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Research Report

The correlation between dental caries and serum iron (Fe) levels in female students of Mamba'ul Khoiriyatil Islamiyah (MHI) Madrasa in Jember, East Java, Indonesia

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ABSTRACT

Background: *Dental caries may cause discomfort and pain when chewing food, which in turn leads to insufficient absorption of nutrients, including iron, by the body. Lack of iron intake can cause iron-deficiency anaemia. Iron deficiency may also decrease salivary secretion and buffer capacity due to reduced salivary gland function, which may lead to dental caries.* **Purpose:** *This study aims to analyse the correlation between dental caries and serum iron (Fe) levels in the students of Mamba'ul Khoiriyati Islamiyah (MHI) Madrasa Aliyah in Bangsalsari Jember.* **Methods:** *Out of 71 students aged 15-18 years, 24 students were examined for caries with the DMF-T index and blood samples were also collected using the phlebotomy technique to assess the serum iron (Fe) level in μg/dL. The data were analysed using the Spearman's correlation test (α = 0.05).* **Results:** *The average DMF-T score was high (7 ± 3.4) and the average serum iron (Fe) level was below normal (38 ± 11.5 μg/dL). The Spearman's correlation test for dental caries and serum iron (Fe) levels showed significant results (p <0.05).* **Conclusion:** *The occurrence of dental caries correlates with serum iron (Fe) levels. The higher the level of serum iron (Fe), the lower the level of dental caries.*

Keywords: dental caries; iron-deficiency; students

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INTRODUCTION

Caries is the most common dental disease, and it is considered to be a major global dental and oral health problem.[1] Caries occurs due to the demineralisation process caused by acid bacterial activity from fermentable carbohydrates. Within a certain period of time, this process may damage tooth enamel, causing a cavity.[2] The prevalence of dental caries in Indonesia is relatively high, and has increased from 43.4% in 2007 to 53.2% in 2013.[3] The basic health research (BHR) carried out in 2013[3] also showed that the prevalence of caries tends to increase with age, as it was 1.4% in the 12-14 year age group and 1.8% in those aged 15-24 years. The national health and nutrition examination survey states the prevalence of caries in the age groups of 12-15 years and 16-19 years was 14.5% and 22.6% respectively.[4]

Anaemia or low haemoglobin levels in the blood denote a condition in which the body cannot meet physiological needs.[5] Anaemia is caused by iron deficiency in high-risk groups including children, women of childbearing age and pregnant women.[5] Younger women also commonly have increased iron needs as a result of rapid growth and mestruation.[6]

In 2005, the number of people worldwide with anaemia was 1.62 million. Women of childbearing age were among those with anaemia, who in 2011 accounted for 29% of the world population (528.7 million people).[5] The BHR in 2007 showed that the percentage of anaemia in Indonesia in women of childbearing age who were not pregnant (≥ 15 years) in urban areas was 19.7%. Furthermore, the percentage of anaemia in childbearing women aged 15-44 years was 35.3% in 2013.

This study aims to analyse the correlation between dental caries and serum iron (Fe) levels in the students of Mamba'ul Khoiriyatil Islamiyah Madrasa, Bangsalsari, Jember. According to the primary healthcare of Bangsalsari, there is a high prevalence of anaemia in female students at this school. Most of them live in dormitories and have separate classrooms from male students, making sampling easier. There are female students aged 15-18 years who need early intervention to avoid anaemia in future pregnancies.

MATERIALS AND METHODS

An analytic observational study was performed on 71 female students aged 15-18 years in Mamba'ul Khoiriyatil Islamiyah (MHI), a Madrasa Aliyah in Jember. The respondents were chosen by using purposive sampling. Blood serum was only taken from 24 students who met the inclusion criteria (willing to be respondents for dental check, physically healthy, not currently menstruating, having normal menstrual periods and not having a chronic disease).

All respondents had signed a consent form stating that they were willing to participate in this study. The respondents were also asked to fill in a form giving personal details (name, home address, age, level of parents' education, parents' occupation, family income, amount of pocket money and residence).

Dental caries was measured by using the decayed, missing, filled (teeth) (DMF-T) index. The tooth was diagnosed as decayed (D) if there was primary or recurrent caries. The missing (M) component related to teeth that had been extracted due to caries, or were indicated for extraction due to caries. The last component, filling (F), related to teeth that had been filled due to caries. The level of dental caries in each respondent was calculated by the sum of the components D, M and F.

