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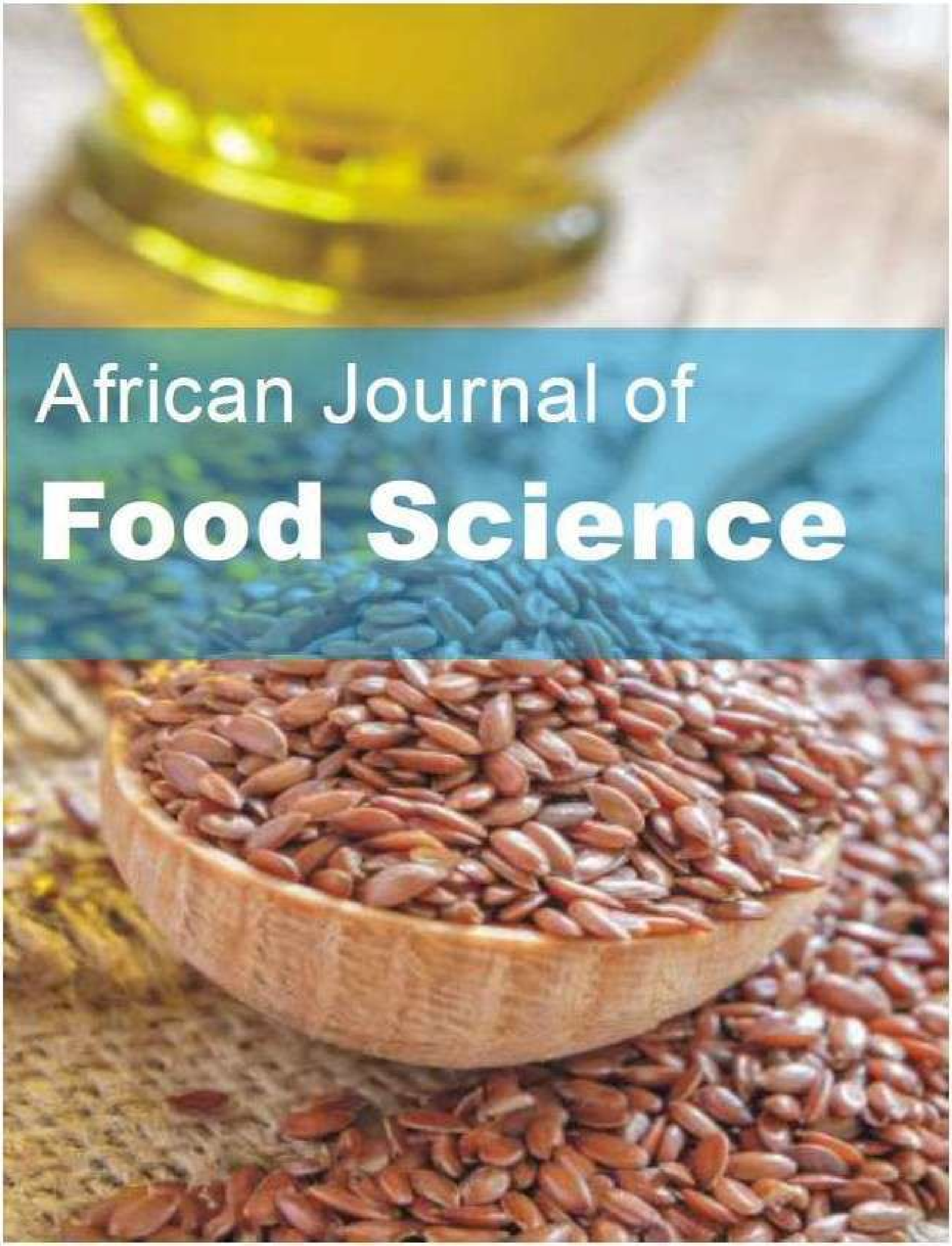

August 2023
ISSN 1996-0794
DOI: 10.5897/AJFS
www.academicjournals.org

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Vol. 17(8) pp. 154-161, August 2023
DOI: 10.5897/AJFS2023.2254
Article Number: 5FDF41770965
ISSN: 1996-0794

http://www.academicjournals.org/AJFS

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African Journal of Food Science

Full Length Research Paper

Consumption of discretionary salt and bouillon in Senegalese households and related knowledge, attitudes and practices

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Received 10 March 2023; Accepted 27 June, 2023

Excessive salt intake is associated with high blood pressure, a major risk factor of cardiovascular diseases. The World Health Organization has set a target of 30% reduction in population salt intake by 2020 to contain the prevalence of high blood pressure (HBP). The aim of the study was to measure the consumption of discretionary salt and bouillon in rural and urban Senegalese households. A cross-sectional descriptive study was conducted among 111 households in Dakar and Kaffrine. Quantities of discretionary salt and bouillon used in the preparation of meals were accurately weighed and contribution of bouillon to salt intake assessed using the Senegalese manufacturing standard of bouillon. Knowledge, attitudes and practices related to consumption of salt and bouillon were collected using a questionnaire. In more than two-thirds of households, per capita salt consumption was high (WHO cut-off >5 g/d), particularly in rural areas (94.4%). Whatever the residence, bouillon contributed to 1/3 of discretionary salt intake. Average individual consumption of salt (discretionary + bouillon) was estimated at 6.3 g/day [4.3; 10.3], with a significant difference between rural and urban areas (10.2g /day vs. 4.6g/day; P<0.01). Urban households gave more importance about the limitation/reduction of salt on cooking, than rural households (63.2% vs 40.7%; P<0.05). In our study areas, discretionary salt consumption per capita was above the WHO recommendation, particularly in rural areas, with a high contribution from bouillon.

Key words: Consumption, discretionary salt, bouillon, Senegalese households, urban, rural, hypertension.

INTRODUCTION

Salt is a product that has long been used in all societies for its capacity to increase the preservation of food and to limit the multiplication of micro-organisms and for its benefits to the food industry (SACN, 2003). Cooking or table salt is composed of sodium chloride (NaCl), it combines two mineral elements: 40% Sodium and 60%

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chloride. Salt is universally consumed regardless of socioeconomic status, and its consumption is very uniform across regions or countries (Mannar, 2018). The main evidence for the association between high intakes of salt and health issues relates to sodium. About 90% of sodium consumed is from two sources: non-discretionary salt added during food processing and manufacturing and discretionary salt added during cooking or at the table (SACN, 2003; WHO, 2017).

Bouillon are seasoning ingredients, in different forms (cubes, powders, liquids), composed mostly of salt, hydrolysed vegetable proteins, starch, herbs, spices, and flavourings, and may contain flavour enhancers such as monosodium glutamate or some yeast extract (Moretti et al., 2018). The maximum amount of salt in a bouillon is fixed at 12.5 g/L by the Codex Alimentarius. In Senegal, according to current legislation, the amount of salt in bouillon must not exceed 55% of the product's weight (*Codex Alimentarius,* 2015; ASN, 2017), which correspond to 5.5g of salt in 10g of bouillon.

Excessive salt consumption contributes significantly to the development of Non-Communicable Diseases (NCDs). Indeed, the link between health problems and high salt consumption is well established, particularly between the consumption of sodium and the development of high blood pressure and other cardiovascular diseases (Meneton et al., 2005; Kotchen et al., 2013). Sodium intake is directly linked to hypertension, which is the most important risk factor for mortality worldwide (Murray and Lopez, 2013). To reduce the risk of cardiovascular disease, the WHO recommends consuming a maximum of 5 g of salt (equivalent to 2 g of sodium) per person per day (WHO, 2012). However, data from various countries indicate that most populations consume higher amounts. In sub-Saharan Africa and many parts of the world, sodium consumption is above 2 g/day (INTERSALT, 1998; Oyebode et al., 2016). The WHO has set as a target, between 2013 and 2020, of a relative reduction of 30% in the population's average salt (sodium) intake, and also a reduction of 25% in the prevalence of high blood pressure or to contain the prevalence of high blood pressure, depending on national circumstances (WHO, 2013).

The management of NCDs is currently a heavy burden on the health system of developing countries. In Senegal, there is no policy on salt reduction (FAO, 2018; WHO, 2018b), probably as in most African countries, due to the lack of sufficient data on salt and bouillon consumption and their link to population health. Gathering data on salt consumption patterns of the population (salt intake, knowledge, attitudes, and behaviours regarding salt use) is an important step to develop and implement a strategy to reduce salt consumption. People's knowledge, attitudes, and behaviours towards salt can help determine the extent to which consumers think salt is a problem. It can also reveal the sources of salt in their diet, the reasons for their decision to buy a particular food, and how they use salt as a condiment when cooking or eating (WHO, 2017). Compared to other countries that have already measured the sodium intake of their population and have public policies to reduce salt consumption, Senegal does not yet have such data. To our knowledge, no research has been conducted to assess the knowledge, attitudes, and practices regarding excessive salt consumption and its impact on public health, as well as the associated determinants.The aims of this study were to measure the per capita consumption of discretionary salt and bouillon and assess related knowledge, attitudes and practices of households.

