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Research article

Does Moringa stenopetala based diet consumption decrease burden of under nutrition in under-five children, Southern Ethiopia?

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ABSTRACT

Background: *Moringa stenopetala* is used for medicinal and nutritional purposes. This study was, therefore, conducted to assess the contribution of *Moringa stenopetala* based diet in reducing under nutrition in under-five children in four districts of Southern Ethiopia.

Method: A community-based comparative cross-sectional study design was employed from August to September 2016 in randomly selected comparative sites among 732 under five children. Anthropometric measurements of weight and height of children were measured based on the standard measurement protocol. Regarding *moringa stenopetala* diet, the consumption habit was collected by using a seven days food frequency questionnaire. Amount of *moringa stenopetala* leaf biomass portion size consumption was measured with local measurement and converted to kilograms. Anthropometric data were analyzed using WHO Anthro software to determine the nutritional status of the child. An independent t-test was conducted to compare the mean difference of WHO-Z score of child nutritional index. Statistical mean significance difference was measured based on p-value less than 0.05 with 95% confidence level. In addition chi-square test with a p-value, less than 0.05 with a 95% confidence level was used to compare the prevalence of stunting, wasting, and underweight in *moringa stenopetala* based diet and non-*moringa stenopetala* based diet consuming area.

Result: The prevalence of stunting was 19% vs. 28.8%, wasting 4.7% vs. 9.6%, and underweight 12.19% vs 13.71% in *moringa stenopetala* based diet consuming and non-consuming participants respectively. There was a significant difference in stunting and wasting ($p < 0.05$) among *moringa stenopetala* based diet-consuming and non-consuming participants. Conclusion: The present study showed that *moringa stenopetala* based diet consumption had a significant contribution in reducing under-nutrition in under-five children.

1. Introduction

Moringa stenopetala (M. stenopetala) a Baker f. (Cufodontis), Chiov (Moringaceae) is a perennial tree endemically grown in South and South-Western parts of Ethiopia, mainly in Gamo Gofa, Wolayta, South Omo and Segen area Zone. The leaflets are separated from the rachis then stripped and plunged into boiling water with salt and cooked as vegetables combined with maize and sorghum flour to prepare the widely known local meal "*Kurkufa, Fososе,* and *Dama*". The leaves are also used to prepare the local drink "*cheka*" [1, 2, 3].

Various investigations conducted on *M. stenopetala on* its medicinal and nutritional value provide information on its importance. The macro

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Table 1. Socio-demographic profile of Under-five Children and Parents in *M. stenopetala* based diet consuming and none consuming participants.

Variable	Variable category	*M. stenopetala* based diet consuming participants	Non-*M. stenopetala* based diet consuming participants
Age of child mother or care giver	16–30	181 (48.70%)	181 (50.30%)
	30–45	155 (41.70%)	87 (24.20%)
	46+	36 (9.70%)	92 (25.60%)
Child Mother Level of education	Do not read and write	229 (61.60%)	191 (53.10%)
	Can read or write	30 (8.10%)	91 (25.30%)
	Elementary school	84 (22.60%)	63 (17.50%)
	Secondary and above	29 (7.80%)	15 (4.20%)
Area of residence	Urban	191 (51.30%)	178 (49.40%)
	Rural	181 (48.70%)	182 (50.60%)
Child Mother occupational status	Farming	184 (49.50%)	147 (40.80%)
	Housewife	60 (16.10%)	97 (26.90%)
	Trader	69 (18.50%)	47 (13.10%)
	Others	59 (15.90%)	69 (19.20%)
Marital status of child mothers or care giver	Married	341 (91.70%)	312 (86.70%)
	Single and others	31 (8.30%)	48 (13.30%)
Wealth quintile of house hold	Lowest	115 (30.90%)	33 (9.2%)
	Second	83 (22.30%)	63 (17.5%)
	Middle	47 (12.60%)	99 (27.50%)
	Fourth	51 (13.70%)	95 (26.40%)
	Highest	76 (20.40%)	70 (19.40%)
Family size of House hold	<5	122 (32.80%)	120 (33.30%)
	5 and above	250 (67.20%)	240 (66.70%)
Sex of child	Male	169 (45.40%)	185 (51.40%)
	Female	203 (54.60%)	175 (48.60%)
Child age	6–11 months	20 (5.40%)	8 (2.20%)
	12–36 months	139 (37.40%)	174 (48.30%)
	37–59 months	213 (57.30%)	178 (49.40%)