The DMF-T index assessment was performed by a clinician using a disposable dental instrument kit (Dochem). The dental caries categories based on the DMF-T index were very low (6.5).[7] Serum iron (Fe) levels were measured in μg/dL. Blood samples were taken intravenously up to 3 cc, then put into a vacutainer tube GP and put in a cooler box (Marvel Hro-B35l) that had been filled with ice packs. The samples were then sent to the laboratory to measure the serum iron (Fe) levels using the phlebotomy technique. The procedure of taking blood serum was as follows. First, all the equipment needed for the procedure (sterile glass or plastic tubes with rubber caps, vacuum-extraction blood tubes, syringe, tourniquet, alcohol hand rub, 70% alcohol swabs for skin) was collected. Next, the patient was prepared for the procedure. The site for drawing blood was selected by extending the patient's arm and inspecting the antecubital fossa or forearm. The tourniquet was then applied about 4–5 finger widths above the venepuncture site and the vein re-examined. The operator then cleaned their hands, washing with soap and water if not visibly contaminated, otherwise cleaning with alcohol rub. After performing hand hygiene, the operator put on well-fitting, non-sterile gloves. The site was then cleaned with a 70% alcohol swab for 30 seconds and allowed to dry completely (30 seconds). The syringe was then injected and the blood drawn. Following this, the blood was put into a test tube. Finally, it was labelled and sent to the laboratory.[8]

The normality test showed that only the serum iron (Fe) level data were not normally distributed. The data were then analysed using the Spearman's correlation test with α = 0.05 to find the correlation between dental caries and serum iron (Fe) levels. All the procedures performed in this study have been reviewed and approved by the institutional ethical committee in the Faculty of Dentistry, University of Jember (certificate number 824/UN25.8/KEPK/DL/2019).

RESULTS

The data in Table 1 shows that the age range of students in MHI Madrasa was 15 to 18 years, with the majority (22 students) aged 15 years (31%). Parental education (father and mother) was mostly at elementary school level. There were 51 respondents who had fathers with elementary school education (71.8%), and 59 respondents who had mothers with elementary school education (83.1%). There were 39 respondents with fathers who were working as entrepreneurs (54.9%), and 36 respondents who had mothers who were housewives (50.7%). The majority of the respondents (45) were from low income families (≤ IDR 1,500,000/month) (63.4%). There were 57 students with an allowance of less than IDR 5000 per day (80.3%). The data revealed that 66 respondents (92.9%) lived in the dormitory and only 5 students (7.1%) lived with their parents.

There were 24 students who were asked about food consumption using food recall 2x24 hours. Most respondents were exposed to deficits in energy, protein, iron (Fe) and vitamin C (Table 2). According to Kusharto and Supariasa,[9] someone who has a daily intake of less than 89% of the recommended dietary allowance (RDA) has an energy and nutrient deficit. Adolescent girls who consume less food containing protein, iron (Fe) and vitamin C are more at risk of anemia.[10]

From the 71 students selected using the inclusion criteria, there were 24 students who were examined for dental caries and serum iron (Fe) levels. The dental caries examination was carried out using the DMF-T index. There were 23 respondents who had dental caries (95.8%). The results showed that the DMF-T score for the 24 students of MHI Madrasa was in the range of 0 to 13 with an average of 7 ± 3.4, which can be grouped into the very high category (Table 3).

The results of the examination of serum iron (Fe) levels showed an average of 38 ± 11.5 μg/dL and ranged from

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12 μg/dL to 50 μg/dL (Table 2). Normal serum iron (Fe) levels in adolescent girls are 50 μg/dL.[11] This indicated that the levels in these students were below normal, and some (10 respondents) might suffer from iron deficiency anaemia (83.3%).

The correlation between dental caries and serum iron (Fe) levels was then analysed using the Spearman's correlation test with a significance of p <0.05. The results showed a significant correlation between the DMF-T scores and serum iron (Fe) levels with a p value of 0.007. This showed that there is a correlation between dental caries and serum iron (Fe) levels (Table 4). The correlation is inverse, meaning the higher the level of serum iron (Fe), the lower the level of dental caries.

DISCUSSION

A high prevalence of dental caries is associated with low socioeconomic conditions.[12] Socioeconomic conditions can be measured using level of parental education, parental income and social status in the community.[13,14] The majority of respondents had parents with a low level of education. This may lead to dental caries as parents with a lower level of education may make poor choices about the level of acid intake of their children.[15] The socioeconomic level of these students was middle to low, due to the fact that the school is not close to any urban areas. This means that medical care, including dental and oral health care, is in shorter supply .[16]

