

Impact Of Food Environment And Diet Quality On The Prevalence Of Low Weight In Children

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ABSTRACT

Background: The first five years of life is a critical time for the growth and development of a child. Malnutrition, notably underweight (weight-for-age Z-score < -2 SD), remains a global public health concern, impairing immune function and increasing disease susceptibility. An unhealthy food environment and poor diet quality can lead to irreversible health consequences.

Objective: The purpose of this cross-sectional study was to assess the food environment and diet quality, as well as their impact on the prevalence of low weight in children from urban and rural areas of Okara, Pakistan.

Study design: It was across-sectional study.

Place and Duration of study: The study was conducted at District Public School

located in an urban area and a government school of rural sector 2/4L, and from a middle-class community, Sidra Ghafoor town Okara.

Method: A structured questionnaire was developed to collect data on anthropometric measurements and diet quality from a randomly selected sample of 100 children. The anthropometric measurements were taken and compared to the WHO child growth standards for the assessment of weight-for-age z-score (underweight). The food environment was assessed for its affordability, accessibility, and availability of nutritious food, while diet quality was evaluated through indicators such as food variety, nutrient adequacy, and moderation.

Results: The obtained data was analyzed using descriptive statistics, and the relationship between the variables was assessed using the chi-square test. The results revealed an 18% prevalence of underweight cases. Food cost challenges affected 49% of households, and most underweight children (94%) belonged to these. It represented a strong relationship between the accessibility of healthy and a variety of foods and better weight status. The availability of food items was assessed, which showed that refined flour was widely available (91%), while nutrient-rich foods, such as dairy, were less accessible (67%). Children with low weight showed no significant association with cereal intake ($p = 0.562$). Animal protein consumption showed a significant impact, including chicken, eggs, and beef ($p < 0.001$), while mutton showed non-significance ($p = 0.181$). Dairy items, such as milk, yogurt, and butter, were also positively associated with a healthy weight ($p < 0.001$). Consumption of pulses and legumes was also significantly associated with the weight status of children. Processed foods showed a significant negative association as their consumption was linked to deviance from the normal weight.

Conclusion: The findings emphasized the improvement in the food environment and the quality of the diet of children under 5 years in order to reduce the prevalence of low and severely low weight.

INTRODUCTION

The word "nutrition" originates from the Latin terms "nutritionem and nutrire," meaning "a nourishing" or "to nourish, suckle". It represents the procedure of providing or receiving nourishment. People intake food and fluids, metabolize them, and then utilize them for their development and health (1). The field of nutrition encompasses food selection, diet, and their overall impact on health and well-being. Nutritional needs vary with age, and failing to meet those normal intakes can lead to disruptions in the physiological processes occurring in the body. A severe form of nutritional deficiency becomes visible in the form of proper clinical signs, while even slight deficiencies may also appear as subtle behavioral or physiological changes (2). Early childhood, spanning from birth to age five, is a crucial period. It lays the groundwork for long-term health and is crucial for quick growth. Since inadequate nourishment during this time might result in irreversible growth retardation, which impairs mental and cognitive capacities, the first 1000 days of this era are particularly crucial. Ultimately, this could lead to subpar performance and decreased productivity as an adult. Careful observation of growth and its relationship to underlying factors is crucial in pediatric healthcare (3). Famine and hunger are not the only aspects of malnutrition that one should address; there are other manifestations as well, such as

undernutrition, overnutrition, and hidden hunger (micronutrient deficiencies). Concerning the various manifestations, several reasons can be categorized under the more general headings of excessive intake, insufficient food consumption, and poor utilization of the nutrients derived from the food ingested (4).

Diet quality is highly influenced by a number of factors that can be categorized into individual, social, economic, environmental, and political aspects. Food insecure people are even more at risk of having an inferior level of diet quality. They have poorer dietary habits because they intake fewer fruits and vegetables, have less willingness to read labels, have a lower level of efficacy for healthy eating and meal planning, and have a low motivation to bring about a positive dietary change (5). Diet quality is also influenced by the level of parental education and their choices regarding their children's diet. The diet indices indicate that most parents lack sufficient knowledge about what they should and should not feed their children (6). It is also decreasing in the industrial world because of continuously decreasing food quality in it (7).