nutrient nutritional composition leaves of *M. stenopetala* consists of 26.6%–30.2% crude proteins, 3.36%–4.29% fats, 38.4% to 41.2 ± 2.89% carbohydrates, and 5.87 ± 0.21% crude fiber [4]. The essential minerals composition samples had a mean value of 54.85 mg/100 gm, 1,918 mg/100 gm, 2.16 mg/100 gm, 0.78 mg/100 gm, 38.19 mg/100 gm, 2, 094 mg/100 gm and 214.10 mg/100 gm of Fe, Ca, Zn, Cu, P, K and Na respectively. Regarding vitamin A composition in the form of beta-carotene 160 μg/100g of leaf samples [5].

M.stenopetala based diet can be of great input to fight against under-nutrition problem with appropriate processing and blending with locally available foods [5, 6]. Despite increased attention was given reduce under nutrition; but nutritional deficiencies remain a devastating problem in developing countries. Under-nutrition in all its forms either directly or indirectly is responsible for approximately half of all deaths worldwide [3, 7].

There are different existing nutritional interventions to address under nutrition and micronutrient deficiencies through supplementation, fortification, and improved complementary food products to improve dietary quality and to end malnutrition [8, 9]. These strategies are helpful to minimize micronutrient depletion among vulnerable groups. But they are not cost-effective and out of the capacity of the majority of poor rural and semi-urban communities. Therefore, upgrading locally available, culturally acceptable, and affordable food item to nutrient-dense food is a key and sustainable promising solution to solve under nutrition. This study was, therefore, conducted to assess the nutritional contribution of *M. stenopetala* based diet in under-five children in four districts of southern Ethiopia.

2. Materials and methods

2.1. Study area and population

The study sites were selected in randomly selected rural and urban sites of Konso and Derashe district in which *M. stenopetala* is a common staple food in the study areas. For comparative purpose equal number of rural and urban study sites were selected randomly from Chencha and Bonkey districts, where *M. stenopetala* is not consumed as a staple food source. The study sites have relatively similar culture, agro ecological, and disease burden except on *M. stenopetala* based diet consumption. A comparative cross-sectional survey was conducted on randomly selected 732 under-five children with their caretakers or biological mothers from August to September 2016.

2.2. Sample size calculation and approach

The sample size was calculated using double population proportion formula by considering a 95% confidence level, 5 % margin of error, and 50% prevalence to get a sufficient sample size. The final sample size was calculated to be 732 including the non-response rate, of which 366 were *M. stenopetala* consuming participants and 366 non consuming participants group. Rural and urban study sites were selected randomly from each district, then the sampling frame was prepared from the list of households, and WHO, KISH methods were applied to select under-five children with their caretakers or biological mothers from each targeted household.

2.3. Data collection techniques and study instruments

A house-to-house interview was conducted using a pre-tested structured questionnaire. The questionnaire covers data on socio-demographic characteristics of children, caregiver or mothers feeding habit, house hold wealth index, health status & exposure to diseases, and dietary consumption of *M. stenopetala* based diet to use as food and/or medicine. Data were collected using digital tablets loaded and programmed with CSPro 7.0 software data collection application tool for interview. Regarding *M. stenopetala* diet, consumption habit was collected by using a seven days food frequency. The amount of *M. stenopetala* leaf portion size consumption was estimated using local measurement approach using hand bunch estimation of mothers and converted to kilograms. The hand bunch measurement approach was used by local community to sell leaves of *M. stenopetala.*

Anthropometric measurements: Child weight, height, mid-upper arm circumference (MUAC) measurements were taken to assess nutritional status of under five children. Weights were measured to the nearest 0.1 kg using calibrated portable electronic digital scale, heights to the nearest 0.1 cm using a portable height-measuring board with a sliding head bar following standard anthropometric techniques. The MUAC of children was measured using a non-stretchable MUAC tape for under five children [10, 11, 12].

2.4. Operational definitions

Moringa based diet consumption for under five children: The portion size of *M. stenopetala* used in diet of under five which were prepared as a form of cultural cereal dish made with maize and sorghum as kurkufa, fosese, dama, cooked vegetable, and soup were measured using hand bunch [13, 14]. Based on this half hand bunch *M. stenopetala* leaves is estimated as half kilogram, and one full hand bunch *M. stenopetala* leaves is estimated as one kilogram.