Table 1. Characteristics of respondents

Characteristics	Total (n)	%
Age		
15 years old	22	31
16 years old	15	21.1
17 years old	18	25.4
18 years old	16	22.5
Total	71	100
Parents' education level		
Father		
Elementary School	51	71.8
Middle School	15	21.1
High School	5	7.1
Total	71	100
Mother		
Elementary School	59	83.1
Middle School	8	11.3
High School	4	5.6
Total	71	100
Parents' occupation		
Father		
Entrepreneur	39	54.9
Farmer	19	26.8
Trader	8	11.3
Construction worker	5	7
Total	71	100
Mother		
Entrepreneur	9	12.7
Farmer	15	21.1
Trader	11	15.5
Housewife	36	50.7
Total	71	100
Family income		
Low (≤ IDR1,500,000/month)	45	63.4
Medium (> IDR1,500,000 - IDR 2,500,000/month)	26	36.6
Total	71	100
Pocket money		
≤ IDR 5,000/day	57	80.3
> IDR 5,000/day - IDR 10,000/day	14	19.7
Total	71	100
Residence		
Dormitory	66	92.9
Outside Dormitory	5	7.1
Total	71	100

Table 2. Total intake of energy, protein, iron (Fe) and vitamin C per day students of MHI Madrasa, Bangsalsari, Jember

Variable	N	Category		Average/day/person
		Inadequate	Adequate	
Energy (Kcal)	24	23	1	1376
Protein (g)	24	24	0	36.5
Iron (Fe) (mg)	24	24	0	5.9
Vitamin C (mg)	24	24	0	13.4

Table 3. Data on the results of the level of dental caries and serum iron (Fe) levels of students of MHI Madrasa, Bangsalsari, Jember

Variable	N	Minimum	Maximum	Average	SD
Dental caries	24	0	13	7	3.4
Serum iron (Fe) level	24	12	50	38 μg/dL	11.5

Table 4. Spearman's correlation test of dental caries with serum iron (Fe) levels

Variable	p-value	Correlation coefficient	Notes
Dental caries - serum iron (Fe)	0.007	-0.539	There is correlation between dental caries and serum iron (Fe) levels.

Parental education, parental work and family income are linked. A higher level of education will lead to jobs with higher salaries.[17] Julianto and Utari[18] state that the level of education significantly influences the level of individual income, where the higher the level of education, the higher the income level. For these students, the low level of education of their parents (mainly their fathers) means that they often work as entrepreneurs with a low income (≤ IDR 1,500,000/month). This can lead to parents believing that dental care for their children is not urgent.[14]

Children who come from low socioeconomic backgrounds do not buy food based on nutritional value, but good taste and low price.[19] The majority of these students had an allowance of less than IDR 5000 per day. This amount of money can be used to buy snacks outside the home (dormitory) that are high in sodium, sugar and fat as well as high-sugar drinks.[20] The children who live with their parents eat food cooked by their mothers, who pay more attention to the nutritional content of the food being served to their families.[21]

The female students often consumed food containing less iron due to the problems associated with a low socioeconomic background.[22] Low haemoglobin levels can affect the inflammatory response in the pulp.[23] Haemoglobin in the blood carries oxygen to the tissues. If the level of haemoglobin in the blood decreases, hypoxia might occur in the tissues, which decreases the inflammatory response in the pulp and increases the level of dental caries.[23]

The DMF-T scores of the respondents averaged 7 ± 3.4. This score, according to the World Health Organization (WHO), is very high. This is probably caused by the consumption of snacks and beverages during the day, such as wafers and sweet tea. Food containing high sugar levels and improper tooth brushing behaviour causes dental caries.[24] Sugary foods tend to increase the occurrence of dental caries compared to fibrous foods.[25] The type of food consumed relates to the formation of dental caries. Consumption of frequent and repeated cariogenic foods will cause the pH of the oral cavity to become more acidic, which facilitates the demineralisation of enamel and formation of dental caries.[24] A good diet and regular dental care are very important to maintain the teeth and prevent vulnerability to cavities. Widayati[26] suggests that there is a need for information regarding the importance of 6 monthly dental and oral examinations for children.

The results of the serum iron (Fe) level examinations showed that the average serum iron (Fe) levels of MHI Bangsalsari Jember female students were below normal. Serum iron (Fe) is a microelement iron that is essential for the body. This substance is required in haematopoiesis (blood formation), specifically for the synthesis of haemoglobin (Hb). Haemoglobin (Hb) as oxygen that delivers erythrocytes is essential for the body. Haemoglobin consists of Fe (iron), protoporphyrin and globin (1/3 Hb weight consists of Fe).[27]

Anaemia generally occurs throughout the world, especially in developing countries. Overall, anaemia occurs in 45% of women in developing countries and in 13% of women in developed countries.[28] Anaemia is characterised by low concentrations of haemoglobin (Hb) or haematocrit of the threshold value. It is caused by low production of red blood cells (erythrocytes) and Hb, increased erythrocyte damage or excessive blood loss.[29]

There are several types of anaemia, but the most common is iron deficiency anemia.[29] It occurs due to an increased need for iron in the body such as during menstruation, pregnancy or childbirth, while only a small amount of iron is entering the body.[30] Adolescent girls are at risk from iron deficiency anaemia because they menstruate every month and lack knowledge about the condition.[31] The volume of blood lost during menstruation ranges from 30 to 50cc per month. This causes women to lose as much iron as 12-15 mg per month or 0.4-0.5 mg per day for 28 to 30 days. During menstruation, women also not only experience iron loss but also experience basal loss. In total, women can experience as much iron loss as 1.25 mg per day.[29]

