining of the permanent tooth replacement.[35]

Conclusion

There is a correlation of BMI with anterior crowding but no correlation between BMI and EH. Further research can be done on other factors such as genetic factors, habit factors that can influence crowding.

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Conflicts of interest

There are no conflicts of interest.

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