A contributing factor to the prevalence of poor diet quality is the easy availability and accessibility of calorie-rich foods compared to nutrient-rich foods, as the latter are often more expensive for most of the population. Consequently, people consume more calories than a diet rich in essential nutrients (8). This fact correlates the difference in price with the social inequities and differing purchasing powers that lead to the provision of healthy diets to the richer parts of society. With all the technological advances related to agricultural growth, the majority of the world's population still faces serious issues of wealth disparity, which is most evident in the food patterns of specific communities. Food insecurity is evident in nutritional deficiencies, and, by comparison, these deficiencies are more prevalent in emerging countries than in the developed parts of the world (9).

Low-income countries also face an issue of poor quality of complementary feeding, as evidenced by low minimum diet diversity levels, infrequent meal frequency, and inadequate minimum diet (10). Complementary feeding is more affected in poor countries, as two of the diet's important factors, diversity in the diet and consumption from animal food sources, are most significantly impacted in underprivileged countries (11). These aspects contribute to the prevalence of poor diet quality in vulnerable groups of various populations. A low level of diet quality furthermore leads to serious outcomes.

Poor diet quality is linked to the degradation of a child's cognitive performance as it increases the tendency for poor school performance in their formative years and low work capacity later in life. Additionally, poor diet quality is associated with specific impacts on later life, as it is a prerequisite for the development of chronic diseases and nutritional deficiencies later in life. This happens because poor dietary patterns give way to stress and several child morbidities, such as diabetes and obesity, and these diseases have debilitating effects on the health that negatively impact the mental and physical fitness of the child, ultimately making him vulnerable to poor academic performance and the lower workspace efficiency (12). It also contributes to the deficiency of essential micronutrients required by the children's bodies. Lacking those nutrients impacts their healthy participation in activities negatively (13).

There is a direct relationship between the quality of diet and the mortality rate, as diet

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patterns and quality have long-lasting effects on the onset of disease. In 2017, 22% of adult deaths were due to poor diet quality, which is a key contributor to both non-communicable diseases (NCDs) and malnutrition. The double burden of undernutrition and non-communicable diseases (NCDs) affects the majority of nations. However, there is no easy worldwide standard for assessing the quality of diets consumed by populations and demographic subgroups (14). In the United States, several healthy dietary guidelines were introduced, and research was conducted to assess their subsequent effects on human health. Over the past decade, it has been established that healthy dietary patterns and improved diet quality are crucial in reducing morbidity and mortality rates (15).

Therefore, given the changing food environment and diet quality, it is essential to evaluate the impact of these factors on the prevalence of underweight children under the age of five. The objectives of the study are to: To assess the food environment and diet quality of the selected population through a cross-sectional study and to correlate the prevalence of low weight among children to the food environment and diet quality

MATERIAL AND METHODS

The study was designed to explore the impact of the food environment and diet quality on the prevalence of low weight in children under the age of five years in the city of Okara. The cross-sectional study was conducted using a self-design questionnaire to gather information from caregivers about children under 5 years of age. A total number of 100 children were selected from two different schools, a District Public School located in an urban area and a government school of rural sector 2/4L, and from a middle-class community, Sidra Ghafoor town Okara. Their data was collected for set parameters. 22 males and 27 females from the rural background and 29 males and 22 females from the urban background were included in the study. Samples were analyzed for the prevalence of underweight, and their food environment and diet quality were assessed using questionnaires. Information on demographics (name, age, gender, family size, and monthly income), anthropometrics (height, weight, and MUAC), food environment (availability, accessibility, and affordability), and diet quality (Food Frequency Questionnaire) was collected from these study subjects.

Children under the age of 5 years who were free from any underlying disease or disorder were included in the study. Children above the age of 5 years were excluded. Children under 5 years of age but with any underlying chronic illness were also excluded from the study.