Iron deficiency anaemia is caused by a lack of iron in the body for erythropoiesis. This is a condition characterised by hypochromic-microscopic red blood cells, decreasing levels of serum iron (Fe) and transferrin as well as a rise in the total iron binding capacity (TIBC). Also, reservation of the iron in the bone marrow and elsewhere is very poor or non-existent. Many factors can cause iron deficiency anaemia, such as profuse bleeding during injury, surgery, menstruation and an increased need for iron in pregnant women and for growth. Other causes include a lack of intake of iron and protein from food and impaired absorption of fluids caused by parasites in the body, such as hookworm or tapeworm. In these cases daily iron intake is needed to replace iron lost through faeces, urine and skin.[27]

The Spearman's correlation test for dental caries and serum iron (Fe) levels showed significant results (p <0.05). The results indicated a correlation between dental caries and serum iron (Fe) levels. Patients with high serum iron (Fe) levels have a low DMF-T score indicating a low prevalence of dental caries, while patients with low serum iron (Fe) levels have a high DMF-T score indicating a high prevalence of dental caries. From this study, it can be concluded there is an inverse correlation between serum iron (Fe) levels and dental caries. These results are in line with research conducted by Daryani et al.[32]

Untreated caries also causes acute and chronic inflammation such as pulpitis, periapical aphasia and fistulas that release various mediators, especially interleukin I and cytokines. Pulp pain at night causes sleep disturbance and decreases glycosteroid production. This decrease causes suppression of haemoglobin production in the blood, leading to anaemia caused by chronic inflammation due to the restrained erythropoiesis.[33]

Dental caries causes discomfort and pain when chewing. As a result, the food cannot be chewed properly, and thus the absorption of nutrients in the intestine is reduced. This can cause nutritional deficiencies, which also affect the iron levels in the body.[34] The most abundant source of iron is

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found in meat, chicken and fish. If the food is not chewed properly, then iron cannot be optimally absorbed by the small intestine.[33] Research by Nagarajan et al.[35] in children with iron deficiency anaemia showed an improvement in nutritional status after overall oral cavity treatment. The treatment relieves pain and therefore increases iron intake.

The theory of the correlation between serum iron (Fe) levels and dental caries is a two-way effect theory.[23] Serum iron (Fe) levels affect the occurrence of dental caries. Conversely, dental caries can also influence the risk of low serum iron (Fe) levels, which can lead to anaemia. The level of dental caries in those with anaemia can also increase due to the formation and decrease in calcification of dentin and enamel.[23] Thus, teeth are easily decalcified and caries might occur. In addition, people who experience severe anaemia usually consume drugs that contain sucrose and are taken frequently and continuously.[23] Sucrose is one of the components that can cause caries if consumed continuously.

Higher levels of dental caries can also occur in patients with anaemia who have complications and require inpatient care. Inpatients have a habit of not maintaining oral hygiene properly due to sufferers having difficulty in brushing their teeth routinely, worsening their oral hygiene and increasing the frequency of caries occurrence.[23]

Another theory states that iron deficiency affects salivary gland function. The function of the salivary glands of iron deficient patients tends to decrease. As a result, salivary secretion and buffer capacity are reduced, which increases the risk of dental caries.[36]

Also, the function of the salivary glands can be disrupted due to iron deficiency, causing reduced salivary secretion and low buffer ability. Salivary buffering is a mechanism to restore the pH of the oral cavity to normal. A low pH can cause tooth decay and damage mucosal surfaces. Saliva has a buffer function to prevent enamel demineralisation based on the phosphate and carbonic/bicarbonate system. When the buffer capacity is low, there is an increased risk of dental caries.[36] In addition, reduced salivary secretion also reduces simple mechanical rinsing, antimicrobial activity, calcium phosphate binding, immune surveillance and antimicrobial peptide secretion in the oral cavity. These are the main natural defence systems in the oral cavity.[37]

The current study supplements the evidence of correlation between dental caries and serum iron (Fe) levels in female students aged 15-18 years. Early intervention is needed to prevent health problems and achieve good health in future pregnancies. Our paper is unique, due to the fact that determination of dental caries using blood serum achieves better results than using saliva samples in general studies. Unfortunately, this study had limited samples due to the fact that many samples did not meet the inclusion criteria. Expansion of location and additional samples in further research are needed to gain the best understanding of oral health and nutritional problems in young women. In conclusion, there is a correlation between dental caries

and serum iron (Fe) levels. The higher the level of serum iron (Fe), the lower the level of dental caries.

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