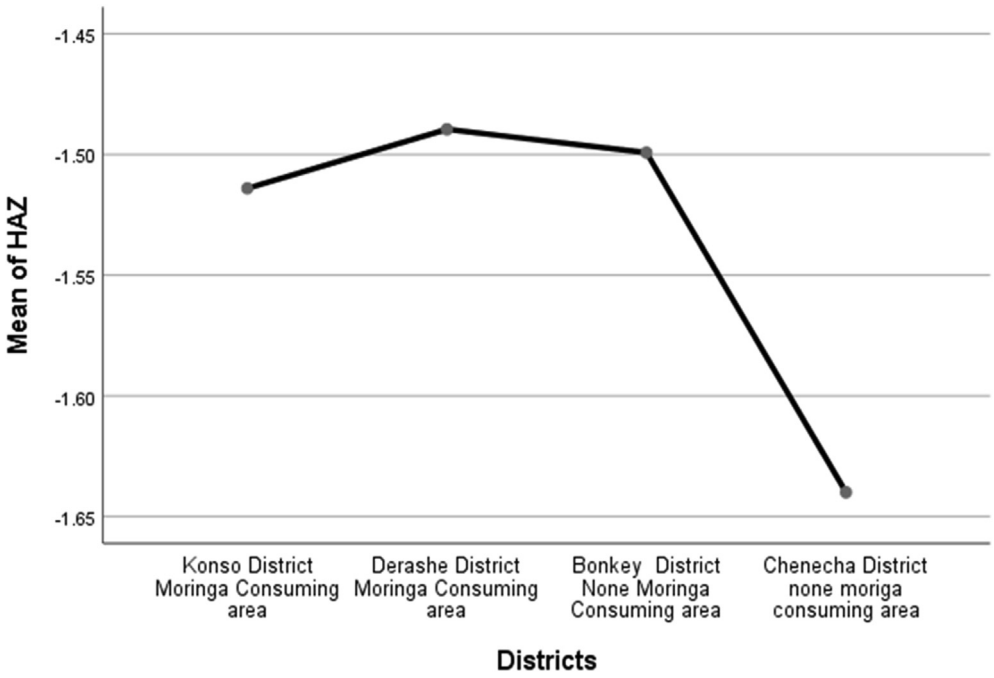

Figure 1. Means Plots of HAZ in *M. stenopetala* based diet consuming and non-consuming participants, Southern Ethiopia.

