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THE DIFFERENCE OF ARCH PROFILES BETWEEN SCHOOLCHILDREN WITH AND WITHOUT FREE MEAL PROGRAM

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ABSTRACT
Introduction*: The development of the dental arch in childhood is influenced by nutritional status, masticatory habits, and orofacial functional stimulation. Free Nutritious Meal Program (Makan Bergizi Gratis/MBG) is a school-based nutritional intervention that may positively affect jaw growth by providing nutrient-rich foods with appropriate textures. This study aimed to compare maxillary and mandibular arch dimensions between children participating in the MBG program and those not enrolled in the program.* ***Methods****: A cross-sectional study was conducted among children aged 10–12 years who met the inclusion criteria from two elementary public schools. Intercanine width, intermolar width, arch length, and arch depth were measured on dental cast models. Data were statistically analyzed to assess differences between the MBG and non-MBG groups. Mann-Whitney test was used for non-normally distributed data, while T-test was used for normally distributed data.* ***Results:*** *Several dental arch parameters, including maxillary intercanine width, maxillary arch length, mandibular intermolar width, and mandibular arch length, were significantly greater in the MBG group compared to the non-MBG group ($p < 0.05$).* ***Conclusion:*** *Participation in the MBG program appears to support transverse and sagittal dental arch development, potentially through enhanced masticatory function and improved daily nutritional intake. These findings highlight the clinical relevance of school-based nutritional interventions as a promotive strategy for children's oral health and early malocclusion prevention.*

Keywords: *Free nutritious meal program, Jaw development, Malocclusion*

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INTRODUCTION

Malocclusion is a common disorder of the dental and jaw relationship that affects oral function, facial aesthetics, and overall oral health. It may present as crowding, spacing, or discrepancies in jaw relationships and has a multifactorial etiology involving genetic factors, nutrition, oral habits, and disturbances in craniofacial growth.[1–3] Multifaceted consequences of malocclusion encompass a broad spectrum of health implications, including masticatory dysfunction, an elevated risk of dental caries, speech impediments, and a diminished quality of life in pediatric populations.[2,4]

Furthermore, malnutrition has been shown to be associated with malocclusion particularly throughout the period of skeletal growth.[5] One of the key contributing factors to malocclusion is suboptimal jaw development, which reduces the available space for permanent tooth eruption and increases the risk of crowding.[6,7] Recent studies highlight the importance of nutrition particularly protein, micronutrients, and minerals in supporting maxillary and mandibular growth by promoting bone metabolism and hard tissue development.[8,9]

The ages of 9–11 years represent a critical growth spurt period for maxillary and mandibular development.[10] During this mixed dentition phase, key dental arch parameters such as intercanine width, intermolar width, and arch perimeter undergo significant changes.[11,12] Growth slowing, followed by pubertal growth, is reported to occur at 11.2 years in females and 13.0 years in males.[13] In humans, a recent anthropometric study in Indonesia showed that stunted children exhibit reduced vertical facial dimensions (Nasion-Subnasale and Subnasale-Menton), indicating nutritional stress affects facial height; This disturbance in skeletal growth may constrain arch length and depth, leading to insufficient space for teeth and predisposing to crowding or other forms of malocclusion.[14]

In response to persistent stunting and malnutrition in Indonesia, the government has launched the Free Nutritious Meal or "Makan Bersama Gratis" (MBG) program starting on January 2025 for elementary school students as an effort to improve daily nutritional adequacy.[15] Eating habits and nutrition status have been shown

in previous research to influence jaw growth.[16,17] Modern-day humans have narrower jaws and more jaw-related problems compared to their ancestors due to multiple factors, such as differences in diet, oral posture, lifestyle, and environment. These factors have been observed to cause visible progressive changes from generation to generation.[18] Components such as calcium, carbohydrate, fat, and several bioactive compounds has been shown to affect the jaw bone microarchitecture.[19] Nutritional deficiencies has also been linked with orofacial developmental anomalies.[20] Beyond its direct impact on nutritional status, the program may also provide indirect benefits for jaw development by offering balanced, nutrient-dense meals with textures that stimulate masticatory function. By ensuring adequate intake of key nutrients during critical windows of growth, MBG could support healthier craniofacial bone formation, potentially reducing the risk of malocclusion that arises from underdevelopment of jaw structures.

