ORIGINAL ARTICLE

Flow Rate and Salivary Buffer Capacity Based on Nutritional Status of Toddlers 3-5 Years Old in Silo II Public Health Center Area, Jember Regency Indonesia (A Cross-Sectional Study)

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ABSTRACT

Introduction: Nutrient deficits affect the development and function of the salivary glands, resulting in a decrease in flow rate and salivary buffering capacity. Salivary research has been associated with the epidemiology of infectious diseases. The objective of this study was to examine the flow rate and salivary buffer capacity of toddlers based on their nutritional condition, including normal, underweight, and stunted toddlers. **Method:** Analytical observational research using a cross-sectional design among children aged 3 to 5 years in the Silo II Public Health Center area (1027 toddlers), with purposive sampling of 285 (95 normal toddlers, 95 stunting toddlers, and 95 underweight toddlers). The research variables were flow rate, salivary buffer capacity, and nutritional status of toddlers. The measuring instruments used were measuring cups, pH meters, and anthropometric indices (Z-Szore) BB/U and TB/U. The research data were analyzed with descriptive statistical tests and continued with the Kruskal Wallis and Mann-Whitney tests. **Result:** The results of Kruskal Wallis test are the average flow rate for normal toddlers is 0.3905, underweight toddlers is 0.2187, and stunted toddlers is 0.1958. The average buffer capacity of normal toddlers is 5.0542, underweight is 2.4640, and stunting is 2.4395. The result of Mann-Whitney tests normal toddlers with underweight have a difference in flow rate and salivary buffer capacity(p-value = 0.000), normal toddlers with stunting have a difference in flow rate and salivary buffer capacity (p-value = 0.000), but underweight toddlers with stunting have no difference (p-value 0.199 and 0.247). **Conclusion:** There are differences in the flow rate and salivary buffer capacity of normal toddlers with underweight. There are differences in the flow rate and salivary buffer capacity of normal toddlers with stunting. There is no difference in flow rate and salivary buffer capacity of underweight toddlers with stunting.
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Keywords: Buffer capacity, Flow rate, Nutritional status, Saliva, Toddlers

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INTRODUCTION

Nutritional deficiencies result in changes in the structure and function of the salivary glands and a decrease in salivary flow rate. Decreased salivary secretion due to atrophy results in a decreased salivary flow rate. This situation is related to a lack of masticatory action in toddlers, which makes toddlers difficult to eat and affects their nutritional status (1–3). The impact of continued undernutrition in toddlers results in decreased salivary gland function and the risk of opportunistic diseases (4). Factors that affect salivary flow rate are salivary gland size, gender, medication consumption, salivary gland disorders, and nutritional status (4,5).

Saliva buffering capacity is one of the salivary characteristics other than flow rate. Salivary buffer capacity is the ability of saliva to endure pH fluctuations. It is essential for oral wellness because it helps to neutralize the acids created by bacteria in the mouth, which can lead to tooth decay (6). Maintaining a healthy salivary buffer capacity is critical for avoiding acid-related dental health problems. Maintaining a healthy salivary buffer capacity through good nutrition, stress management, and general oral health care is critical for maintaining dental health and avoiding oral health concerns (7).
Much of the research on saliva has been related to the epidemiology of infectious diseases. The objective of

this study was to examine saliva (flow rate and salivary buffer capacity) based on the nutritional status of toddlers, including those who were normal, stunted, and underweight. Stunted and underweight toddlers are both undernourished, stunting itself occurs from intrauterine to 1000 days of birth or 2 years and occurs chronically, while undernutrition can occur at any time when someone experiences nutritional deficiencies (8). Researchers examined toddlers aged 3-5 years on the premise that the golden age phase was able to understand other people's conversations, express their thoughts, and have a good level of cooperation (9,10).