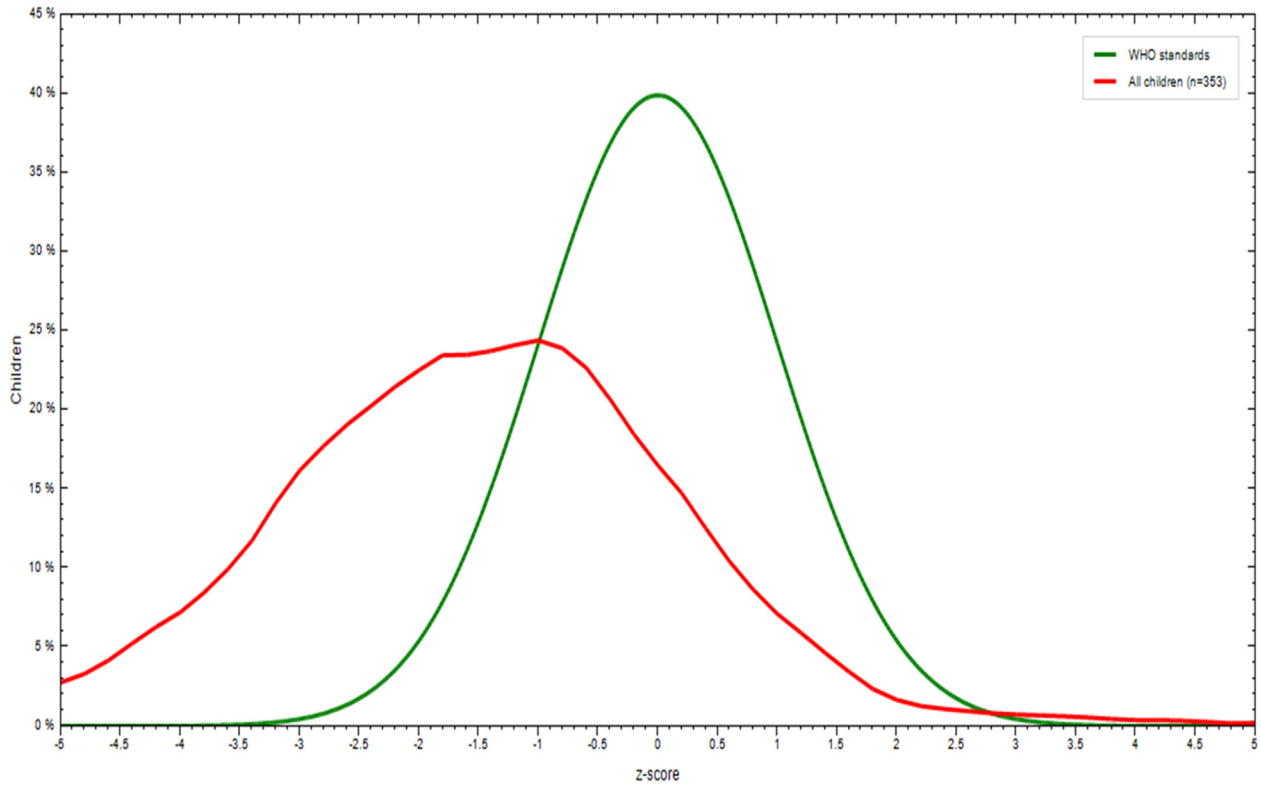

Figure 2. Comparing Z-score of HAZ curve of *M. stenopetala* based diet consuming participants along with WHO standard curve.

Under nutrition for under five children: measured as stunting, wasting and underweight based on world health organization anthropometric indices by using Z-score for Length-for-age or Height-for-age, Weight-for-length or Weight-for-height and Weight-for-age. Then nutritional status is categorized as under nutrition (stunting, wasting and underweight) if < -2 standard deviation, and normal if above -2 standard deviation [12, 15].

2.5. Data management and analysis

The collected data were exported from CSPro 7.0 software to SPSS, version 21, then sorted and cleaned to identify missing and extreme values. Descriptive *statistical* analysis was used to describe frequency and percentages for relevant variables. Anthropometric data were analyzed by WHO Anthro software to determine the nutritional status of the child.