This study was conducted to observe the effects of this relatively new program so far, with a time range of 12 months. Although animal studies cannot be directly extrapolated to humans, several studies has shown differences in jaw growth and bone mineral density after dietary change within weeks to months.[17,21,22] Though most studies in humans involving jaw growth and diet or other external factors have been conducted over the course of years,[23,24] an intervention study in postmenopausal women showed changes in macro and micro bone structure after a three-month exercise program.[25] This suggests potential that the habitual mechanical stimulus of chewing, especially in children entering puberty, may also elicit an adaptive response. Another study showed that nutrition and dietary habits from birth to ages 3-5 were significantly associated with jaw development.[24] However, follow-up studies would be encouraged to observe subsequent developments.

This study aims to compare dental arch profiles between children who participate in the MBG program and those who do not, using dental arch dimension parameters. It also aims to investigate whether there are measurable changes in jaw dimensions and bone structure can be detected over a relatively short time period, and to what extent. This research seeks to determine whether improved nutrition and masticatory stimulation provided through the MBG program contribute to more optimal jaw development in school-aged children. This will be achieved through an evaluation of arch width, arch length, and arch depth.

The novelty of this research lies in evaluating the impact of the new MBG program on children's jaw development so far. The MBG program has only progressively started since January 2025. This study intends to see whether in this timeframe, this new program can already affect arch dimensions in schoolchildren. Therefore, it can be concluded that this study is the first to address this issue. The null hypothesis of this study is there is no difference between the dental arch dimensions of children who participate in the MBG program and those who do not. The alternative hypothesis is that there is a difference of arch dimensions between the two groups.

METHODS

Ethics

This study was approved by the ethical committees of the School of Medicine, Universitas Ciputra Surabaya and complied with the principles outlined in the International Ethical Guidelines for Health-related Research Involving Humans (2016) by Council for International Organizations of Medical Sciences (CIOMS).[26] Code of ethical approval letter was 282/EC/KEPK-FKUC/X/2025. Written informed consent was obtained by their parents or legal guardian for participation in this study. Intra- and extra-oral clinical examinations were performed to determine whether the participants met the inclusion criteria.

Study Design

This study was an analytical observational investigation using a cross-sectional design with a comparative analytic objective. The research was conducted in two public elementary schools (SDN) in Surabaya, East Java, Indonesia. A search was done for a search for two schools, with and without MBG within the same area, with the intention that both would have comparable demographics. This approach aimed to minimize the impact of demographic differences and confounding variables on the results.

Study Population

SDN Klampis Ngasem 3 was designated as the MBG group, representing a school that had implemented the MBG program for one full year, while SDN Keputran 1 served as the non-MBG group, representing a school that had not received the program. Total sampling of the whole population was used. Data collection was carried out in December 2025. Inclusion criteria in this study population consisted of all students aged 10–12 years in both schools. We selected this age range since growth of the maxilla, mandible, and cranial base was reported to start from 8.17-9.46 years old, reaching peak velocity at 12.57-14.28 years old on average.[27] A growth spurt of the maxilla and mandible happens at the ages of 9–11 years old.[10] Maxillary growth has been reported to increase in pace from ages 5-11 years, while mandibular growth reaches peak velocity around 13.6-14.5 years for males and 10-12 years for females.[28] Growth slowing has been reported to start as soon as 11.2 years in females and 13.0 years in males.[13] Samples were selected using total sampling based on the following inclusion criteria: (1) aged 10–12 years; (2) no history of orthodontic treatment; (3) no systemic abnormalities or chronic diseases that may affect craniofacial growth; (4) no history of head or facial trauma; (5) willingness to undergo clinical examination and dental arch impression taking; and (6) provision of written informed consent from parents or legal guardians.

Specific inclusion criteria for MBG group were: (1) participants who have received the MBG starting near the beginning of the program, that is for at least 12 consecutive months prior to the time of measurement, (2)

MBG attendance of ≥80% of sessions/program activities during the 12-month period (attendance defined according to program records). Specific inclusion criteria for non-MBG group were they have not received the MBG at any time during the 12 months preceding measurement.

Exclusion criteria for this study were: (1) children who are uncooperative or unable to undergo examination or impression procedures (e.g., severe behavioral disorders, cognitive limitations preventing compliance with instructions), (2) failure to obtain written parental/guardian consent or refusal to participate, (3) children who take vitamins that affect growth or bone metabolism, (4) participants with comorbidities which may affect measurement results, such as: congenital or syndromic craniofacial anomalies, long-term use of medications, and history of significant facial or jaw trauma within the past 12 months.