METHODS

Study design and socio-demographic characteristics

This descriptive cross-sectional pilot study was conducted from July to November 2019 in rural (Kaffrine, groundnut basin in central-western of Senegal) and urban areas (Dakar, capital of Senegal). It was conducted as part of a study on nutritional status (Thiam et al., 2022). In this study, 60 mother-child pairs were selected for nutrient intakes measurement in rural area, using weighed food record method, and their respective households were all enrolled. The same sample size of households was also retained in urban area using purposive sampling approach, in which households were selected in each neighborhood, on the only condition that they were willing to participate. Overall, we finally got the consent of 111 households, which were then selected, 54 urban and 57 rural households. In Dakar, households located in eight (8) neighborhoods: Parcelles Assainies units 04 and 16, Dalifort, Khar Yalla, Djida Thiaroye Kao, Daroukhane, Fass, and Jaxaay. In Kaffrine, the households selected were in the villages of Mbaracounda and Malem Thialène in the department of Malem Hodar. The socio-demographic variables collected were the composition of the household, energy sources, access to drinking water, and type of combustible material used for household cooking.

The size of the household was calculated by considering the number of people living in the same house and sharing the same meals from morning to night.

Determination of salt and bouillon consumption

The weight food record (gold-standard method) was used to quantify the amount of discretionary salt and bouillon consumed by the household throughout all day of the survey (Gibson, 2005; Thompson and Subar, 2013; FAO, 2018). In each household, an interviewer spent all day and asked respondents to indicate the quantity of salt and/or bouillon that was used for the preparation of each meal consumed by the whole household. Thus, each quantity of salt or bouillon was systematically weighed just before being added to the cooking/preparation, using a precision food scale (Gram, Barcelona, Spain; Soehnle, Roma, 65847). For packaged salt or bouillon, which was fully used, quantity was collected by recording the weight marked on the package. The contribution of bouillon to daily salt intake was estimated by applying the maximum percentage of 55% salt in accordance with the standard of the Senegalese Association for Standardization (Association Sénégalaise de Normalisation - ASN, 2017). Total household salt

Table 1. Characteristics of households.

Parameter	All (N= 111)	Rural (N= 54)	Urban (N= 57)	*P*
Household size	13 ± 7	15 ± 8	11 ± 7	0.013
Number of adults	7 ± 4	8 ± 4	6 ± 5	0.166
Number of children and adolescents	6 ± 4	7 ± 4	4 ± 3	0.001
Number of meals per day	2.17 ± 0.5	2.4 ± 0.6	1.9 ± 0.3	<0.001
Utilities				
Clean Water	100	100	100	-
Electricity	73	64.8	80.7	0.059
Television	62.2	27.8	94.7	0.000
Freezer/refrigerator	41.4	7.4	73.7	0.000
Combustibles				
Wood/Charcoal	57.7	66.7	49.1	0.061
Gas	42.3	33.3	50.9	

Values are expressed as mean ± SD or as percentage.
Source: Authors

consumption was determined by adding the amount of discretionary salt and that of salt contained in the bouillon used during the preparation of meals over the day. Individual salt consumption (g/day) was then estimated per capita by dividing the total amount of salt consumed by the household size. The level of household per capita salt consumption was determined using the WHO cut-off (WHO, 2012).

Assessment of Knowledge’s, attitudes and practices related to salt consumption

Data on knowledge, attitudes and practices (KAP) were collected using a questionnaire based on the WHO STEPS manual (WHO, 2005). The questionnaire was translated in French, respecting all procedures for validation. Following this, the questionnaire was included in a mobile data collection application: ODK (Open Data Kit, v1.18.1) and the information’s were collected using a tablet computer.

Statistical analysis

Data analysis was carried out with Excel 2016 (Microsoft Corporation) and Stata/SE version 12.1 (STATA Corporation). A descriptive analysis was used to determine the main characteristics of interviewed households. The results are expressed as mean ± standard deviation and as a percentage. Variables with a non-symmetrical distribution such as salt consumption are expressed in median and interquartile range. The student’s t-test and the Kruskal-Wallis test were used respectively for the comparison of means and medians of bouillon or salt consumption, between rural and urban areas, and Pearson's χ^2 test for the comparison of percentages. A significance level of 5% was used for all analyses.

RESULTS

Socio-demographic characteristics of households

The socio-demographic characteristics of the households are described in Table 1. The average size of a household was significantly higher in rural areas (15 ± 8 persons) than in urban areas (11 ± 7 persons), as well as the number of children and adolescents living in these households (P<0.05). There was no statical difference between the numbers of adult members in households. In each household, members who shared the meals were considered to represent the size of the household. The number of cooked meals was an average of 1.9 in urban households and 2.4 in rural households with a significant difference (P<0.001) between the two areas.

Consumption of discretionary salt

Overall, households consumed a median of 45 g of salt per day (Table 2). This quantity of salt added during meal preparation was significantly higher in rural (89.5 g/day) than in urban areas (23 g/day) (P<0.001). At the individual level, the same trend was observed with a significantly higher per capita salt consumption in rural (7.1 g/day) compared to urban areas (2.7 g/day) (P<0.001). Considering the main meal, the amount of discretionary salt is still significantly higher in rural households (39.5 g/day vs. 17 g/day; P<0.001).

Contribution of bouillon to salt intake

The majority of households (94.6%) were using bouillon for cooking. Most of them used several brands at the same time. The median consumption of bouillon by households (Table 2) was 50 g per day, which was significantly higher in rural areas than in urban areas (62.5 g vs. 30 g; P<0.001), and it was the same when

Table 2. Consumption of salt and bouillon by households.

Parameter	All (N= 111)	Rural (N= 54)	Urban (N= 57)	*P*
Discretionary salt by household (g/day)	45 [23 ; 90]	89.5 [49 ; 162]	23 [17 ; 40]	< 0.001
Discretionary salt per individual (g/day)	4 [2.4 ; 6.9]	7.1 [4.3 ; 9.9]	2.7 [2.0 ; 3.4]	< 0.001
Consumption of bouillon per household (g/day)	50 [30 ; 65]	62.5 [50 ;89]	30 [20 ; 50]	< 0.001
Consumption of bouillon per individual (g/day)	4.5 ± 2.6	5.3 ± 2.8	3.6 ± 2.1	< 0.010
Salt contribution of bouillon per household (g/day)	27.5 [16.5 ; 35.7]	34.4 [27.5 ; 48.9]	16.5 [11 ; 27.5]	< 0.001
Discretionary salt for the main meal by household (g/day)	26 [15 ; 46]	39.5 [26 ; 58]	17 [10 ; 27]	<0.001
consumption of bouillon for the main meal by household (g/day)	20 [10 ; 30]	30 [20 ; 48]	10 [10 ; 20]	<0.001
Salt contribution of bouillon for the main meal per household (g/day)	11 [5.5 ; 16.5]	16.5 [11 ; 26.4]	5.5 [5.5 ; 11]	<0.001

Values are expressed as mean ± SD or median with interquartile rang.
Source: Authors

Table 3. Estimate of individual salt intake and level of salt consumption.

Characteristics	All (N= 111)	Rural (N= 54)	Urban (N= 57)	*P*
Total salt consumption (discretionary salt + salt contribution of bouillon) per household (g/day)	74.5 [42 ; 139.5]	136.6 [86.1 ; 212.3]	43.4 [31.5 ; 64]	< 0.001
Total salt consumption for the main meal (discretionary salt + salt contribution of bouillon) per household (g/day)	38 [23 ; 59]	56.4 [40 ; 82.5]	24 [16.2 ; 34]	< 0.001
Total salt consumption (discretionary salt + salt contribution of bouillon) per capita (g/day)	6.3 [4.3 ; 10.3]	10.2 [6.8 ; 13.4]	4.6 [3.6 ; 5.7]	< 0.001
Total salt consumption for the main meal (discretionary salt + salt contribution of bouillon) per capita (g/day)	3.3 [2.3 ; 4.7]	4.5 [3.1 ; 6.2]	2.6 [1.9 ; 3.4]	< 0.001
Level of consumption (%)				
High (>5g/person/day)	66.7	94.4	40.4	<0.001

Values are expressed as median with interquartile range or percentage.
Source: Authors

reported at the individual level, 5.3 g/day ± 2.8 in rural areas and 3.6 ± 2.1 g/day in urban areas (P<0.01). The median salt intake from bouillon was estimated at 27.5 g of salt per household, representing an average of 2.5 g/day for each individual in the household. The median amount of bouillon added to the main meal was 20 g/day overall and significantly higher in rural areas (30 g/day).

Assessment of household and per capita total salt consumption (discretionary salt + bouillon salt)

The median household total salt consumption was 74.5 g per day (Table 3). This quantity was significantly higher in rural area compared to urban area (136.6 g/d vs 43.4 g/d ; P<0.001). The average per capita salt consumption was 6.3 g per day, with a significant difference between rural and urban area, respectively (10.2 g/d vs 4.6 g/d ; P<0.001). Compared to the WHO recommendation, 66.7% of households' had a per capita consumption of salt more than 5g per day. When considering salt consumed at the main meal in rural households vs. salt consumed at the main meal in urban households, there was still a significant difference between the two areas (56.4

Table 4. Knowledge, attitudes and practices related to salt and bouillon use.

Characteristics	All (N= 111)	Rural (N= 54)	Urban (N= 57)	*P*
Consumption of bouillon	94.6	98.2	91.2	
Knowledge of the composition of bouillon	23.4	20.4	26.3	
Health consequences of excessive salt	75.7	70.4	80.7	
Frequency of adding bouillon to meals				
Always/Often	91.9	96.3	87.7	
Sometimes	1.8	1.9	1.8	
Never	6.3	1.8	10.5	
Cooking without bouillon	49.5	30.2	69.2	<0.001
Reasons for using bouillon				
To enhance the taste	85.7	86.8	84.6	
By habit	19.1	20.8	17.3	
Perception on the amount of salt consumed (How do you rate the amount of salt you eat?)				
Low	6.3	5.6	7	
Adequate	82.9	85.2	80.7	
High	10.8	9.3	12.3	
Limitation/reduction of salt in diet (Is it important for you to reduce the salt in your diet?)				
Very important	52.3	40.7	63.2	0.018
Less important	11.7	7.4	15.8	
Not important	29.7	46.3	14	<0.001

Values are expressed as percentage.
Source: Authors

g/day vs. 24 g/day; P<0.001).