Based on the EPPGBM report in February 2022, it was recorded that the Silo II Public Health Center area had a high prevalence of stunting, namely 1,269 toddlers. This is reinforced by data from the Ministry of Village and PDTT's E-Health Development Worker (E-HDW) report in March 2021 that Silo Sub-district has the highest stunting rate in Jember at 49% (11). The Silo sub-district is located in the highlands and is quite famous for its agricultural and plantation potential. Most of the people work in the agricultural and plantation sectors as laborers to meet their families' economic needs. People who work as plantation laborers in Silo Subdistrict indicate that in the area there are still many people with middle to lower economic conditions, which is one of the indirect causal factors for the large number of stunting rates in the area (12).

The objective of this research was to investigate differences in the flow rate and the salivary buffer capacity in toddlers based on their nutritional status.

MATERIALS AND METHODS

Analytical observational research using a cross-sectional design on children aged 3 to 5 years in the Silo II Public Health Center area. The study included 1027 toddlers. Sampling was obtained by purposive sampling in each category of nutritional status of 285 toddlers (95 normal toddlers, 95 stunting toddlers, and 95 underweight toddlers). The formula for calculating the sample size from Slovin (13), is

$$n=\frac{N}{1+Ne^{2+}}$$

$$n=\frac{1027}{1+1027(0,1)^2}$$

$$n\cong 91,1$$

$$n=95$$

Inclusion criteria are normal, stunted, and underweight toddlers aged 3-5 years with parents or guardians and willing to sign Informed Consent. Exclusion criteria were uncooperative respondents or those with systemic diseases/mental disorders. The study variables were flow rate, salivary buffer capacity, and nutritional status of toddlers. The salivary flow rate was evaluated using a Casio HS-70W-1 Stopwatch (Indonesia), Saliva Pot, Measuring Cup, and 10 cc syringe, and the results were classified as low (0.25), normal (0.25- 0.35 mL/min), and high (>0.35 mL/min) (14). Salivary buffer capacity was tested with a pH meter brand Lohand (Indonesia) and 5mmol HCL solution, and the results were classified as low (pH 4), normal (pH 4-5), and high (pH 5-7) (15). To test the salivary buffer capacity can be done by checking the pH by looking at the numbers on the pH device after the device is dipped in 5% HCl (HCL 5mmol/l). Testing the salivary buffer capacity in this study using the Ericsson method, as follows.

a. Mix 0.5 ml of saliva that has been collected with 1.5 ml of HCl solution 5mmol/l
b. Stir and centrifuge the two mixtures for 1 minute
c. Let stand for 10 minutes
d. Measure using a pH meter.(15)

It is necessary to calibrate the pH meter first so that the tool is more stable and accurate when used. The pH meter calibration steps that can be taken are as follows:

a. Enter calibration mode
b. Place the electrode into the first calibration buffer.
c. If doing a two-point calibration, use pH 7.01 buffer first, wait until the screen will display pH 7.01
d. Then continue calibration using pH 4.01 or pH 10.01 and wait until the screen will display the pH used 4.01 or 10.01, then the pH meter is ready for use.(16)

With anthropometric index measurement methods (Z-Score) BB/U and TB/U, the nutritional condition of children under five years old is classified as normal, underweight, or stunting. Underweight children based on BB/U is Z-score ≤ - 2.0 SD. Stunted toddlers based on TB/U is Z-score ≤ - 2.0 SD (17). Weight scales with the Camry ISO 9001: 2008 EB9003 brand (China) and Microtoise Nus-Lab brand (Indonesia) were used to measure the toddlers' weight and height. Silo II Public Health Center data were used to collect information on normal, underweight, and stunted toddlers.

The study's findings were collated and evaluated using descriptive statistical tests, and then the Kruskal Wallis tests were used to compare differences in flow rate and salivary buffer capacity between normal, underweight, and stunted toddlers. Followed by the Mann Whitney test to analyze differences in flow rate and salivary buffer capacity in 2 nutritional status categories. This research has received approval from The Ethical Committee of Medical Research Faculty of Dentistry University of Jember with Number: 1995/UN25.8/KEPK/DL/2023.

RESULT

The flow rate and salivary buffer capacity of toddlers aged 3-5 years in the working area of Silo II Jember Public Health Center were studied based on their nutritional condition (normal, underweight, and stunting). The study's findings are presented in table I and II.