Data Collection

Extraoral and intraoral clinical examinations were carried out by three dentists to ensure that all subjects met the inclusion criteria. Examiners were calibrated by briefing to ensure the usage of same methods of measurement, measuring in the same room, and taking the mean of three measurements as result. Eligible participants subsequently underwent maxillary and mandibular impression taking using alginate impression material (Chromatic Alginate, Hygedent, China). All impressions were taken by a dentist with a minimum of nine years of clinical experience. Alginate mixing was performed according to the manufacturer's instructions to maintain optimal material consistency. Each impression was inspected to confirm that the entire dental arch had been captured accurately and without distortion. The impressions were then rinsed under running water, disinfected with an antiseptic spray, and immediately poured using dental stone (Elite Rock, Sandy Brown; Zhermack, Italy). Dental stone was prepared following the manufacturer's recommended ratio, and pouring was carried out carefully to minimize the risk of defects, including distortion and porosity, thereby ensuring high-quality study models.

Variables Measurements

Measurements of dental arch dimensions were performed on the maxillary and mandibular study models using a vernier caliper with an accuracy of ±0.2 mm. All measurements were performed by an orthodontist. To enhance reliability, each parameter was measured three times, and the mean value was recorded as the final data. Models were placed on a flat surface with the occlusal plane parallel to the tabletop. The specific landmarks recorded for this study were in millimeters (mm) such as Intercanine Width (IC) which was measured as the linear distance between the cusp tips of the right and left permanent canines. If cusp tips were worn or indistinct, the measurement was taken at the most prominent point of the canine crowns. Intermolar Width (IM) which was measured as the distance between the mesiobuccal cusp tips of the right and left first permanent molars. If cusp tips were indistinct, measurements were taken at the central fossae. Arch Length (AL) which was measured as a curvilinear distance following the contour of the dental arch, starting from the midpoint between the mesial contacts of the central incisors, extending to the canine cusp tips, and continuing to the mesiobuccal cusp tips of the first molars. Measurements were taken separately for the right and left sides, and total arch length was obtained by summing both sides and Arch Depth (AD) which was measured as the perpendicular distance from the most labial point of the central incisors to the line connecting the mesiobuccal cusp tips of the right and left first permanent molars. This parameter reflects the anteroposterior depth of the dental arch.

Statistical Analysis

Data analysis was performed using an independent sample t-test for normally distributed data and the Mann–Whitney U test for non-normally distributed data. IM, AL, and AD are normally distributed. Age and IC are not normally distributed. Statistical processing was conducted using IBM SPSS version 26 with a significance level of $p = 0.05$. The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

RESULTS

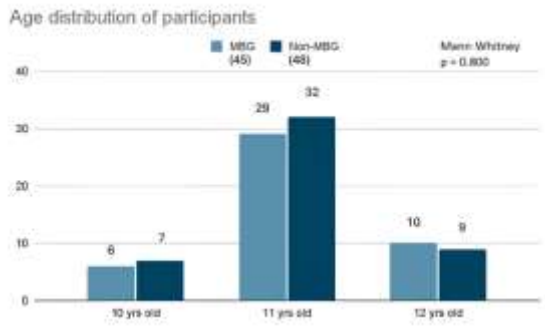

Figure 1. Age distribution of participants in MBG and non-MBG group

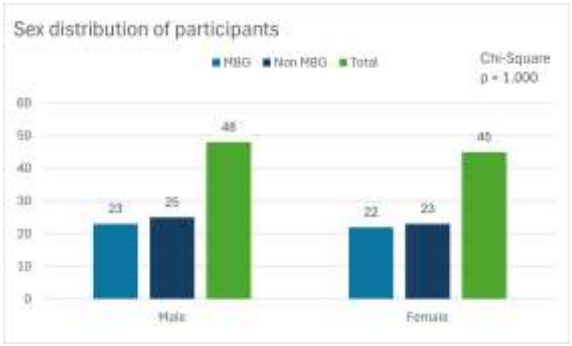

Figure 2. Sex distribution of participants in MBG and non-MBG group

The characteristic profiles of subjects in the MBG and non-MBG groups showed similar distribution. Based on sex, the proportion of male students in the MBG group was 23 students (51.10%), which was comparable to the non-MBG group with 25 students (52.10%). The proportion of female students was also comparable between

the two groups, with 22 students (48.90%) in the MBG group and 23 students (47.90%) in the non-MBG group. Statistical analysis using Chi-Square (p=1.000) indicated no significant difference between the groups based on sex distribution. The mean age of students in both the MBG and non-MBG groups was 11 years, with an age range of 10–12 years. The test results showed no significant difference in age distribution between the two groups (p = 0.800, Table 1). These findings indicate that both groups had homogeneous baseline characteristics.