Knowledge, attitudes and practices related to salt and bouillon consumption

As described on Table 4, 75.7% of the households were informed about excessive salt consumption. Among possible diseases related to salt consumption, high blood pressure was cited by more than half (57%) of respondents. A large majority (83%) believed that they were consuming the right amount of salt, however, more than half (52.3%) attached great importance to reducing/limiting salt in their diet. Overall, 94.6% of these households were using bouillon when preparing meals, but less than a quarter of the respondents (23.4%) knew at least one of the components of bouillon. They were mainly used to enhance the taste of food (85.7%) or as a cooking habit. Nearly half (49.5%) of households felt they could cook their meals without bouillon, with significant difference between urban and rural households (69.2% vs 30.2%; P<0.001).

DISCUSSION

In this study, the average salt consumption per individual (6.3 g/day) was comparable to findings of studies conducted in Malawi (Prynn et al., 2018) Italy (Donfrancesco et al., 2021) and Vanuatu (Paterson et al., 2019), using the standard 24-hour urine collection method, which found that these populations consumed 7.1g, 7.2g and 5.9g of salt/day respectively. However, the salt consumption of our population was lower than the average consumption of adult population over 20 years old (8g/day) reported in the Senegal profile for non-communicable diseases (WHO, 2018a). Results from other studies using the same methodology as ours in Nepal (Ghimire et al., 2019), or by measurement through standard 24-hour urine collection in various countries (Lazda et al., 2018; Menyanu et al., 2020; Neupane et al., 2020) also found higher quantities. Differences in methodology and geographical location explain the differences in estimated salt consumption. The 24-hour collection of urine is a direct and more accurate method that directly reflects individual consumption. On the other hand, the per capita estimate of salt consumption is an aggregate measure that represents the average salt consumption in a given population. Overall, higher per capita consumption suggests greater availability of salt in the diet which could be associated with higher levels of urinary sodium in the population. It also depends on the culture, economic context, and dietary habits.

The consumption of salt by rural households was double that of urban households (10.2 vs. 4.6 g/day), which is probably because rural households were preparing significantly more meals than urban households. Indeed, rural households were more likely to prepare and consume the three main daily meals together as a whole household.

In urban areas, the main meal consumed by all members of the household was lunch, while breakfast and dinner were often eaten outside the household. The number of cooked meals was an average of 1.9 in urban households and 2.4 in rural households with a significant difference (P<0.001) between the two areas. When considering salt consumed at the main meal in rural households vs. salt consumed at the main meal in urban households, there was still a significant difference between the two areas. This confirms the same pattern observed when all the meals prepared in the household were taken into account.

The per-individual consumption of bouillon estimated in this study was almost double the amount estimated in the national survey on household use of adequately iodized salt and bouillon in Senegal (IPDSR, 2014). The proportion of households consuming bouillon was equal to that reported at the national level (94%) in a survey on the status of certain micronutrients (UCAD/COSFAM/NI, 2011). The rate of bouillon use in urban areas was comparable to observations made in Benin and Guinea according to a meta-analysis of urban populations in five sub-Saharan African countries (Leyvraz et al., 2018). Our results showed that rural households were adding twice the amount of bouillon than urban households. This quantity of bouillon added was probably linked to the quantity of food cooked and consequently to the larger household size in rural areas. Given that a bouillon cube weighs on average 10-12 g, this means that a rural household added approximately 6 bouillon cubes per day for meal preparation, compared to 3 cubes for an urban household.

In general, the per capita salt consumption of these Senegalese households was well above the WHO standard, indicating that actions should be taken to improve awareness and promote a reduction of salt consumption. In particular, the use of seasoning bouillon, which represented more than a third (37%) of the salt consumed by our households, should be rationalised. The situation is particularly alarming as discretionary sources account for about 15-20% of total dietary sodium intake (SACN, 2003). This suggests that total salt consumption from all sources is considerably very high.

Urinary sodium analysis, which is the gold standard method that accurately gives the amount of salt consumed at the individual level (McLean, 2014), was not used in this study due to a lack of resources and time. The consumption of discretionary salt at the household level measured by weighing method did not take into account all sources of salt in our diet. But, in developing countries, the majority of dietary salt is added during food preparation (Brown et al., 2009).

Another limitation of this study is that the sample was not representative at national level but given that salt consumption patterns are generally uniform across the same population and context (Mannar, 2018), the data from this study provides a good overview of the overall situation in the country. However, this study should be complemented by measuring salt from processed foods (industrial or artisanal) and foods prepared and/or eaten outside the home (e.g., from street vendors, fast-food) to have a better estimate of total salt consumption in Senegalese households.

Our study population's knowledge about the harmful effects of excessive salt consumption and the importance of reducing salt in the diet was comparable to results obtained in Ethiopia and Kenya (EPHI, 2015; KNBS, 2015). However, there was less awareness in our study population (75.7%) about the consequences of high salt consumption, compared to the national STEPS survey conducted in 2015 (ANSD, 2015), which reported that 88.3% of Senegalese think that salt can harm their health. In rural areas, the lack of importance given to limiting or reducing salt in the diet was due to limited knowledge and the absence of communication and awareness-raising strategies on salt consumption and their link with cardiovascular diseases. Indeed, in the program to strengthen nutrition, the talks organised by community health workers were generally limited to infant and child feeding, hygiene measures and precautions, pre- and post-natal care and the use of iodised salt... Despite the very frequent and widespread use of bouillon, few of the people in charge of cooking in the households visited could name at least one ingredient in their composition. This indicates a lack of knowledge and nutritional education, which was more marked in rural areas. This could be explained by the fact that women were more interested in the flavour enhancer function of bouillon than in their composition or their nutritional value.

At least two-thirds of the households surveyed had a per capita consumption of discretionary salt above the WHO recommendations (5 g/day), yet most think they were consuming the right amount of salt. This perception of individuals was similar to that reported at national level (ANSD, 2015). Individuals with a high preference for salt also had a higher salt consumption but they assessed the right amount according to their attraction for salty taste, which leads to false perceptions on the quality of their diet (Pilic et al., 2020). Dependence on high salt intake in humans is induced early in life, so as people grow older, their dependence on salty foods, reinforced by exposure to manufactured products, worsens (Roberts, 2001).

Conclusion

This study showed that Senegalese households (rural and urban) use high quantities of salt and consequently per capita salt consumption was above WHO recommendations. The consumption of bouillon contributed significantly to salt intake, particularly in rural areas. Since the contribution of potentially salt-rich processed foods was not considered in this study, salt consumption would probably be higher, particularly in urban areas. The current levels of salt consumption would expose urban as well as rural population to a high risk of hypertension and other diet-related non-communicable diseases.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The authors thank the administration and traditional personalities in Malem Hodar district and all the households, nurse managers, village chiefs and relays who contributed greatly to the work, for their availability, their understanding, and the rigour of their work.

REFERENCES

Agence Nationale de la Statistique et de la démographie (ANSD) (2015). Enquête nationale sur les facteurs de risques des maladies non transmissibles. Ministère de la Santé et de l'Action Sociale, Sénégal.

Association Sénégalaise de Normalisation (ASN) (2017). Bouillon alimentaires d'assaisonnement - Spécifications NS 03-146. ASN, Sénégal.

Brown IJ, Tzoulaki I, Candeias V, Elliott P (2009). Salt intakes around the world: implications for public health. International Journal of Epidemiology 38(3):791-813.

Codex Alimentarius (2015). Norme pour les bouillons et consommés. CODEX STAN 117-1981.

Donfrancesco C, Lo Noce C, Russo O, Minutoli D, Di Lonardo A, Profumo E, Buttari B, Iacone R, Vespasiano F, Vannucchi S, Onder G, Galletti F, Galeone D, Bellisario P, Gulizia MM, Giampaoli S, Palmieri L, Strazzullo P (2021). Trend of salt intake measured by 24-h urine collection in the Italian adult population between the 2008 and 2018 CUORE project surveys. Nutrition, Metabolism and Cardiovascular Diseases 31(3):802-813.

Ethiopia Public Health Institute (EPHI) (2015). STEPS report on risk factors for chronic non-communicable diseases and prevalence of selected NCDs. Federal Ministry of Health, Ethiopia.

Food and Agriculture Organisation (FAO) (2018). Strengthening sector policies for better food security and nutrition results. Food and Agriculture Organization, Rome.

Food and Agriculture Organisation (FAO) (2018). Dietary Assessment: A resource guide to method selection and application in low resource settings. Food and Agriculture Organization, Rome.

Ghimire K, Adhikari TB, Rijal A, Kallestrup P, Henry ME, Neupane D (2019). Knowledge, attitudes, and practices related to salt consumption in Nepal: Findings from the community-based management of non-communicable diseases project in Nepal (COBIN). Journal of Clinical Hypertension 21(6):739-748.

Gibson RS (2005). Principles of Nutritional Assessment (2nd ed.). Oxford University Press

Institut de Population, Développement et Santé de la Reproduction (IPDSR) (2014). Enquête nationale sur l'utilisation du sel adéquatement iodé et des bouillons par les ménages et sur le statut en iode des femmes enceintes et en âge de procréer. Institut de Population, Développement et Santé de la Reproduction, Sénégal.