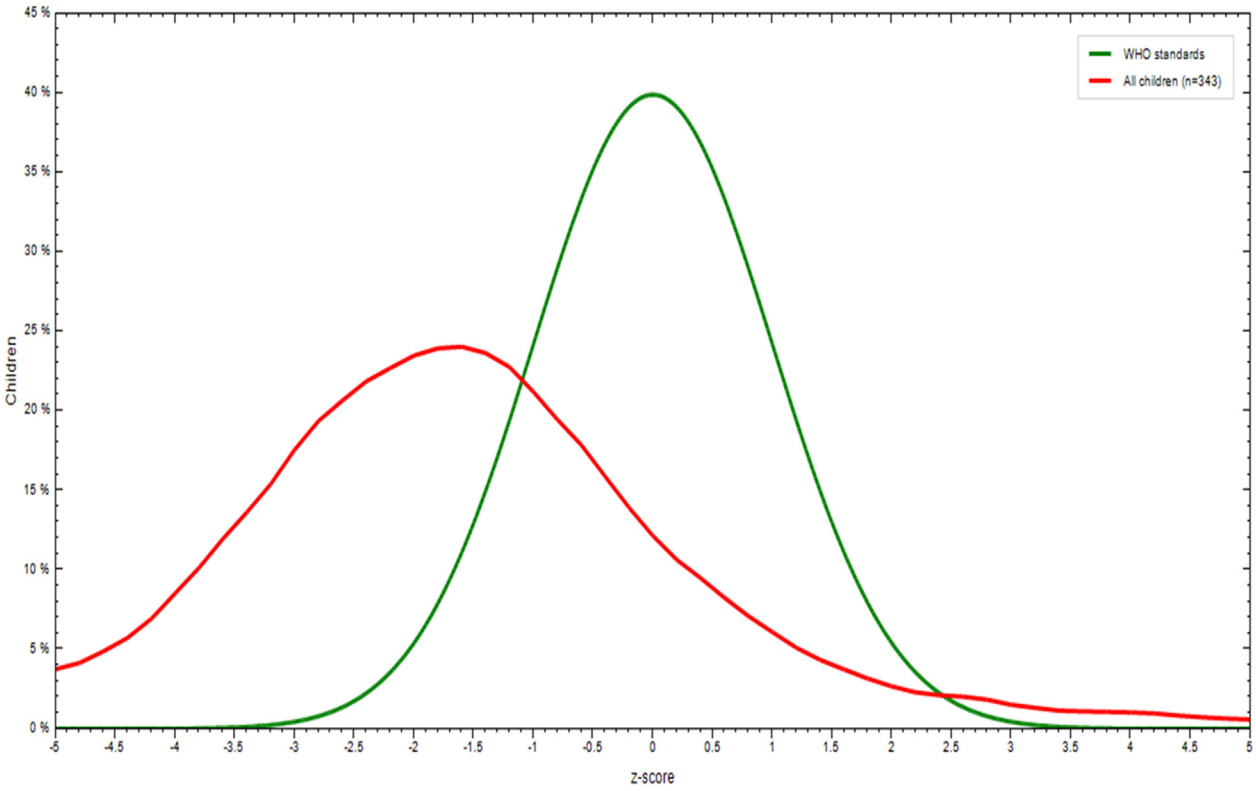

Figure 3. Comparing Z-score of HAZ curve of non- *M. stenopetala* based diet consuming participants along with WHO standard curve.

Independents t-test was conducted to see the mean difference WHO-Z score level, and **statistical** mean significance difference was declared based on a p-value less than 0.05 with a 95% confidence level. In addition, chi-square test with a p-value, less than 0.05 with a 95% confidence level was used to compare the prevalence of stunting, wasting, and underweight in *M. stenopetala* based diet consuming and non-consuming participants.

2.6. Compliance with ethical standards

The protocol of the study was approved by the Institution Review Board of Ethiopian Public Health Institute with IRB number (EPHI 6.13/796). Data were collected anonymously without any personal identifiers. Letter of support was obtained from the Southern Ethiopia region health office to facilitate the study. The objective, potential risk, benefits, and confidentiality were made known to child mothers or care givers. Informed consent was obtained from each child mother or care giver before administering the questionnaire and anthropometric measurement.

3. Result

3.1. Socio-demographic characteristics of the study participants

A total of 732 children caregivers were interviewed, and anthropometric data were collected from 718 children a response rate of 98.09%. The mean (SD) age of under-five children was 3.2 ± 1.24 years. From all study participants 51.6% of the children was females and 48.4% males with a ratio of 0.94. Half of the child mothere or caregivers in both *M. stenopetala* consuming and non-consuming participants were in the age range of 16–30 years. More than half of the mothers or caregivers did not attended formal education. Regarding occupational status of mothers or caregivers who participated in this study 49.5% and 40.80%) of them were farmers in *M. stenopetala* consuming and non-consuming participants respectively (Table 1).

3.2. Nutritional status of under five children

3.2.1. Stunting (height-for-age)

Height-for-age (HAZ) is an age- and sex-normalized measure of child length <2 years and height for children whose age was ≥2 years relative to the median age of reference population. It is expressed as a linear growth retardation and cumulative growth deficit, and indicates whether there is resulting from chronic malnutrition. In this study, the overall mean of HAZ was -1.53 ± 2.12 for all study participants, and was -1.53 ± 1.91 and -1.65 ± 2.1 in *M. stenopetala* consuming and non-consuming areas, respectively (Figure 1).

The prevalence of stunting was 19% with 95% CL (17.00, 21.00), and 28.80% (with 95% CL (26.40, 31.20) among *M. stenopetala* based diet consuming, and non-consuming participants respectively under five children who consume *M. stenopetala* based diet had lower prevalence of stunting compared to non-consuming participants (p-0.03) (Figures 2 and 3).

3.3. Wasting (weight-for-height)

The weight-for-height index (WHZ) measures body mass in relation to body height or length and describes current nutritional status of children. In this study, the overall median z-score of wasting was 0.95 ± 3.13 for *M. stenopetala* based diet consuming participants, while 1.12 ± 3.088 in non-consuming participants.