The height was measured in centimeters using a stadiometer to the nearest 0.10 cm, following a standard procedure. Any extra clothing and hindering objects, such as shoes, glasses, and hair ornaments, worn by the subjects were removed. The subject was then made to stand on a flat, non-carpeted surface, with feet placed flat on the base plate of the stadiometer. Their feet were kept slightly apart, aligned with the hips to ensure comfort. I ensured that the subject's legs were straight, hands rested at their sides, shoulders were leveled, and both the head and buttocks were touching the stadiometer rod. Once correctly positioned, I gently lowered the movable block until it touched the mid-crown of the subject's head to record the measurement.

The weight of study participants was measured in kilograms. Additional clothing and

any other weighted objects, such as glasses, watches, shoes, and any items that could influence the measurement, were removed. I ensured that the subject stood at the center of the weighing platform with equal weight distributed on both feet. The weight measurement was then recorded accurately to the nearest 0.1 kg to improve precision. The standard of the World Health Organization (WHO) was followed to calculate body mass index of the study population.

$$\frac{\text{BMI Weight in kg}}{\text{Height in meter square}}$$

Measuring mid-upper arm circumference (MUAC) is a commonly used anthropometric measurement to assess nutritional status, particularly in children and adults. MUAC is a practical and straightforward measurement that can provide valuable information about muscle mass and fat stores. A flexible, non-stretchable measuring tape was used to wrap around the upper arm. The respondents were asked to extend their arms fully and relax the muscles. The arm was positioned at the side of the body, with the palm facing inward. The midpoint between the acromion process (the tip of the shoulder) and the olecranon process (the tip of the elbow) was located in the correct position for measuring MUAC. The measuring tape was wrapped around the midpoint of the upper arm, ensuring it was snug but not too tight. The tape was applied directly to the skin without compressing the underlying tissues.

Table 1: WHO Classification of Nutrition Conditions in Children on Anthropometry

Condition	Cut-off Values	Indicator Used
Thin	BMI-for-age between -2 to -3 SD	BMI-for-age
Severely Thin	BMI-for-age < -3 SD	BMI-for-age
Stunted	Height-for-age < -2 SD	Height-for-age
Severely Stunted	Height-for-age < -3 SD	Height-for-age
Underweight	Weight-for-age < -2 SD (up to 10 years)	Weight-for-age (up to 10 years)
Severely Underweight	Weight-for-age < -3 SD (up to 10 years)	Weight-for-age (up to 10 years)

Statistical Analysis

The significance level of variables including the effect of availability, affordability, accessibility, diet quality, diet diversity and dietary pattern on the prevalence of low weight in children under age of 5 years was analyzed by using an appropriate statistical design (16). The significance of numerous independent variables was checked by a Chi Square Test score of less than 0.05. The data analyzed using the SPSS Version 23.0.

RESULTS

Demographic and Socioeconomic Information

The mean age of the participants was 41.27 months, with a standard deviation of 10.88 months, indicating a moderately wide age distribution across the sample. As presented in table 4.1, the range of 24 to 35 months was the most prominent, while overall distribution among different age groups was almost comparable. The gender distribution followed the pattern of 51% males and 49% females. The demographic background showed that 49% of the study participants belonged to rural areas, while 51% were from urban backgrounds. Gender distribution in each area represented that the rural population consisted of 22 males and 27 females, while the urban data set was comprised of 29 males and 22 females.

Parents education showed that the highest proportion had secondary education (34%), followed by primary education (28%). About 22% had attained higher education, while 16% had no formal education. Regarding fathers, secondary education was also the most common level, reported by 29% of participants. Primary education was reported by 26%, while 21% had higher education. Notably, 24% of fathers had no formal education. An even pattern across all three socioeconomic classes, with 33% of children belonging to the lower class, 34% to the middle class, and 33% to the higher class.