INTERSALT Cooperative Research Group (1988). Intersalt: an international study of electrolyte excretion and blood pressure. Results for 24 hour urinary sodium and potassium excretion. British Medical Journal 297(6644):319-328.

Kenya National Bureau of Statistics (KNBS) (2015). Stepwise survey for non-communicable diseases risk factors. Kenya National Bureau of statistics, Ministry of Health, Kenya.

Kotchen TA, Cowley AW, Frohlich ED (2013). Salt in Health and Disease — A delicate balance. The New England Journal of Medicine 368(13):1229-1237.

Lazda I, Goldmanis M, Siksna I (2018). Salt Consumption in Latvian Population: A Pilot Study. Medicina 54(1):10.

Leyvraz M, Mizéhoun-Adissoda C, Houinato D, Baldé NM, Damasceno A, Viswanathan B, Amyunzu-Nyamongo M, Owuor J, Chiolero A, Bovet P (2018). Food consumption, knowledge, attitudes, and practices related to salt in urban areas in five sub-Saharan African countries. Nutrients 10(8):1028.

Mannar MGV (2018). Salt, In: Food Fortification in a Globalized World. Elsevier.

McLean R (2014). Measuring Population Sodium Intake: A Review of Methods. Nutrients 6(11):4651-4662.

Meneton P, Jeunemaitre X, de Wardener HE, MacGregor GA (2005). Links between dietary salt intake, renal salt handling, blood pressure, and cardiovascular diseases. Physiological Reviews 85(2):679-715.

Menyanu EK, Corso B, Minicuci N, Rocco I, Russell J, Ware LJ, Biritwum R, Kowal P, Schutte AE, Charlton KE (2020). Salt and potassium intake among adult Ghanaians: WHO-SAGE Ghana Wave 3. BMC Nutrition 6(1):1-5.

Moretti D, Hurrell RF, Cercamondi CI (2018). Bouillon Cubes, In: Food Fortification in a Globalized World. Elsevier, Academic Press pp. 159-165

Murray CJL, Lopez AD (2013). Measuring the global burden of disease. The New England Journal of Medicine 369(5):448-457.

Neupane D, Rijal A, Henry ME, Kallestrup P, Koirala B, Mclachlan CS, Ghimire K, Zhao D, Sharma S, Pokharel Y, Joseph K, Olsen MH, Schutte AE, Appel LJ (2020). Mean dietary salt intake in Nepal: A population survey with 24-hour urine collections. Journal of Clinical Hypertension 22(2):273-279.

Oyebode O, Oti S, Chen Y-F, Lilford RJ (2016). Salt intakes in sub-Saharan Africa: a systematic review and meta-regression. Population Health Metrics 14(1):1-4.

Paterson K, Hinge N, Sparks E, Trieu K, Santos JA, Tarivonda L, Snowdon W, Webster J, Johnson C (2019). Mean dietary salt intake in Vanuatu: A population survey of 755 participants on Efate Island. Nutrients 11(4):916.

Pilic L, Lubasinski NJ, Berk M, Ward D, Graham CA, Anastacio VDS, King A, Mavrommatis Y (2020). The associations between genetics, salt taste perception and salt intake in young adults. Food Quality and Preference 84:103954.

Prynn JE, Banda L, Amberbir A, Price AJ, Kayuni N, Jaffar S, Crampin AC, Smeeth L, Nyirenda M (2018). Dietary sodium intake in urban and rural Malawi, and directions for future interventions. The American Journal of Clinical Nutrition 108(3):587-593.

Roberts WC (2001). High salt intake, its origins, its economic impact, and its effect on blood pressure. The American Journal of Cardiology 88(11):1338-1346.

Scientific Advisory Committee on Nutrition (SACN) (2003). Salt and health. The Stationery Office, London.

Thompson FE, Subar AF (2013). Dietary assessment methodology. In A. M. Coulston, C. J. Boushey, M. G. Ferruzzi, & L. M. Delahanty (Eds.), Nutrition in the Prevention and Treatment of Disease (3rd ed., pp. 5-48). Academic Press.

Thiam M, Diouf A, Coly OB, Kébé SD, Diongue O, Badiane A, Faye MN, Sylla PMDD, Idohou-Dossou N, Médoc JM (2022). Dietary intakes and nutritional status of mother-child (6-23 months old) pair targeted through the "organic residual products for biofortified foods for Africa project" in rural area in Senegal. International Journal of Child Health and Nutrition 11(3):119-130.

Université Cheikh Anta Diop (UCAD), Comité Sénégalais pour la Fortification des Aliments en Micronutriments (COSFAM), Micronutrient Initiative (MI) (2011). Rapport de la situation de base du statut en vitamine A et en fer chez les enfants de 12 - 59 mois et chez les femmes en âge de procréer (15 - 49 ans) dans le cadre du programme de fortification des aliments en micronutriments au Sénégal. COSFAM, Sénégal.

World Health Organization (WHO) (2005). The WHO STEPS Surveillance Manual: WHO STEPwise approach to chronic disease risk factor surveillance. World Health Organization, Geneva.

World Health Organization (WHO) (2012). Guideline: Sodium intake for adult and children. World Health Organization, Geneva.

World Health Organization (WHO) (2013). Global action plan for the prevention and control of noncommunicable diseases 2013-2020. World Health Organization, Geneva.

World Health Organization (WHO) (2017). The SHAKE Technical Package for Salt Reduction. World Health Organization, Geneva.

World Health Organization (WHO) (2018a). Country profiles for non-communicable diseases (NCDs): Senegal. World Health Organization, Geneva.

World Health Organization (WHO) (2018b). Global nutrition policy review 2016-2017: country progress in creating enabling policy environments for promoting healthy diets and nutrition. World Health Organization, Geneva.

Vol. 17(8) pp. 162-166, August 2023
DOI: 10.5897/AJFS2023.2264
Article Number: C09A49871023
ISSN: 1996-0794

http://www.academicjournals.org/AJFS

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African Journal of Food Science

Full Length Research Paper

Physicochemical and nutritional characteristics of bee pollen from Burkina Faso

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Received 24 May, 2023; Accepted 17 July, 2023

This prospective study consisted in determining the physico-chemical and nutritional composition of the pollen produced in different localities of Burkina Faso. The main constituents were determined by standard methods. The results show a mass proportion (g/100 g) of dry matter between 17.15 ± 3.69 to 34.65 ± 5.05 for proteins, 43.93 ± 2.05 to 59.11 ± 5, 05 for carbohydrates, 5.29 ± 0.05 to 18.94 ± 0.18 for total lipids and an energy value between 366.29 and 454.84 (Kcal/100 g). The pH, dry matter, Brix degree, titratable acidity, humidity, and total ash were respectively between 3.63 ± 0.056 and 5.3 ± 0.042, 91.15 ± 0.07 and 93.20 ± 0.14, 0.17 ± 0.03 and 2.06 ± 0.05, 4.49 ± 0.01 and 24.5 ± 0.00, 6.80 ± 0.14 and 8.85 ± 0.07, 2.19 ± 0.57 and 7.3 ± 0.57. The calcium, sodium, iron, zinc, potassium and magnesium contents were respectively between 4.91 ± 0.35 and 57.12 ± 0.176; 4.50 ± 0.007 and 8.94 ± 0.049; 4.82 ± 0.035 and 17.34 ± 0.530; 11.23 ± 0.021 and 59.33 ± 0.098; 8.60 ± 0.141 and 33.46 ± 0.742 and 2.75 ± 0.0127 and 108.88 ± 0.120. The results obtained on the physicochemical and nutritional characteristics of the pollen produced in Burkina Faso could be used in food formulation.

Key words: Pollen, physicochemical, nutritional characteristics, Burkina Faso.

INTRODUCTION

Bee products are nowadays used as food, food supplements, additives in cosmetic products and therapeutic API drugs. Pollen is one of these hive products presented in the form of microscopic grains contained in the anthers of the stamens of flowering plants (Prost and Le Conte, 2005). It is also the most important source of protein for the survival of bees (Almeida et al., 2005). Indeed, for food needs, beekeepers can collect bee pollen, in the form of pellets, by installing a trap or pollen trap at the entrance of the hive (Almeida et al., 2005).

Pollen can be used and consumed as a dietary supplement for its high dietary and dietary values. It is also rich in nutrients and biologically active substances (Silva et al., 2004). Its physicochemical and nutritive composition depends mainly on the bee species and the

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climatic conditions of the production region.

The beekeeping sector is growing in Burkina Faso due to the growing demand for hive products (Bambio, 2020). The production of bee products has increased from around 500 tonnes over the period 2011-2015 (Bambio, 2020) to 1500 tonnes in 2022 (MEDIAPROD and CTA, 2022). One of the major constraints in this sector is the lack of knowledge of modern production techniques inherent in the lack of actor training (Bambio, 2020). Pollen production in Burkina Faso remains embryonic and its biochemical composition remains unknown. This may limit its use and consumption.

To date, practically no study to our knowledge has focused on the physicochemical and nutritional characterization of pollen from Burkina Faso. This characterization would be very important for the use of pollen in food and nutritional technology. The aim of this work is to constitute a database on the physicochemical and nutritional characteristics of the pollen produced in Burkina Faso. This database could be used in the formulation of pollen-based foods.

MATERIALS AND METHODS

Biological material

The biological material is made up of the samples of bee pollen. These pollen samples were collected based on availability and accessibility to beekeepers.