The prevalence of wasting was 4.7% with 95% CL (3.6, 5.8), and 9.60% with 95% CL (8.08, 11.28) among *M. stenopetala* based diet consuming and non-consuming participants respectively (Figures 4 and 5). There was statistically significant difference of wasting among *M. stenopetala* based diet consuming and non-consuming participants.

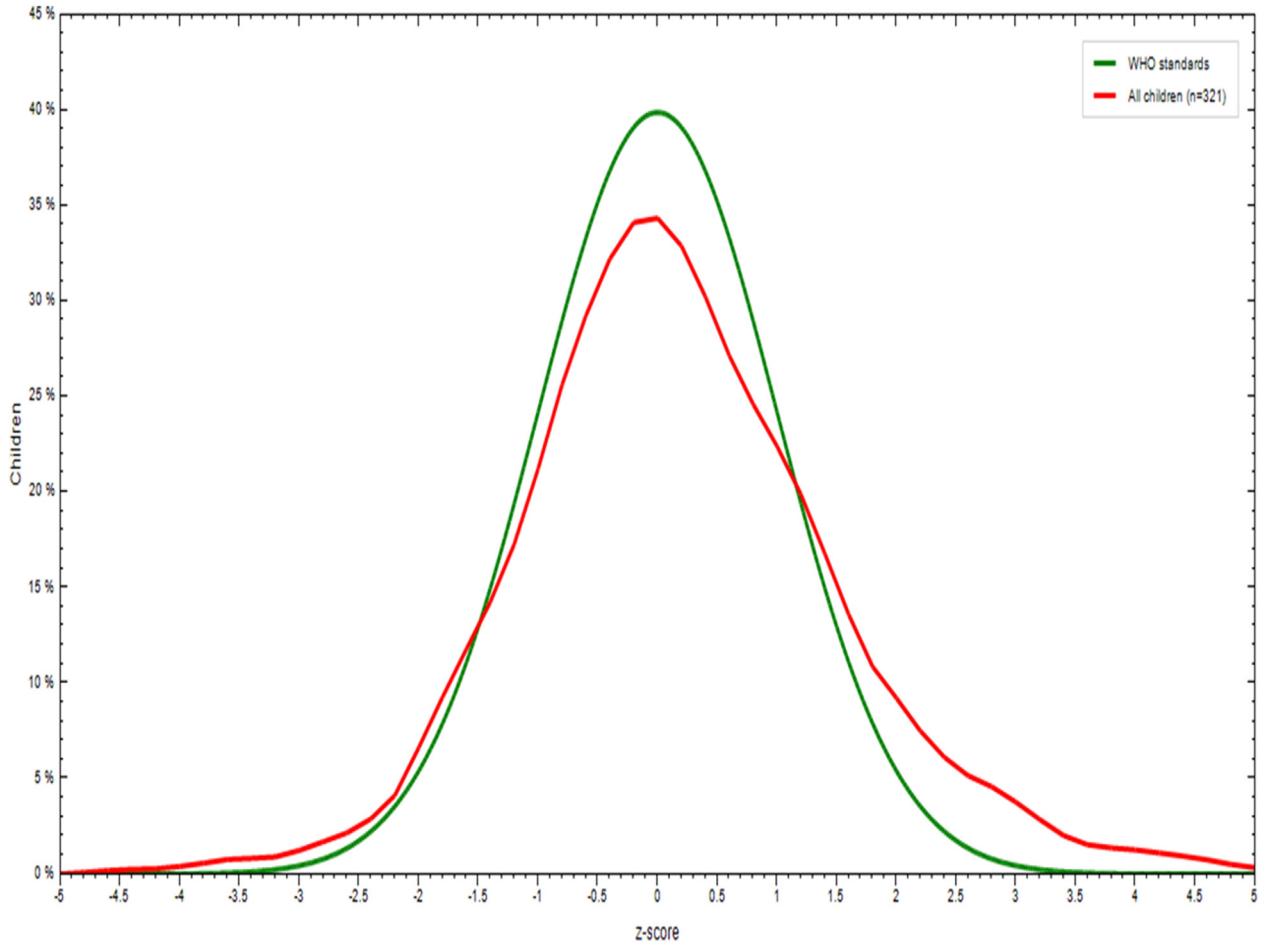

Figure 4. Comparing Z-score of WHZ curve of *M. stenopetala* based diet consuming participants along with WHO standard curve.