Anthropometric Measurements:

In the study population, the heights of the 100 children ranged from 75 cm to 110 cm, with a mean height of 94.42 cm and a standard deviation of 8.33 cm. This average height is within the normal range for children aged 24–59 months. The weights of the 100 children in the study ranged from 7 kg to 22 kg, with a mean weight of 13.54 kg and a standard deviation of 2.88 kg. This average falls within the expected range for children aged 24–59 months, but the wide range indicates noticeable variation due to differences in age and nutritional status. Among 100 children, the BMI ranged from 6.80 to 21.60, with a mean BMI of 13.54 and a standard deviation of 2.88. This average fell within the typical BMI range for children aged 2 to 5 years, but the wide range reflected noticeable differences in nutritional status within the group.

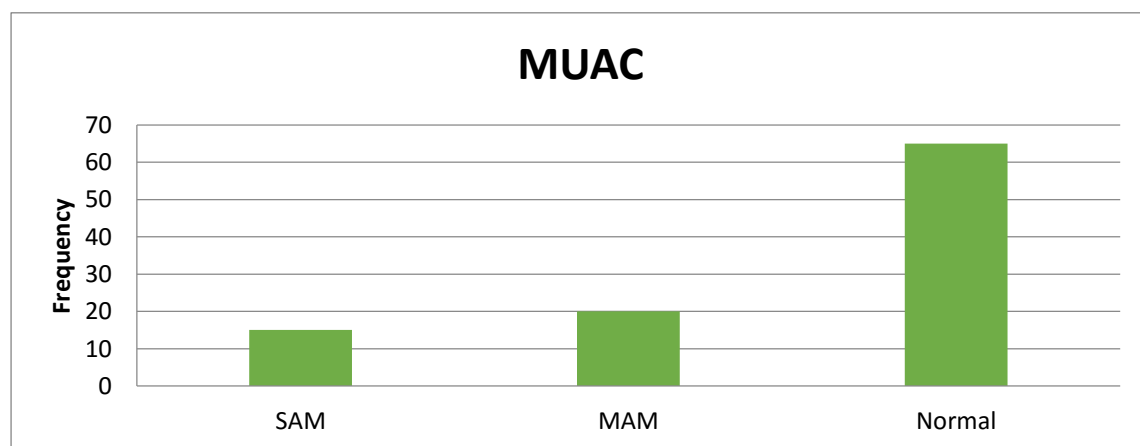


Figure 1: Prevalence of MAM and SAM in Children

Table 2: Impact of Availability of Different Food Groups on Weight of Children

Food Group	Chi-Square	P-Value
Fruits	16.388	<0.001*
Vegetable	3.100	0.376 ^{NS}
Animal Proteins	18.701	<0.001*
Milk and Milk Product Availability	29.978	<0.001*
Wholegrains	16.403	=0.001*

Table 3: Frequency of Wholegrain, Refined flour items Consumption in Children

Children								
Wholegrain								
Variables		Never	1-3 times per month	2-4 times a week	Once a day	2-3 times a day	P value	
	Severely Underweight	3	1	2	2	0	0.562	
	Underweight	2	2	3	1	2		
	Normal	17	4	20	17	3		
	Overweight	5	5	6	4	1		
Refined flour items								
		Never	1-3 times per month	Once a week	2-4 times a week	Once a day	2-3 times a day	P value
	Severely Underweight	4	1	1	0	1	1	0.424
	Underweight	1	3	1	1	4	0	
	Normal	8	13	15	3	11	11	
	Overweight	3	6	2	1	6	3	

Responses from 100 participants revealed that 22% reported that “they sometimes have not enough food to eat,” indicating food insecurity. Another 40% mentioned having enough to eat but not always the kinds of food they wanted, reflecting limited dietary diversity or quality. Only 38% of the respondents stated that they always had enough food to eat and that they also had access to a variety of food they preferred.

The distribution of primary food sources among the participants revealed that the local general store was the most commonly accessed source, reported by 45% of the respondents. Supermarkets followed it at 29%, and farmers' markets at 19%. A smaller proportion relied on their production (6%) and restaurants (1%) as their primary sources.