Sampling

Bee pollen was collected in Kenyann type hives in the following localities in Burkina Faso: Fada N'Gourma, Banfora, Tenkodogo, Koudougou, Sapouy and Bobo Dioulasso. These different localities are distributed in two different climatic domains characterizing each of the domains by different vegetation. The localities of Tenkodogo, Fada, Koudougou, and Sapouy are located in the northern Sudanese domain characterized by vegetation composed of shrubby savannah, while the localities of Bobo Dioulasso and Banfora are located in the southern Sudanese domain characterized by vegetation composed of wooded to shrubby savannah. Two samples per locality were taken, packaged in jars and kept in the refrigerator.

Method for determining the biochemical composition

The pH was measured using a pH meter according to the method of Doukani et al. (2013). The titratable acidity was determined by titration of 5 g of bee pollen according NF V 05-101, 1974 and the results are expressed as a percentage (%) of bee pollen. The total ashes were determined by incineration at 550°C for 4 h in a muffle furnace according to the ISO standard 2171 (2007).

The soluble dry extract or the Brix degree of the samples was determined using a digital refractometer. Moisture and dry matter were determined by oven drying (Gacem et al., 2011). The protein content was determined according to the ISO 16634 method, 2008. The fat content was made by Soxhlet extraction according to the method of AOAC 960.39 (1999) using hexane as solvent. Carbohydrates were assayed by the spectrophotometric method of Montreuil and Spik, 1969. The mineral content (calcium, magnesium, sodium, zinc, iron, copper) of the pollen samples was determined by flame atomic absorption spectrophotometry after mineralization of the samples according to the ISO 1762 standard, 2019. The theoretical energy value was calculated using the Merrill coefficients (Merill and Watt, 1955) adopted by the FAO in 1970.

Statistical analyzes

The results of the analysis are presented as mean ± standard deviation. The processing of the results was done by analysis of variance (ANOVA) at the significance level of 5%. These analyses were carried out with the software "XLSTAT version 2022.1."

RESULTS

The macronutrient and micronutrient composition of bee pollen samples varied by locality (Tables 1, 2, and 3). Table 1 presents the values of proteins, lipids, carbohydrates, ash, and energy. The protein varied from 17.15 (Koudougou) to 34.65 (Fada N'Gourma) (m/m). Pollens from Fada N'Gourma, Tenkodogo and Sapouy were the richest in protein with respective contents of 34.65, 28.65 and 27.32. Carbohydrate varied from 43.93 (Tenkodogo) to 59.11 ± 5.05 (Koudougou) (m/m). Pollens from Koudougou, Sapouy and Bobo Dioulasso were the richest in carbohydrate with respective contents of 59.11, 58.18 and 52.86 (m/m). The fat varied from 5.29 (Fada N'Gourma) to 18.94 (Banfora) (m/m). Pollens from Banfora, Tenkodogo and Bobo Dioulasso were the richest in fat with respective contents of 18.94, 18.28 and 14.80 (m/m). The energy values varied from 366.29 (Bobo) to 454.84 (Tenkodogo) (Kcal/100 g). Pollen from Tenkodogo had the highest energy value. Ash varied from 2.19 (Tenkodogo) to 7.3 (Banfora) (m/m). Pollen from Banfora contained the most minerals. At table 2, the pH varied from 3.63 (Bobo Dioulasso) to 5.3 (Tenkodogo). Pollen from Bobo Dioulasso had the highest pH value. The humidity varied from 6.80 (Sapouy) to 8.85 (Banfora). Pollens from Sapouy and Fada N'Gourma had the lowest humidity values with respective values of 6.80 and 6.85. The dry matter varied from 91.15 (Banfora) to 93.20 (Sapouy) (m/m). Pollens from Sapouy and Fada N'Gourma were the richest in dry matter with respective values of 93.20 and 93.15 (m/m). The Brix degree and the titratable acidity varied respectively from 0.17 (Fada) to 2.06 (Banfora) and from 4.49 (Tenkodogo) to 24.5 (Koudougou). Pollens from Banfora and Koudougou had the highest values respectively for Brix degree and titratable acidity. At the table 3, the Sodium contents vary from 4.50 (Bobo Dioulasso) to 8.94 (Banfora) (m/m). Pollens from Banfora and Koudougou were the richest in sodium with respective contents of 8.94 and 6.78 (m/m). Calcium contents vary from 4.91 (Koudougou) to 57.12 (Fada) (m/m). Pollens from Fada N'Gourma and Banfora were the richest in calcium with respective contents of 57.12 and 37.36 (m/m). The magnesium contents vary from 2.75 (Koudougou) to 108.88 (Fada N'Gourma) (m/m).

Table 1. Biochemical composition and energy value of pollen from different localities in Burkina Faso.

Pollen	Protein (m/m)	Lipid (m/m)	Carbohydrates (m/m)	Ash (m/m)	Energy value (kcal/100 g)
Koudougou	17.15± 3.69[f]	12.2± 0.12[d]	59.11± 3.89[a]	4.54±0.06[c]	414.84
Sapouy	27.32± 1.38[c]	5.40± 0.13[e]	58.18± 3.42[b]	2.30±0.28[e]	390.60
Fada N'Gourma	34.65± 5.05[a]	5.29± 0.05[f]	46.76± 2.28[e]	6.45±1.06[b]	373.25
Tenkodogo	28.65± 2.05[b]	18.28± 0.18[b]	43.93± 3.69[f]	2.19±0.57[e]	454.84
Bobo Dioulasso	21.65± 1.44[d]	14.80± 0.14[c]	52.86± 0.76[c]	2.64±0.14[d]	366.29
Banfora	17.82± 3.35[e]	18.94± 0.18[a]	47.09± 2.11[d]	7.3±0.57[a]	430.10

The values reported in the same column and bearing the different superscript letters are significantly different at the 5% level.
Source: Authors

Table *2*. Biochemical composition of pollen from different localities in Burkina Faso.

Pollen	pH	Humidity (m/m)	Dry matter (m/m)	Degree Brix	Titratable acidity (g/L)
Koudougou	4.4± 0.035[c]	7.00± 0.28[c]	93.00± 0.28[c]	1.04±0.02[b]	24.5± 0.00[a]
Sapouy	3.7± 0.021[e]	6.80± 0.14[e]	93.20± 0.14[a]	0.67±0.04[c]	11.5± 0.70[d]
Fada N'Gourma	4.6± 0.007[b]	6.85± 0.07[e]	93.15± 0.07[b]	0.17±0.03[e]	4.75± 0.35[e]
Tenkodogo	5.3± 0.042[a]	6.95± 0.35[d]	93.05± 0.35[b]	0.31±0.12[d]	4.49± 0.01[f]
Bobo Dioulasso	3.63± 0.056[e]	8.05± 0.21[b]	91.95± 0.21[d]	0.66±0.02[c]	20.25± 1.06[c]
Banfora	4.09± 0.042[d]	8.85± 0.07[a]	91.15± 0.07[e]	2.06±0.05[a]	22.5± 2.12[b]

The values reported in the same column and bearing the different superscript letters are significantly different at the 5% level.
Source: Authors

Table 1. Mineral salt content of pollen from different localities in Burkina Faso.

Pollen	Sodium (m/m)	Calcium (m/m)	Magnesium (m/m)	Zinc (m/m)	Potassium (m/m)	Iron (m/m)
Koudougou	6.78± 0.042[b]	4.91± 0.35[f]	2.75± 0.0127[f]	17.94± 0.014[c]	33.46± 0.742[a]	17.34± 0.530[a]
Sapouy	4.58± 0.007[d]	9.03± 0.27[d]	13.69± 0.070[d]	11.99± 0.106[d]	10.15± 0.509[c]	5.41± 0.028[c]
Fada N'Gourma	5.22± 0.014[c]	57.12± 0.176[a]	108.88± 0.120[a]	59.33± 0.098[a]	9.99± 0.657[d]	5.43± 0.014[c]
Tenkodogo	5.26± 0.007[c]	8.87± 0.091[e]	12.42± 0.035[e]	11.23± 0.021[f]	10.13± 1.393[c]	5.28± 0.014[d]
Bobo Dioulasso	4.50± 0.007[e]	9.59± 0.077[c]	14.62± 0.212[c]	11.51± 0.007[e]	8.60± 0.141[e]	4.82± 0.035[e]
Banfora	8.94± 0.049[a]	37.36± 0.353[b]	66.50± 0.318[b]	46.06± 0.007[b]	26.65± 1.294[b]	13.68± 0.00[b]

The (mean) values reported in the same column and bearing the different superscript letters are significantly different at the threshold of $P<0.05$.
Source: Authors

Pollens from Fada N'Gourma and Banfora were the richest in magnesium with respective contents of 108.88 and 66.50 (m/m). The zinc contents vary from 11.23 (Tenkodogo) to 59.33 (Fada N'Gourma) (m/m). These were the pollens from Fada N'Gourma and Banfora which had high zinc concentrations with respective contents of 59.33 and 46.06 (m/m).

Potassium contents vary from 8.60 (Bobo Dioulasso) to 33.46 (Koudougou) (m/m). Pollens from Koudougou and Banfora had high potassium concentrations with respective contents of 33.46 and 26.65 (m/m). Iron contents vary from 4.82 (Bobo Dioulasso) to 17.34 (Koudougou) (m/m). Pollens from Koudougou and Banfora were the richest in iron with respective contents of 17.34 and 13.68 (m/m).