Table I shows that there are minor differences in nutritional status between normal, underweight, and stunted toddlers, but the differences are not significant. Male and female toddlers have generally similar distributions regardless of nutritional status, implying that gender may not be a key influence in nutritional disparities.

Table I. Distribution of Respondents Based on Age and Gender

No	Respondent Characteristics	Nutritional Status		
		Normal	Under-weight	Stunting
1	Age	n (%	n %	n %
	25-36 months	36 37,9	24 25,2	32 33,7
	37-48 months	57 60	45 47,4	62 65,3
	49-60 months	2 2,1	26 27,4	1 1
	Total	95 100	95 100	95 100
2	Gender	n %	n %	n %
	Male	46 48,4	48 50,5	47 49,5
	Female	49 51,6	47 49,5	48 50,5
	Total	95 100	95 100	95 100

Table II. Distribution of Respondents Based on Parents' Education Level, and Parents' Occupation

No	Respondent Characteristics	Nutritional Status					
		Normal		Underweight		Stunting	
1	Parents' Education Level	n	%	n	%	n	%
	Elementary	52	54,7	53	55,8	55	57,9
	Junior High School	22	23,2	24	25,3	24	25,3
	Senior High School	21	22,1	18	18,9	16	16,8
	Higher Education	0	0	0	0	0	0
	Total	95	100	95	100	95	100
2	Parents' Occupation	n	%	n	%	n	%
	Civil Servants	2	2,1	0	0	0	0
	Entrepreneur	20	21	18	18,9	15	29,5
	Garden/ farm Laborer	72	75,8	76	80	76	66,3
	Unemployment	1	1,1	1	1,1	4	4,2
	Total	95	100	95	100	95	100

Table II shows that the majority of parents in all groups had completed elementary school, demonstrating a uniform educational background among respondents. No parents were found to have a higher degree, indicating a possible lack of higher-level educational resources. Garden/farm laborer is the most common occupation among parents, with a majority in each category working in this field. Civil servant occupations are notably lacking among the respondents' parents. Furthermore, the average flow rate and salivary buffer capacity based on the nutritional status of toddlers shows in Table III.

Table III shows toddlers with normal nutritional status had a considerably greater average salivary flow rate (0.3905 ± 0.10627) than underweight (0.2178 ± 0.0991) and stunted toddlers (0.1958 ± 0.09556). In a comparable way, toddlers with normal nutritional status had a much larger mean salivary buffer capacity (5.0542 ± 0.7922) than underweight (2.4640 ± 1.13162) or stunted toddlers (2.4395 ± 0.69408). Additionally, Kruskal Wallis and Mann Whitney tests were used to investigate differences in flow rate and buffer capacity

Table III. Mean and SD of Flow Rate and Salivary Buffer Capacity in Toddlers With Normal, Underweight, and Stunting Nutrition Status

No	Variable	n	Normal		Underweight		Stunting	
			Mean	SD	Mean	SD	Mean	SD
1	Salivary Flow Rate	95	0,3905	0,10627	0,2178	0,0991	0,1958	0,09556
2	Capacity Salivary Buffer	95	5,0542	0,79222	2,4640	1,13162	2,4395	0,69408

Table IV. Test of Differences in Flow Rate and Buffer Capacity in Toddlers With Normal, Underweight and Stunted Nutritional Status

Variable	p-value	Description
Salivary flow rate of normal-underweight-stunted toddlers	0.000	At least one pair of different groups
Salivary flow rate of normal-underweight toddlers	0.000	There are differences
Salivary flow rate of normal-stunted toddlers	0.000	There are differences
Salivary flow rate of underweight-stunted toddlers	0.199	There is no difference
Salivary buffer capacity of normal-underweight- stunted toddlers	0.000	At least one pair of different groups
Salivary buffer capacity of normal-underweight toddlers	0.000	There are differences
Salivary buffer capacity of normal-stunted toddlers	0.000	There are differences
Salivary buffer capacity of underweight-stunted toddlers	0.247	There is no difference

in normal, underweight, and stunted toddlers. The outcomes are shown in Table IV.