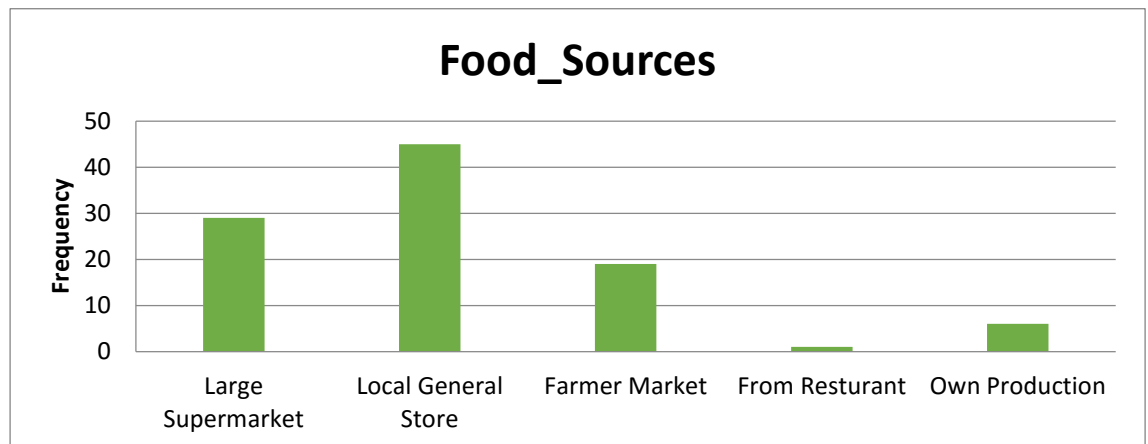


Figure 2: Frequency of Food Sources in Past 12 Months

A high proportion of households reported having access to vegetables (94%) and refined flour items (91%), indicating that these items are commonly available in the community. Fruits were available in 55% of households, while 45% reported a lack of access to fruits, highlighting a moderate level of fruit availability. Access to animal protein sources was slightly above average, with 52% of households reporting availability. Milk and milk products were available in 67% of households, whereas 33% lacked these items. 53% of respondents showed whole grain availability, representing a nearly equal distribution between those who had access and those who did not.

Table 4: Frequency of Meat, Dairy Products and Fruits and Vegetables Consumption and its Impact on Weight of Children

Food Items	Consumption frequency	Severely underweight	Underweight	Normal	Overweight	P value
Chicken	Never	0	1	5	0	<0.001*
	1-3×/month	7	9	38	6	
	Once/week	0	0	12	1	
	2-4×/week	1	0	6	0	
	Once/day	0	0	0	14	
Mutton	Never	8	10	49	20	0.181 ^{NS}
	1-3×/month	0	0	12	1	
Beef	Never	8	10	22	20	<0.001

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	1-3×/month	0	0	39	1	*
Fish	Never	8	10	34	21	<0.001
	1-3×/month	0	0	27	0	*
Egg	Never	4	0	0	0	<0.001
	1-3×/month	4	0	24	4	*
	Once/week	0	10	19	13	
	2-4×/week	0	0	10	2	
	Once/day	0	0	8	2	
Milk	Never	0	0	0	1	<0.001
	1-3×/month	8	1	5	2	*
	Once/week	0	0	17	4	
	2-4×/week	0	0	15	6	
	Once/day	0	0	24	4	
Yogurt	2-3×/day	0	0	0	4	
	Never	7	5	4	4	<0.001
	1-3×/month	1	5	18	6	*
	Once/week	0	0	23	2	
	2-4×/week	0	0	16	3	
Butter	Once/day	0	0	0	2	
	2-3×/day	0	0	0	4	
	Never	8	10	18	2	<0.001
	1-3×/month	0	0	29	3	*
	Once/week	0	0	4	5	
Fruits	2-4×/week	0	0	6	4	
	Once/day	0	0	3	6	
	2-3×/day	0	0	1	1	
	Never	7	0	0	3	<0.001
	1-3×/month	0	9	28	18	*
Vegetables	Once/week	1	1	6	0	
	2-4×/week	0	0	21	0	
	Once/day	0	0	6	0	
	Never	1	0	1	0	<0.001
	1-3×/month	0	0	3	17	*
	Once/week	0	1	5	0	
	2-4×/week	7	9	48	4	
	Once/day	0	0	4	0	