DISCUSSION

The fat contents obtained from pollen samples from the localities of Banfora, Tenkodogo and Bobo Dioulasso were higher than those obtained by Souza et al. (2018) (14 g/100 g), Heldt et al. (2019) (4.64 g/100 g), Aličić et al. (2020) (6.78 g/100 g), Okumus et al. (2018) (13.30 g/100 g), Veysel et al. (2021) (10.951 g/100 g). The protein contents obtained from pollen samples from the localities of Fada N'Gourma, Tenkodogo and Sapouy were higher than those obtained by Souza et al. (2018) (26.76 g/100 g), Liolios et al. (2016), (30.11 g/100 g), Heldt et al. (2019), (21.35 g/100 g) and El Ghouizi et al. (2021) (30.32 g/100 g). Total carbohydrate contents obtained from pollen samples from the localities of Koudougou, Sapouy and Bobo Dioulasso were higher than those obtained by Heldt et al. (2019) (15.50 g/100 g) but lower than that of Aličić et al. (2020) (73.76 g/100 g). Total ash contents obtained from pollen samples from the localities of Banfora, Fada N'Gourma and Koudougou were superior to those obtained by Souza et al. (2018) (2.83 g/100 g), Heldt et al. (2019) (2.22 g/100 g), El Ghouizi et al. (2021) (4.22 g/100 g), Aličić et al. (2020) (3.08 g/100 g), Okumus et al. (2018) (2.45 g/100 g), and Veysel et al. (2021) (2.44 g/100 g). The energy values obtained from the pollen samples from the localities of Tenkodogo, Banfora and Koudougou were higher than those obtained in the region of South America (Argentina and Brasil) by Souza et al. (2018) (368 Kcal/ 100 g of pollen). This difference in results can be explained by the diversity of floral species (Younsi and Lazizi, 2016).

The dry matter contents obtained from pollen samples from the localities of Sapouy, Fada N'Gourma and Tenkodogo were superior to those obtained by Veysel et al. (2021) (71.47-81.38 (g/100 g)). Moisture contents (8.85± 0.07, 8.05± 0.21, and 7.00± 0.28 (m/m)) obtained from pollen samples from the localities of Banfora, Bobo Dioulasso and Koudougou were the highest. Furthermore, the moisture content of Sapouy pollen has the lowest content (6.8 g/100 g).

This moisture content was higher compared to the maximum threshold value in Argentina and Brazil (3 g/100 g and 4 g/100 g). This content was close to the content obtained by Souza et al. (2018) (6.73 g/100 g). It was lower than that obtained by Heldt et al. (2019) (7.44 g/100 g), El Ghouizi et al. (2021) (10.7 g/100 g). However, this moisture content was higher than that obtained by Aličić et al. (2020) (6.07 g/100 g). High humidity of pollen can make spoilage possible particularly by moulds. This requires a conservation technique to obtain pollen with a humidity of less than or equal to 6% in order to facilitate conservation.

The pH values obtained from pollen samples from the localities of Tenkodogo, Fada N'Gourma and Koudougou were similar to those obtained by Souza et al. (2018) (4.0-6.0) and El Ghouizi et al. (2021) (4.19-4.82). The analysis of the titratable acidity showed us a fluctuation of the values. These results corroborated the values of Younsi and Lazizi, 2016) (6 g/L to 19 g/L). This fluctuation can be explained by the free acidity of fresh pollen due to the action of the natural lactic flora which is found in fresh pollen to hydrolyze organic compounds, particularly carbohydrates, to release organic acids.

The micronutrient contents of pollen from Fada N'Gourma were highest in Calcium, Magnesium and Zinc. The calcium content was higher than the calcium contents obtained by El Ghouizi et al. (2021) (2.273 mg/100 g) and Veysel et al. (2021) (54.031 mg/100 g) but lower than the content obtained by Heldt et al. (2019) (1120 mg/100 g). The magnesium content was also higher than the magnesium contents obtained by El Ghouizi et al. (2021) (79.335 mg/100 g) and Veysel et al. (2021) (99.076 mg/100g) but lower than that obtained by Heldt et al. (2019) (170 mg/100 g). The zinc content was also higher than the zinc contents obtained by El Ghouizi et al. (2021) (3.883 mg/100 g), Heldt et al. (2019) (50 mg/100 g) and Veysel et al. (2021) (3.126 mg/100 g). The potassium content obtained from pollen from Koudougou was lower than the potassium content obtained by Heldt et al. (2019) (360 mg/100 g), El Ghouizi et al. (2021) (468 55 mg/100 g) and Veysel et al. (2021) (54.031 mg/100 g). On the other hand, the iron content obtained in the same locality was higher than the iron content obtained by Heldt et al. (2019) (5.00 mg/100 g), El Ghouizi et al. (2021) (6.88 mg/100 g) and Veysel et al. (2021) (7.481 mg/100 g). The sodium content obtained from pollen from Banfora was lower than the sodium content obtained by Heldt et al. (2019) (36 mg/100 g) and El Ghouizi et al. (2021) (39.722 mg/100 g) but higher than the content (6.465 mg/100 g) obtained by Veysel et al. (2021). The botanical origin and the nature of the species foraged may be the cause of this difference in results (Younsi and Lazizi, 2016).

Conclusion

This study shows the nutritional richness of the pollen produced in Burkina Faso. Indeed, it is rich in carbohydrates, proteins and fats. It is also rich in micronutrients such as calcium (57.12 mg/100 g), magnesium (108.88 mg/100 g), zinc (59.33 mg/100 g), potassium (33.46 mg/100g) and iron (17.34 mg/100 g). The study shows that the biochemical composition of pollen produced in Burkina Faso varies depending on the region of origin but also is different from pollen from other countries. This difference could be explained by the floral diversity and the action of the natural lactic flora.

The results of this study could contribute to the popularization of pollen and to promote its technological and nutritional use.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The Laboratory of Biochemistry, Biotechnology, Food and Nutrition (LABIOTAN), The National Soils Office (BUNASOL) and the National Agency for Sanitary, Security of Environment, Nutrition, Labor and Health Products (ANSSEAT) are thanked for collaboration under analytics. The ISP/IPICS/RABIOTECH project is thanked for financial support.

REFERENCES

Aličić D, Flanjak I, Ackar D, Jasic M, Babic J, Šubarić D (2020). Physicochemical properties and antioxidant capacity of bee pollen collected in Tuzla Canton (B&H). Journal of Central European Agriculture 21(1):42-50.

Almeida –muradian, Pampelune LC, Coimbra S (2005). Composition chimique et l'évaluation botanique de boulettes séchées pollen d'abeille. Journal of Food Composition and Analysis 18(1):105-111.

Association of Official Analytical Chemists (AOAC) (1990). Official Method of Analysis, 15th ed., Association of Official Analytical Chemists. Washington, DC. USA.

Bambio FZ (2020). Production de miel au Burkina Faso. Available at: Production de miel au Burkina Faso (investirauburkina.net)

Doukani K, Tabak S, Gourchala F, Mihoub F, Ounes M, Benbaguara M (2013). Caractérisation physico-chimique du blé fermenté par stockage souterrain (Matmora). Revue Ecologie-Environnement (9):9.

El Ghouizi A, el Menyiy N, Bakour M, Badiaa L (2021). Moroccan monofloral bee pollen: botanical origin, physicochemical characterization, and antioxidant activities. Journal of Food Quality 2021:10.

Gacem MA., Ouold el hadj Kheil A, Gacemi B (2011). Etude de la qualité physico-chimique et mycologiquedu blé tendre local et importe stocke au niveau de l'office algérien interprofessionnel des céréales(OAIC) de la localité de Saida (Algérie). Algerian Journal of Arid Environment 1(2):67-76.

Heldt L., Pereira D, Souza B, Almeida-Muradian L, Carpes S (2019). Fortification of beef burger with the addition of bee pollen from Apis mellifera L. Emirates Journal of Food and Agriculture 31(11):895-901.

International Standardization Organization (ISO) (2007). Méthode de dosage des cendres dans les céréales, les légumineuses et leurs produits de mouture destinés à l'alimentation humaine ISO 2171.

International Standardization Organization (ISO) (2008). Food products Determination of the total nitrogen content by combustion according to the Dumas principle and calculation of the crude protein content. Part 2: Cereals, pulses and milled cereal products. International norm ISO 16634-2, Available at http:// www.iso.org Accessed March 2019

International Standardization Organization (2019). Papier, carton et pâtes et nanomatériaux à base de cellulose — Détermination du résidu (cendres) après incinération à 525°C. ISO 1762 Quatriéme édition.

Liolios V, Tananaki C, Dimou M, Kanelis D, Goras G, Karazafiris E, Thrasyvoulou A (2016). Ranking pollen from bee plants according to their protein contribution to honeybees. Journal of Apicultural Research 54:1-11.

MEDIAPROD, CTA (2022). Burkina Faso : Les acteurs apicoles, en marche vers une labélisation du miel. Available at : https://agribusinesstv.info/fr/burkina-faso-les-acteurs-apicoles-en-marche-vers-une-labelisation-du-miel/

Merill BK, Watt A (1955). Energy value of food: Basis and Derivation. USDA ARS.

Montreuil J, Spik G (1969). Micro dosage des glucides, méthodes colorimétriques de dosage des glucides totaux. Université de Lille France 85 p.

Okumus G, Alina V, Yildiz O, Yücel B (2018). Physicochemical and antioxidant properties of bee-pollens collected from Romania. 6th International Muğla Beekeeping and Pine Honey Congress. Turkey 9.

Prost JP, Le Conte Y (2005). Apiculture: connaître l'abeille. Ed. Technique et documentation Paris France pp. 579-600.

Silva TMS, Camara CA, Links AC, Barbosa – filho JM., Silva EMS, Freitas BM (2004). Chemical composition and free radical scavenging activity of pollen loads from stingless bee Melipona subnitida Duc. Jornal of Food Composition and Analysis 19(6-7):507-511.