Table 1. Age distribution in MBG and Non-MBG Groups

Group	n	Mean	Median	SD	Shapiro-Wilk			Mann-Whitney		
					Statistic	df	Sig.	Mean Rank	Sum of Ranks	p
MBG	45	11.040	11.000	0.767	0.808	45	0.000	46.310	2084.00	
Non-MBG	48	11.080	11.000	0.794	0.800	48	0.000	47.650	2287.00	
Total	93	11.060	11.000	0.777						0.800

Table 2. Analysis of differences in maxillary and mandibular Intercanine width (IC), Intermolar width (IM), Arch Length (AL), and Arch Depth (AD) between the MBG and Non-MBG Groups

Jaw	Variable	MBG	Non MBG	p - Value
Maxillary	Intercanine Width	32.200 ± 2.351	30.940 ± 2.273	0.011*
	Intermolar Width	51.470 ± 2.446	50.560 ± 2.240	0.066
	Arch Length	74.240 ± 4.890	72.040 ± 4.589	0.027*
	Arch Depth	26.710 ± 2.685	26.500 ± 2.744	0.709
Mandibular	Intercanine Width	24.730 ± 2.397	23.650 ± 1.929	0.069
	Intermolar Width	45.070 ± 2.580	43.250 ± 2.589	0.001*
	Arch Length	64.180 ± 5.445	61.920 ± 4.556	0.032*
	Arch Depth	23.020 + 2.379	22.330 + 2.692	0.195

Single asterisk symbol after p-value indicating p-value less than 0.05, double asterisk symbol after p-value indicating p-value less than 0.01

The analysis presented in Table 2 shows the comparison of maxillary arch dimensions between the MBG and non-MBG groups, revealing differences in several parameters. For maxillary intercanine width, the MBG group had a mean value of 32.200 ± 2.351 mm, which was higher than the non-MBG group with a mean of 30.940 ± 2.273 mm. This difference was statistically significant (p = 0.011). For maxillary arch length, the MBG group demonstrated a mean of 74.240 ± 4.890 mm, compared to 72.040 ± 4.589 mm in the non-MBG group, also showing a significant difference (p = 0.027). Meanwhile, maxillary intermolar width was slightly higher in the MBG group (51.470 ± 2.446 mm) than in the non-MBG group (50.560 ± 2.240 mm), but the difference was not statistically significant (p = 0.066). Similarly, maxillary arch depth showed comparable values between the MBG group (26.710 ± 2.685 mm) and the non-MBG group (26.500 ± 2.744 mm), with no significant difference (p = 0.709). Overall, these findings indicate that children participating in the MBG program exhibited larger dental arch dimensions in certain parameters, particularly maxillary intercanine width and maxillary arch length, compared with children who did not participate in the program.

The analysis of mandibular arch dimension differences between the MBG and non-MBG groups revealed several important findings. For mandibular intercanine width, the MBG group had a mean value of 24.730 ± 2.397 mm, higher than the non-MBG group with 23.650 ± 1.929 mm; however, this difference did not reach statistical significance (p = 0.069). For mandibular intermolar width, the MBG group had a mean value of 45.070 ± 2.580 mm, greater than the non-MBG group at 43.250 ± 2.589 mm, and this difference was statistically significant (p = 0.001), indicating that MBG participants had larger mandibular intermolar dimensions. Mandibular arch length also showed a significant difference, with the MBG group presenting a mean of 64.180 ± 5.445 mm compared to 61.920 ± 4.556 mm in the non-MBG group (p = 0.032), suggesting an influence of the MBG program on mandibular arch length. In contrast, mandibular arch depth showed no significant difference between the MBG

group (23.020 ± 2.379 mm) and the non-MBG group (22.330 ± 2.692 mm), with p = 0.195. These findings suggest that the MBG program is associated with certain mandibular arch growth parameters particularly intermolar width and arch length—but not with intercanine width or arch depth.

DISCUSSION

This study demonstrates differences in maxillary and mandibular arch dimensions between students who participated in the MBG program and those who did not. Several parameters, including maxillary intercanine width, maxillary arch length, mandibular intermolar width, and mandibular arch length, were greater in the MBG group, whereas other parameters showed no significant differences. These findings provide important insights into the potential role of school-based nutritional programs in supporting the development of children's orofacial structures.