Table 5: Frequency of Pulses and Legumes, Processed Foods Consumption and its Impact on Weight of Children

Food Item	Consumption Frequency	Severely Underweight	Under-weight	Normal	Over weight	P Value
Moong Daal	1-3×/month	0	0	0	21	<0.001*
	Once/week	5	10	61	0	
	2-4×/week	3	0	0	0	
White Chickpeas	1-3×/month	5	2	33	21	<0.001*
	Once/week	3	8	28	0	
Black Chickpeas	Never	0	0	0	17	<0.001*
	1-3×/month	4	2	33	4	
	Once/week	3	8	28	0	
	11+ times	1	0	0	0	
Masoor Daal	Never	0	0	0	16	<0.001*
	1-3×/month	8	0	0	4	
	Once/week	0	10	61	0	
	2-3×/day	0	0	0	1	
Processed Foods	Never	0	2	3	4	<0.001*
	1-3×/month	8	0	32	1	
	Once/week	0	3	21	5	
	2-4×/week	0	0	1	0	
	Once a day	0	2	2	8	
	2-3×/day	0	3	2	3	

DISCUSSION

The results of the study revealed that there were 8% severely underweight, 10% underweight, 61% normal, and 21% overweight individuals in the study sample. Most of them lacked either food or variety in their diets. Most of their families were buying groceries from local stores. Among the highest available food items, refined flour items were available to 91% of individuals, while milk product products were available to 67% of individuals. The impact of the availability of fruits, animal

proteins, milk and milk products, and wholegrain was found to have a significant relationship with weight status. In contrast, the availability of vegetables did not show any significant relationship. The study revealed that while access to fresh fruits and vegetables (58% easy access) and meat products (44% easy access) showed no significant association with weight status ($p > 0.05$), milk and milk product accessibility (44% difficult/12% complicated) significantly influenced nutritional outcomes ($p = 0.031$). The study found that while market distance (60% near vs. 40% far) and ease of access (89% easy) showed no significant association with weight status ($p > 0.05$), perceived availability of healthy food options (73% available) and satisfaction with food variety (76% somewhat satisfied) were strongly linked to nutritional outcomes ($p < 0.001$). Notably, overweight and underweight individuals disproportionately reported limited healthy options (e.g., 18/21 overweight participants) and dissatisfaction with variety, suggesting that food quality and diversity might influence weight status.

The study revealed significant associations between food affordability and nutritional status, with 49% of respondents reporting unaffordable food prices. A strong link was found between perceived affordability and weight status ($p < 0.001$), where undernourished groups (17/18 underweight/severely underweight) disproportionately reported unaffordability versus overweight individuals (20/21 found food affordable). Household expenditure patterns showed that 24% of spending exceeded 50% of income on food, indicating financial strain. While direct food insecurity markers were low (8% meal reduction, 7% food support), the rural-urban affordability gap (51% of rural respondents found food unaffordable compared to 47% of urban respondents) highlights systemic disparities. These findings suggest that economic access to nutritious food has a significant impact on weight outcomes. The analysis revealed significant associations between most food groups and weight status ($p < 0.001$), with key exceptions: whole grains ($p = 0.562$) and mutton showed no significant impact. Refined flour demonstrated the strongest negative association ($p < 0.001$). At the same time, dairy products (milk, yogurt, butter), fruits and vegetables, legumes and pulses, and other animal proteins (excluding mutton) all significantly influenced weight outcomes. Processed foods showed particularly detrimental effects. Getaneh et al. (2019) assessed, and the results demonstrated that 18.2% of children were wasted, and 41.6% were underweight (17). Akombi et al. (2017) stated that during the first few years of life, inadequate nutrition, low-quality diet, and insufficient complementary feeding lead to wasting and underweight children (18). Several factors play an important role there that contribute to the worsening of this scenario, and some of these factors are the mother's practices and nutritional disparities. Abbas asserted that in Pakistan, low birth weight and subsequent wasting is one of the largest factors in infant death and disease. 1 in 5 children has his/her weight way below the normal range, and this condition makes nutritional deficiencies and other grave dietary consequences possible.