Table IV shows that there are differences in the flow rate and salivary buffer capacity between normal and underweight toddlers with a p-value of 0.000, differences between normal and stunted toddlers with a p-value of 0.000, and no differences between underweight and stunted toddlers with p-values of 0.199 and 0.247.

DISCUSSION

Most of the respondents were 37-48 months old with normal, underweight, and stunted toddlers. The number of male respondents is not much different from females. The age of a toddler has been recognized as an indicator that can influence nutritional status. Children below the age of five are especially at risk for malnutrition because their bodies require appropriate nutrients for growth and development, and they are prone to infections that can lead to malnutrition. Gender, in addition to age, is frequently connected with the nutritional condition of children under the age of five, but this is still a source of contention. Stunting affects both male and female toddlers equally (18).

Subdistrict Silo II is an area on the outskirts of Jember Regency that is located furthest from the city center, and its natural conditions are located in the highlands, which are almost 80% plantations. The education level of the majority is primary school (low category) and the occupation is farm laborer. Educational development in rural areas is lower than in urban areas. Villagers have lower motivation to learn, lack cultural stimulation, closed social atmosphere, and poverty. Low education in rural areas is accompanied by low socio-economic conditions (19). Human capital theory holds that education impacts labor's marginal productivity, which in turn determines income. Intellectual education is usually thought to be a form of economic capital, and higher education is preparation for labor. Education has an impact on production; education is linked to work (20). Education has a positive impact on employment rates in the short and long term (21). Education helps a person acquire the skills and knowledge needed to work. An increase in education provides an increase in the ability and quality of work (22).

Normal children had a higher average flow rate and salivary buffer capacity than underweight and stunted children. Nutritional status is a factor that affects salivary gland function. Malnutrition in children results in decreased salivary gland function resulting in decreased flow rate and salivary buffer capacity (1,2,23). In line with research on children in India aged 5-12 years, the order of salivary flow rate without and with the lowest stimulation is the stunting group (0.14 ± 0.04 ml/min), then the underweight group (0.21 ± 0.20 ml/min), and continued by the normal nutrition group (0.53 ± 0.15 ml/min) (1). The reduction in salivary flow rate is proportional to the degree of malnutrition (4).

A study in healthy children aged 6-15 years in Switzerland found a positive correlation between salivary flow rate and salivary buffer capacity without stimulation (24). Changes in the composition of bicarbonate (HCO_3^-) which plays a major role in determining the buffer capacity of saliva will increase if the salivary flow rate increases and vice versa (25,26). Salivary buffer capacity is related to salivary flow rate because one of the functions of saliva is as a buffer (27), so if the flow rate increases it will also be accompanied by an increase in salivary buffer capacity.

There are differences in the flow rate and salivary buffer capacity of normal toddlers with underweight and stunting. This is in line with research on children aged 6-12 years in Pantai Labu District which found significant differences in salivary flow rate (p=0.0001) and salivary buffer capacity (p=0.0001) in stunting and normal groups (28). In line with this, a study of children aged 1 to 5 years in Maceio City, Brazil found a link between salivary flow rate and nutritional status (p=0.015) (4). Reduced salivary secretion in malnourished children is caused by atrophy of the salivary glands, resulting in hyposalivation (23).

There is no difference in flow rate and salivary buffer capacity between underweight and stunted toddlers. This condition is due to underweight and stunted toddlers both experiencing chronic malnutrition, so both experiences decreased salivary secretion and disrupt the function of saliva for buffering (23,29).

Both the government and parents must take a proactive approach to ensuring the appropriate flow and buffering capacity of saliva in underweight and stunted toddler. The government needs to improve health facilities and infrastructure and more actively conduct promotive and preventive activities related to children's health. In addition, parents need to pay more attention to their children's health and conduct regular medical check-ups to avoid nutritional status disorders.

CONCLUSION

Underweight and stunted toddlers differ from their normal counterparts in flow rate and salivary buffer capacity. Furthermore, there is no substantial difference in these elements between underweight and stunted toddlers.

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