The significant differences in maxillary intercanine width and maxillary arch length indicate that children participating in the MBG program exhibit more favorable maxillary arch development. A plausible biological mechanism is increased masticatory stimulation resulting from nutrient-dense and appropriately textured foods provided through the MBG program. Optimal masticatory activity has been shown to enhance muscle function and influence the transverse growth of the jaws. Sella-Tunis et al[29] suggested an association between masticatory muscle function and mandibular shape, while Liang et al[30] observed that the infant craniofacial system exhibits functional adaptation in response to masticatory forces. These findings are supported by Zhao et al[31], who reported that soft diets tend to reduce masticatory muscle activity and limit mandibular growth. Furthermore, Boo Gordillo et al[24] and Chow et al[32] showed that nutritional quality also affects orofacial structural development and masticatory function.

Significant differences in mandibular intermolar width and mandibular arch length further highlight the influence of the MBG program. The greater width and length observed in the MBG group suggests that the impact of improved and varied dietary intake extends beyond the maxilla. Perinetti and Contardo[33] and Montasser[34] explained that dentofacial growth during childhood is highly responsive to functional stimuli; thus, children who consume a more varied range of food textures are more likely to exhibit improved dentoalveolar arch development. Anand et al[2] and Dung et al[35] also noted that environmental factors such as oral habits and dietary patterns—are significant determinants of variability in dental arch dimensions.

Several other variables did not show significant differences between the MBG and non-MBG groups. The nonsignificant findings for maxillary intermolar width and mandibular intercanine width may be attributed to the relatively stable nature of these parameters and their strong hereditary component. Fujita and Maki[17] noted that dentofacial development, particularly in the posterior region, is strongly influenced by genetic factors, making short-term changes less observable. Meanwhile, the lack of significant differences in maxillary and mandibular arch depth may be related to the greater influence of sagittal skeletal relationships and incisor positioning on arch depth, as described by Alshammari et al.[1]

In a public health context, these findings are relevant because malocclusion has been recognized as a global health concern. Peres et al[36] highlighted those oral diseases, including malocclusion, pose a major worldwide health challenge. The prevalence of malocclusion among school-age children is influenced by factors such as nutrition and oral habits, and jaw development, as reported by Anand et al.[2] Suboptimal arch dimensions may increase the risk of future malocclusion. Studies by Škrinjarić et al[37] and Knigge et al[38] demonstrated that disruptions in arch growth contribute to the development of Class II and Class III malocclusions. Additionally, Göranson et al[39] noted that malocclusion negatively affects oral health related quality of life in adolescents. Thus, the present study adds to the evidence that nutrition-based interventions during childhood may help reduce the risk of malocclusion later in life. This study is also consistent with findings by Bulut et al[40], who emphasized the strong relationship between nutritional status and craniofacial development in children. Children with better nutritional intake tend to experience more optimal jaw growth, whereas poor nutritional status may negatively affect occlusal development and orofacial structures.

This study has several limitations. The cross-sectional design limits the ability to establish causal relationships between the MBG program and arch development. The one-year duration of the MBG program may not be sufficient to produce larger observable changes in certain structural parameters. Additionally, other factors that may influence jaw development, such as oral habits, mouth breathing, and family history of malocclusion, were not evaluated. The study relied on program attendance records to classify MBG exposure. These records, while official, may not fully capture the actual intake or consumption of the provided meals. The nutritional content of MBG meals although standardized was not directly evaluated, meaning variability in meal preparation, portion sizes, or the child's actual consumption could influence observed outcomes. Measurements based on conventional dental casts also carry potential technical variations that may affect precision. However, as the dentists were initially calibrated, the results are likely still valid since the variability in measurement techniques were minimized. Conducting further research would be beneficial to strengthen and verify the validity of these findings.

CONCLUSION

This study implicates that the Free Nutritious Meal (MBG) program has the potential to provide a positive impact on the development of dental arch dimensions in school aged children. These findings strengthen the evidence that adequate nutritional quality and masticatory stimulation play an important role in supporting the growth of orofacial structures and dental arch development during the mixed-dentition period. The MBG program, as a large scale government initiative, may therefore have benefits that extend beyond general health and academic performance, potentially reducing the risk of future malocclusion associated with constricted arches or inadequate arch length. Future longitudinal research incorporating detailed nutritional assessments, growth monitoring, and evaluation across multiple developmental stages is warranted to clarify the mechanisms underlying these associations and to strengthen causal inferences. Nonetheless, the present findings highlight the potential orthodontic and public health value of sustained nutritional support program for school-aged children.

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