The results lined with Adeomi et al., 2022 who conducted research to find the relationship between dietary diversity and nutritional status. The results showed that traditional dietary pattern which includes mostly staple food had no effect on prevalence of thinness and low weight (19). The diverse dietary pattern was found to have an inversely significant relationship with thinness. Because a diverse diet implies

a healthy dietary pattern, the inverse link between diversified diet and thinness was expected. The results are also supported by the survey study conducted by Wolde and Belachew (2019), which stated that the cereal staple food group was the mainly consumed food group among thin children. The combined effect of cereals on the prevalence of weight status is non-significant as supported by all evidences (20).

The significant relationship between meat and poultry consumption and prevalence of undernutrition and low weight is supported by Aiga et al., 2019 who conducted a cross-sectional study to assess the risk factor for malnutrition and found significant relationship between animal source foods and undernutrition. Inadequate intake of animal-based protein was significantly associated with being stunted and thin (21). The study also stated that adequate food availability and dietary diversity over a sufficient period are necessary for increasing likelihood of catch-up in height-for-age and weight-for-age, which are expectable during growing age. The results are also lined with the research conducted by Nicholaus et al. 2020 on the relationship of dietary practices, nutrient adequacy and nutritional status of children. Results indicated that almost half of the respondents, 84 (51.2%), consumed meat 1 to 2 times per week (22).

The statistically significant association was found between stunting, thinness and fruits and vegetable consumption. The study by Yallew et al., 2022 concluded that the frequent consumption of citrus fruits decreased the risk low weight and thinness in children. The rarely used fruits and vegetable consumption also resulted in stunting (23). The results are also supported by Łuszczki et al., 2019 who conducted a survey in school canteens to analyze the consumption of fruits and vegetables among school children of southeast Poland. The findings of the survey revealed that the frequency of fruit and vegetable intake increased with age in both males and females. Analysis of the association between the results of the amount of consumed fruit and vegetables in school canteens and body weight and height showed a positive correlation between consumed fruits and vegetables and BMI, indicating that higher BMI was associated with higher consumption of fruits and vegetables in school canteens (24).

CONCLUSION

This study demonstrated that the various components of a poor food environment and the quality of the diet have a significant impact on the nutritional status of children under the age of 5 years. The findings emphasized the improvement in the food environment and the quality of the diet of children under 5 years in order to reduce the prevalence of low and severely low weight.

REFERENCES

- Kettings C, Sinclair AJ, Voevodin M. A healthy diet consistent with Australian health recommendations is too expensive for welfare-dependent families. *Australian and New Zealand journal of public health*. 2009;33(6):566-72.
- Brown JE, Isaacs JS, Krinke UB, Lechtenberg E, Murtaugh MA, Sharbaugh C, et al. *Nutrition through the life cycle*: Cengage Learning Kanada; 2017.
- Siddiq M, Shah GH, Mayo-Gamble TL, Zubair A. Determinants of child stunting, wasting, and underweight: Evidence from 2017 to 2018 Pakistan Demographic and Health Survey. *Journal of nutrition and metabolism*.

Online ISSN

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Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

2023;2023(1):2845133.

Ngo J, Ortiz-Andrellucchi A, Serra-Majem L. Malnutrition: Concept, classification and magnitude. Academic Press (Elsevier); 2015.

Ranjit N, Macias S, Hoelscher D. Factors related to poor diet quality in food insecure populations. *Translational Behavioral Medicine*. 2020;10(6):1297-305.

Asghari G, Mirmiran P, Yuzbashian E, Azizi F. A systematic review of diet quality indices in relation to obesity. *British Journal of Nutrition*. 2017;117(8):1055-65.