Under five children who consume *M. stenopetala* based diet had lower prevalence wasting as compared to non-consuming participants (p-0.001) (Table 2).

3.4. Underweight (weight-for-age)

Weight-for-age is a composite index of height-for-age and weight-for-height that accounts for both acute and chronic under nutrition. It is a good index to assess the long and short-term contribution of *M. stenopetala* based diet consumption. The prevalence of underweight in *M. stenopetala* based diet consuming areas was 12.19% with 95% CL (10.49, 13.89), while 13.71% with 95% CL (11.91, 15.51) in non-consuming participants (Table 2). There was difference in prevalence of underweight, but not statistically significant among *M. stenopetala* based diet consuming and non-consuming participants.

4. Discussion

The current study showed that there were existence of relatively lower prevalence of stunting, wasting and underweight observed in *M. stenopetala* based diet consuming as compared to non consuming under five children. This study confirmed that *M. stenopetala* based diet consumption contribute to reduce the burden of under nutrition in the study setting. This finding was in agreement with a study conducted to compare the effect of moringa powder supplement among under five children in Burkina Faso, which reveals that groups who were receiving the moringa supplement recorded a higher average weight gain (8.9 ± 4.3 g/kg/day, against 5.7 ± 2.72 g/kg/day in not receiving group) and a quicker recovery rate, with an average stay of 36 ± 16.54 days, against 57 ± 19.20 days amongst those not receiving the moringa supplement [16].

The improved nutritional status among *M. stenopetala* based diet children consuming participants due to its high protein contents, which is easily digested, rich with essential amino acids, and other essential micronutrients [4, 6, 17]. This high quality protein value of *M. stenopetala* leaves contributed to mitigate linear growth retardation by satisfying the protein requirements, and boost the immune system against diseases in children [5, 18, 19].

Raw leaves of *M. stenopetala* contain 9% crude protein on a dry matter basis and a higher percentage of carbohydrates, crude fibre, and calcium compared to kale and Swiss chard [6]. Vitamins are present at nutritionally significant levels averaging 28 mg/100 g of vitamin C and 160 μg/100 g of beta carotene [6, 17, 20]. Due to these higher contents of various micro and macronutrient composition of *M. stenopetala* has great input to fight under nutrition in children to improve all fom of malnutrition [20]. This finding supported with nutritional value of *M. olifera's* nutrient-dense leaves are high in protein quality, leading to its widespread use by doctors, healers, nutritionists and community leaders, to treat under-nutrition and a variety of illnesses. In addition chemical composition of leaves and seeds of *M. stenopetala* revealed its potential as a protein and energy supplement for human and ruminant livestock [21, 22]. Moreover, the nutritional attributes of *M. stenopetala* can be highly beneficial to human and animal feeding [23].

5. Conclusion and recommendation

From the present study, it can be concluded that *M. stenopetala* based diet consumption had a significant association between consumption of