Souza BR, Sattler JA, Mello AA, Granato D, Araújo ED, Freitas AD, Barth OM, Sattler A, Muradian LB (2018). Physicochemical parameters and content of B-complex vitamins: an exploratory study of bee pollen from southern Brazilian states. Revista Chilena de Nutrición 45:232-242.

Veysel B, Topal E, Çakici N, Yildizdal İ, Tosunoğlu A. (2021). Palynological analyses, chemical and mineral composition of some honeybee polen pellets (Bazı Bal Arısı Polenlerinin Palinolojik Analizleri, Kimyasal ve Mineral Madde İçerikleri). Uludağ Arıcılık Dergisi 21(2):187-197.

Younsi D, Lazizi N (2016). Etude des caractéristiques physico-chimiques du pollen d'abeille de la région de Naciria (W. Boumerdes). (Mémoire de fin d'étude en Master). Université Mouloud Mammeri de Tizi-Ouzou, République Algérienne Démocratique et Populaire 81 p.

Vol. 17(8) pp. 167-178, August 2023
DOI: 10.5897/AJFS2022.2226
Article Number: 0F2B9DE71113
ISSN: 1996-0794

http://www.academicjournals.org/AJFS

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African Journal of Food Science

Full Length Research Paper

Feeding practices and nutrition status of children aged 0-59 months from Njombe and Geita, Tanzania

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Received 8 September, 2022; Accepted 20 February, 2023

This study aimed to assess infant and young child feeding (IYCF) practices, child nutrition status, and their variations within ethnic groups in regions with high prevalence rates of stunting. A cross-sectional study was conducted on a sample of 150 mother-child pairs that were randomly selected within regions of high stunting rates (Njombe and Geita) in Tanzania. Socio-demographic, IYCF practices, and anthropometric data (HAZ, WAZ, and WHZ) were measured and further analysed in IBM SPPS Statistics 21. In general, major ethnic groups in the Njombe district had a higher rate of stunting (53.8% vs. 37.6%; p = 0.5) than major ethnic groups in the Bukombe district. Infants aged 0-11.9 months were more stunted than other age groups. Both had optimal IYCF practices, where 46.9% of infants initiated breast milk within 1 h after birth; minimum dietary diversity was 11.6%, and only 9.1% of children in Bukombe district had a minimum acceptable diet. The major ethnic group in Njombe had a mean HAZ of -1.85, while the major ethnic group in Bukombe had a mean HAZ of -0.91. This indicates the need for initiating and expanding multicomponent nutrition interventions based on ethnic features allied with IYCF practises and child nutrition status improvement.

Key words: Nutrition status, stunting, ethnicity, infant and young child feeding (IYCF) practices, underweighting.

INTRODUCTION

Despite some improvements in infant and young child health, malnutrition continues to be a significant public health issue in Tanzania and other developing nations (Powell et al., 2017). Tanzania was ranked among the nations with the highest intolerable burden of child malnutrition worldwide (Fanzo et al., 2018). Globally, approximately 21.9% of children under five were stunted, and 7.4% were wasted (DIPR, 2020), whereas in Africa, approximately 58.8% of children aged 0-59 months were stunted, and 14% were wasted (WHO et al., 2019). According to the most recent national nutrition survey conducted in Tanzania in 2018, 31.8% of children under the age of five were stunted and 14.6% were underweight. The 2015-2016 Demographic and Health Survey found that 5% of children under the age of five were underweight.

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UNICEF and other child nutrition and health experts claim that optimum infant and young child feeding (IYCF) has the largest impact on child survival of all established preventive health and nutrition interventions (Demilew et al., 2017; Hashmi et al., 2019). Poor IYCF practises can lead to malnutrition, which affects child survival (Mihretie, 2018). Undernutrition is the leading cause of poor health in children under five (Fanzo et al., 2018). Poor IYCF practises cause malnutrition in 45% of children under 5 worldwide (Asoba et al., 2019). When national policies and programme strategies prioritise early infancy nutrition and IYCF, child undernutrition, morbidity, and mortality can be reduced.

WHO and UNICEF recommend exclusive breastfeeding for the first 6 months, then introducing nutritionally adequate and safe complementary foods while continuing regular on-demand breastfeeding for two years or longer (UNICEF, 2018; WHO, 2021). The IYCF recommends breastfeeding within an hour after birth, exclusive breastfeeding for the first 6 months, introducing semi-solid, solid, and soft foods between 6 and 8 months of age, a minimum dietary diversity, a minimum acceptable diet, vitamin A and iron-rich foods, and also a supplement (Rollins et al., 2016; Powell et al., 2017). Children under the age of five are stunted, wasted, and underweight as a result of malnutrition. However, height/length for age (HAZ) indicates stunting, weight for age (WAZ) indicates underweight, and weight for length and height (WHZ) indicates wasting (WHO and UNICEF, 2021).

Some positive developments in the field of child nutrition have occurred despite slow progress in the area of IYCF core practises (WHO and UNICEF, 2021; URT, 2015; Fanzo et al., 2018). Chronic malnutrition is a severe concern in Njombe and Geita despite the government's initiatives to end malnutrition and other efforts to ensure sufficient food supplies and a high degree of food security (URT, 2015, 2018, 2019). The Tanzania National Nutrition Survey Report indicates that 53.6% of Njombe children aged 0-59 months are stunted (2018-2019). This is 4.6% more than in 2015, despite Geita's decline from 41 to 38.9%. This study's primary hypothesis was that ethnicity has an effect on appropriate IYCF practises in places with a high prevalence of stunting. In Tanzanian regions with high chronic malnutrition rates, the study compared breastfeeding, supplementary feeding, and child nutrition.

MATERIALS AND METHODS

Description of study areas

The study was undertaken in two regions with high malnutrition rates (Njombe and Geita) (Njombe Rural and Bukombe). The Njombe Rural district covers 3448 km^2 and was one of six districts in the Njombe region before joining Iringa. It is surrounded by Wanging'ombe, Kilombero, Makambako, and Njombe town. Temperatures range from 2 to 20°C on a higher plateau and 20 to30°C on a lower plateau, although only 371 km^2 is agriculturally suitable ground (URT, 2007, 2016). Geita's Bukombe district has 10,842 km^2. Bukombe is located between 31 and 32° East and 3 and 3.33° South. It borders Urambo, Kahama, Kibondo, and Biharamulo. Bena and Hehe are significant ethnic groups in Njombe, while Sukuma and Sumbwa are in Bukombe. The majority of the population in a certain district shared a similar ethnic background. Njombe and Bukombe districts are within Tanzania's most nutritionally vulnerable regions, with 53.6 and 38.9% of children stunted (URT, 2015, 2016, 2018).

Study design

The cross-sectional study was used to assess the feeding practices and nutritional status of children less than 5 years old. It is employed because survey methods are typically used to gather data; they are cost-effective, quick to run and provide occurrence rates of various nutritional aspects (Connelly, 2016). It focuses on studying and drawing implications from existing differences amongst people, subjects, or phenomena (Kothari, 2017).

The study population and target groups

The research included women and caregivers of children younger than five who lived in the Bukombe and Njombe Rural districts. There are 20,594 and 51,153 women of reproductive age in Njombe Rural and Bukombe, respectively, with a 60 and 86% chance of having a child younger than 5 years old (URT, 2013). There was an average of 56 309 mothers caring for children younger than five years old in the study areas. Women/Caregivers of children under the age of five were eligible to respond. The eligibility criteria for such women should be at least the same as those who lived in study areas in the past 12 months.

The sample size

The Green (1991) rule of thumb determined the minimal sample size needed to detect a statistically significant difference (Dattalo, 2018; Pajula and Tohka, 2016; Walker et al., 2017). The Green formula is n = 50 + 8p, where p is the number of regression predictors in the Green formula. Twelve predictors were enough to address the study's major questions. However, the sample size is:

$$N \geq 50 + 8(12) = 146$$

Adding 4 more equally distributed samples increased the power and form a sample size of 150 participants. Thus, 150 people, 65 from Njombe and 85 from Bukombe since Bukombe district exceeds Njombe in population. Researchers agree that at least 100 participants are recommended for a relevant social science analysis (Denscombe, 2017; Ferguson, 2016; Mondragon, 2017; Vasileiou et al., 2018).

Sampling procedures

In this study, a multi-stage sampling method was used to acquire eligible respondents within the study areas. The two districts (Bukombe and Njombe) from the regions with high stunting rates and different ethnic groups were purposefully selected. A list of eligible households in selected villages was made, and if the total number of households in a village was higher than the sample size needed for a certain area, the interval of households visited was found by dividing the total number of households by the sample size needed in that village.

Data collection

A structured questionnaire was used by the researcher to conduct a household survey among those who were eligible to take part in the research and lived in the study areas. Quantitative and qualitative information were used to collect information from women with children under 5 years who resided in the study areas. Information on socioeconomic and sociodemographic background, the mother's knowledge of nutrition, feeding practices, and anthropometric measurements were provided in the questionnaire.

Measurements

Anthropometric measurement

In order to determine a child's nutritional status, the researcher had to measure the child's weight and height and assess their age. The Seca 874 electronic weighing scales were used to measure the weight of a child under the age of five. To begin with, the weights of infants and children who were unable to stand were recorded on the scales. It will also be reset to zero on the weighing scale. In addition, the mother requested that she hold the baby and stand on the scale while the baby is weighed in. The children's exact ages were determined by recording their birth dates on their clinic cards. In addition, the children's height and length were measured while they were lying down using a height-length board with a precision of 0.1 cm.