Setayeshgar S, Maximova K, Ekwaru JP, Gray-Donald K, Henderson M, Paradis G, et al. Diet quality as measured by the Diet Quality Index–International is associated with prospective changes in body fat among Canadian children. *Public health nutrition*. 2017;20(3):456-63.

Beebe D, Chang JJ, Kress K, Mattfeldt-Beman M. Diet quality and sleep quality among day and night shift nurses. *Journal of nursing management*. 2017;25(7):549-57.

Braha K, Cupák A, Pokrivčák J, Qineti A, Rizov M. Economic analysis of the link between diet quality and health: Evidence from Kosovo. *Economics & Human Biology*. 2017;27:261-74.

Uwiringiyimana V, Ocké MC, Amer S, Veldkamp A. Predictors of stunting with particular focus on complementary feeding practices: A cross-sectional study in the northern province of Rwanda. *Nutrition*. 2019;60:11-8.

Krasevec J, An X, Kumapley R, Bégin F, Frongillo EA. Diet quality and risk of stunting among infants and young children in low-and middle-income countries. *Maternal & child nutrition*. 2017;13:e12430.

Naveed S, Lakka T, Haapala EA. An overview on the associations between health behaviors and brain health in children and adolescents with special reference to diet quality. *International Journal of Environmental Research and Public Health*. 2020;17(3):953.

Nair MK, Augustine LF, Konapur A. Food-based interventions to modify diet quality and diversity to address multiple micronutrient deficiency. *Frontiers in public health*. 2016;3:277.

Bromage S, Batis C, Bhupathiraju SN, Fawzi WW, Fung TT, Li Y, et al. Development and validation of a novel food-based global diet quality score (GDQS). *The Journal of nutrition*. 2021;151:75S-92S.

Sotos-Prieto M, Bhupathiraju SN, Mattei J, Fung TT, Li Y, Pan A, et al. Association of changes in diet quality with total and cause-specific mortality. *New England Journal of Medicine*. 2017;377(2):143-53.

Montgomery DC. Design and analysis of experiments: John Wiley & sons; 2017.

Getaneh Z, Melku M, Geta M, Melak T, Hunegnaw MT. Prevalence and determinants of stunting and wasting among public primary school children in Gondar town, northwest, Ethiopia. *BMC pediatrics*. 2019;19(1):207.

Akombi BJ, Agho KE, Hall JJ, Wali N, Renzaho AM, Merom D. Stunting, wasting and underweight in sub-Saharan Africa: a systematic review. *International journal of environmental research and public health*. 2017;14(8):863.

Adeomi AA, Fatusi A, Klipstein-Grobusch K. Food security, dietary diversity, dietary patterns and the double burden of malnutrition among school-aged children

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

- and adolescents in two Nigerian States. *Nutrients*. 2022;14(4):789.
- Wolde T, Belachew T. Predictors of thinness and improved dietary diversity among School Aged Children in Southern Ethiopia. *Nutrition and Dietary Supplements*. 2019:49-58.
- Aiga H, Abe K, Andrianome VN, Randriamampionona E, Razafinombana AR, Murai T, et al. Risk factors for malnutrition among school-aged children: a cross-sectional study in rural Madagascar. *BMC public health*. 2019;19(1):773.
- Nicholaus C, Martin HD, Kassim N, Matemu AO, Kimiywe J. Dietary practices, nutrient adequacy, and nutrition status among adolescents in boarding high schools in the kilimanjaro region, Tanzania. *Journal of Nutrition and Metabolism*. 2020;2020(1):3592813.
- Yallew WW, Tadesse AW, Noor RA, Fawzi W, Berhane Y. Stunting and thinness in school-attending adolescents in Addis Ababa. *BMC nutrition*. 2022;8(1):159.
- Łuszczki E, Sobek G, Bartosiewicz A, Baran J, Weres A, Dereń K, et al. Analysis of fruit and vegetable consumption by children in school canteens depending on selected sociodemographic factors. *Medicina*. 2019;55(7):397.