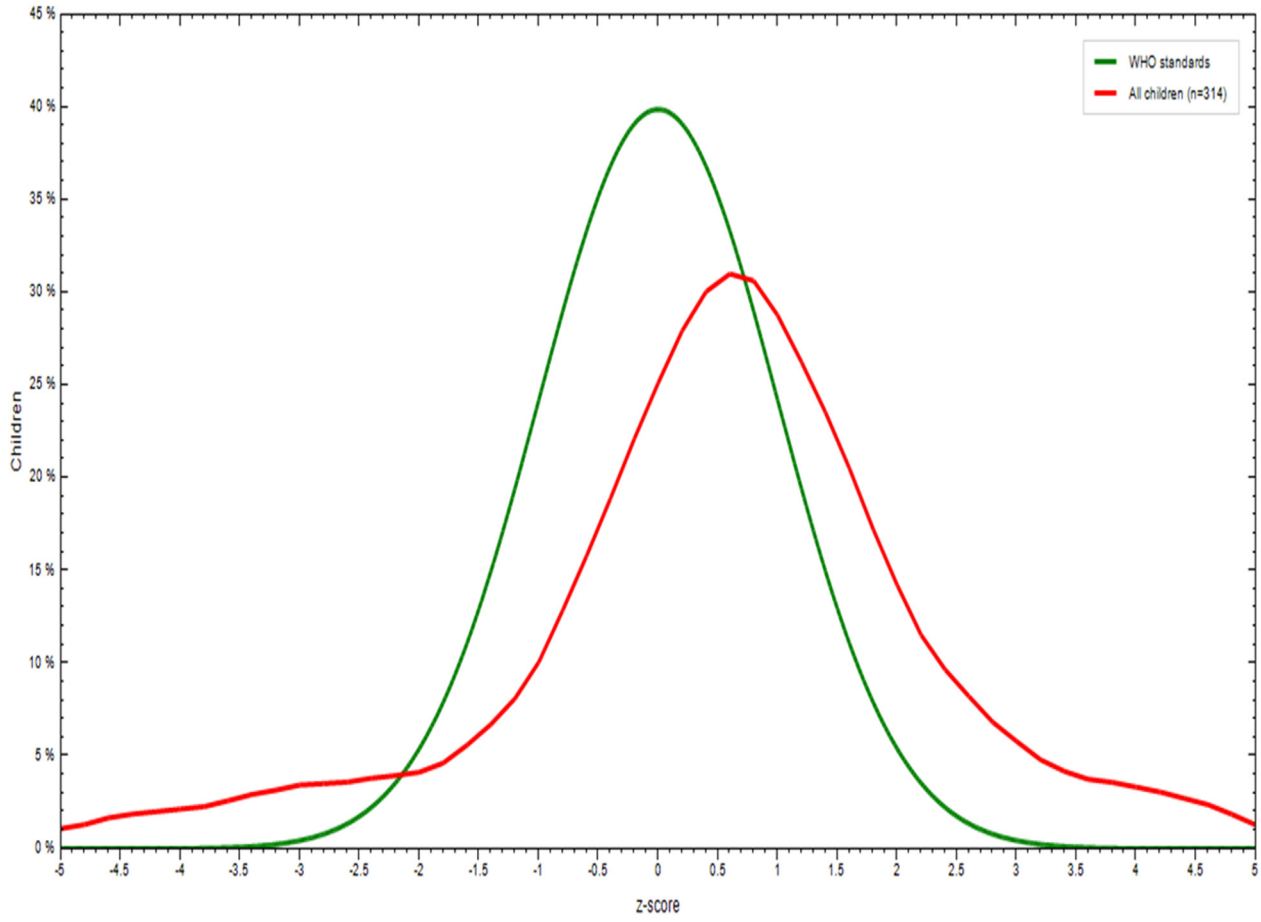

Figure 5. Comparing Z-score of WHZ curve of non-*M. stenopetala* based diet consuming participants along with WHO standard curve.

Table 2. Summary of the prevalence of under nutrition among under-five children in *M. stenopetala* amount of leaf consuming and non-consuming participants.

Nutritional index	Category nutritional status	*M. stenopetala* based diet consumption status		Chi square (χ^2)
		M. stenopetala based diet consuming participants	Non- *M. stenopetala* based diet consuming participants	
Stunting (Ht for age)	Stunting	19%	28.80%	0.003
	Normal	81.00%	71.200%	
Wasting (Wt for Ht)	Wasting	4.70%	9.68%	0.001
	Normal	95.3.20%	90.13%	
Underweight (Wt for age)	Under weight	12.19%	13.71%	0.84
	Normal	87.81%	86.29%	

moringa and lower risk of stunting and wasting in under five children where the plant grows abandantly. Therefore, due attention should be given to plant *M. stenopetala* trees on large scale for further food based undernutrition intervention.

Strength and limitation of the study: This comparative community-based study is the first of its kind for assessment of the contribution of *M. stenopetala* based diet consumption on the burden of undernutrition in under five children. The cross sectional study nature may have some limitation to establish temporal relationship between the exposures and outcome, and it may serve as a baseline for other studies.

Declarations

Author contribution statement

Eskeziyaw Agedew, Direselign Misker, Terefe Gelibo, Ashenife Tadelle, Eyasu Makonnen, Solomon Worku, Alemayehu Bekele, Yelmtsehay Mekonnen, Adamu Belay, Feyissa Challa, Temsgen Awoke, Negero Gemeda, Haregewoyin Kerebih, Simon Shiberu, Asfaw Debella: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data included in article/supp. material/referenced in article.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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