Dietary assessment

In this case, we used the 24-h recall diet method, which is based on the food consumed by children aged 6 to 59 months in the previous 24 h. The mothers or caregivers had to remember and describe all of the food and beverages their children had consumed in the previous 24 h. Many more questions were posed about how well babies fared when they were introduced to non-breastfeeding fluids and foods as recommended by the World Health Organization (WHO).

Data analysis

The Statistical Package for the Social Sciences, version 21 (IBM Corp., 2011, Armonk, NY) was utilised to analyse quantitative data collected via structured interviews. After the data was entered from the structured questionnaire, it was searched for informality, trends, and outliers. A p-value of 0.05 was used to demonstrate the statistical significance of the association between variables. The transformed data was appropriate for determining the correlation and effects between variables.

Anthropometric data

ENA analysed anthropometric raw data for Standardized Monitoring and Assessment of Relief Transitions (SMART) 2011 to determine Height for Age Z (HAZ), Weight for Age Z (WAZ), and Weight for Height Z (WHZ) scores under WHO flags. Additionally, the data from ENA for SMART were entered into IBM SPSS version 21 for extensive analysis.

Descriptive statistics

Descriptive statistics were used for socio-demographic variables to check out the occurrence of features associated with child nutritional status. The frequency distribution, mean, Chi-squared, and standard deviation of the descriptive data were computed and tabulated.

Binary logistic regression

Binary logistic regression analysis was used to determine the relationship and influence between social-demographic features, feeding practices, and child nutrition status (Stunting and Underweight). The statistical model as well as the applied variables were specified as the following.

The binary logistic regression model:

$$Logit\ (Ti) = \log\ (Ti\ /\ 1\text{-}Ti) = h_0 + h_1x_1 + h_2x_2 + h_3x_3 + \ldots\ldots\ldots\ldots h_kx_k \quad (1)$$

where *Logit (Ti)* = in odds (event) that is a natural log of the odds of an event (HAZ or WAZ versus Normal) occurring; *Ti* = Probability that the event will occur, {Prob (event)}; *1-Ti* = Probability that the event will not occur, {Prob (no-event)}; h_0 = Constant of the equation; h_1-h_k = Coefficient of the independent variables; k = Number of independent variables; x_1= household size; x_2 = Child sex (female); x_3 = Child age; x_4 = Child birth weight; x_5 = Child received all Vaccines (Yes); x_6 = Early initiation of breast milk (Yes); x_7 = Minimum meal frequency (Yes); x_8 = Minimum acceptable diet (Yes); x_9 = Time to the nearest health facility; x_{10} = Maternal nutrition knowledge (knowledgeable); x_{11} = Maternal formal education (Yes).

RESULTS

Respondent's socio-demographic characteristics

The socio-demographic features of the respondents (n = 150) are presented in Table 1. The mothers were aged between 21 and 35 years; the majority were married in both districts and had at least a primary level of education. About 94% had a monthly income of less than 450 000 Tanzanian shillings and 2.7% had no income. The majority of respondents (84.7%) participated in agricultural activities, and the rest were either public servants, micro entrepreneurs, or domestic helpers. The major ethnic groups in Njombe were 31.3% Bena and 10.7% Hehe, while in Bukombe they were 28% Sukuma and 23% Sumbwa.

Children's characteristics and health information

The findings (Table 1) indicate that 56.7% of children younger than five years are female, whereas more than 80% are infants. The majority of children (86.7%) were born in health care facilities, while the remainder were born at home. Approximately 92.7% of babies were born with a typical birth weight of 2500 g, and the majority of children received all recommended vaccinations by the age of eligibility. The majority of mothers and their children (69.3%) arrive at the nearest health facilities within 30 min or less.

Infant and young child feeding practices variation within the districts

The IYCF practise indicators did not differ significantly

Table 1. Demographic and socio-economic characteristics of mother and children (n=150).

Category	Sub-category	Bukombe Dc n=85	Njombe Dc n=65	Total
Marital status	Married	77 (90.6)	56 (86.2)	133 (88.7)
	Divorced/Separated	4 (4.7)	2 (3.1)	6 (4)
	Never Married	4 (4.7)	7 (10.8)	11 (7.3)
Maternal age	Mean (SD)	27.04 (5.75)	28.80 (6.71)	27.80 (6.23)
Level of education	Primary	51 (60)	46 (70.8)	97 (64.7)
	Secondary	17 (20)	15 (23.1)	32 (21.3)
	Technical/Vocational	3 (3.5)	0 (0.0)	3 (2)
	None	14 (16.5)	4 (6.2)	18 (12)
Ethnicity	Bena	0 (0.0)	47 (72.3)	47 (31.3)
	Hehe	0 (0.0)	16 (24.6)	16 (10.7)
	Sukuma	42 (49.4)	0 (0.0)	42 (28)
	Sumbwa	35 (41.2)	0 (0.0)	35 (23.3)
	Other tribes	8 (9.4)	2 (3.1)	10 (6.7)
Occupation	Farmer	68 (80)	59 (90.8)	127 (84.7)
	Domestic help	15 (17.6)	2 (3.1)	17 (11.3)
	Farmer	68 (80)	59 (90.8)	127 (84.7)
	Public servants/SME's/Others	2 (2.4)	4 (6.2)	6 (4.0)
Maternal Income	Less than TZS 450,000	78 (91.8)	63 (96.9)	141 (94)
	TZS 450,001-700,000	5 (5.9)	0 (0.0)	5 (3.3)
	Don’t know/remember	2 (2.4)	2 (3.1)	4 (2.7)
Child sex	Boy	40 (47.1)	25 (38.5)	65 (43.3)
	Girl	45 (52.9)	40 (61.5)	85 (56.7)
Child age group	0-5 months	12 (14.1)	4 (6.2)	16 (10.7)
	6-11 months	24 (28.2)	13 (20.0)	37 (24.7)
	12-24 months	44 (51.8)	38 (58.5)	82 (54.7)
	25-59 months	5 (5.9)	10 (15.4)	15 (10.0)
Child birth place	Home	18 (21.2)	2 (3.1)	20 (13.3)
	Health facility	67 (78.8)	63 (96.9)	130 (86.7)
Birth weight	<2.5 kg	3 (3.5)	8 (12.3)	11 (7.3)
	≥2.5 kg	82 (96.5)	57 (87.7)	139 (92.7)
Child vaccination	Completed all vaccines	54 (63.5)	53 (81.5)	107 (71.3)
	Not completed/<9 months	31 (36.5)	12 (18.5)	43 (28.7)
Time to reach the nearest health facility	1-30 min	55 (64.7)	49 (75.4)	104 (69.3)
	31-60	21 (24.7)	16 (24.6)	37 (24.7)
	>61	9 (10.6)	0 (0.0)	9 (6)

Number in brackets is percentages.
Source: Authors

across the districts of Bukombe and Njombe as shown in Table 2. In contrast, approximately 55.8 and 37.9% of children in the districts of Bukombe and Njombe were breastfed within 1 h of delivery, which was equivalent to the nationwide average of 49.3% for both locations. In addition, infants aged 20-23.9 months continued nursing, and more than 70% of children under 2 years were nursed appropriately. According to the age category, infants under six months were exclusively breastfed and continued breastfeeding until 12 months. In addition, 60%

Table 2. WHO-acceptable indicators for determine IYCF practices.

Indicator	Definition	Bukombe Dc	Njombe Dc	Sig
Early initiation of breastfeeding	Children born in the previous 24 months and breastfed within 1 hour after birth	49 (55.8)	31 (37.9)	0.124
Exclusive BF under 6 months	Infant aged 0-5.9 months who had not consumed only breast milk	32 (100)	24 (100)	-
Continued BF at 1 year	Infant aged 12-14.9 months who were received breast milk on previous 1 day	27 (100)	24 (100)	-
Introduction of solid, semi-sold or soft foods	Infant aged 6-8 months who consumed these foods on the previous 1 day	23 (37.5)	23 (60)	0.429
Minimum dietary diversity*	Infants aged 6-23.9 months who received 4 or more food groups on previous day	31 (15.1)	25 (8.1)	0.210
Minimum meal frequency	Proportional of infants aged 6-23.9 months who received solid, semi-sold or soft foods as per recommended number on 1 day before	40 (60.6)	31 (47.8)	0.344
Minimum acceptable diet	Breastfeed infants aged 6-23.9 months who met both minimum dietary diversity and meal frequency	23 (9.1)	0 (0)	0.137
Consumption of iron-rich/ iron-fortified food.	Infants aged 6-23.9 months who received iron-rich/ iron fortified food on the previous day	42 (66.7)	37 (77.3)	0.396
Continued breastfeeding.	Infants 21-23.9 months of age who were still breastfed	23 (21.4)	21 (14.3)	0.694
Age-appropriate breastfeeding	Infants 0-23.9 months of age who were appropriately breastfed	59 (72.2)	42 (78.6)	0.532
Predominant breastfeeding under 6 months	Infants aged 0-5.9 months who received breast milk as the predominant foods on the previous day	21 (5.9)	21 (16.7)	0.334

*Number in brackets means percentages.**Individual dietary diversity score was used to determine minimum dietary diversity of the infants; the data were developed from 24-h recall by summing up the number score of food groups consumed by infants within the previous 24 h. The food groups were ranged from 1-7 as per WHO-recommendation and those who received at least 4 food groups were considered as they met the minimum dietary diversity.
Source: Authors

of 6-8 month-old infants in the Njombe district ate solid, semi-solid, or soft foods, compared to only 37.5% in the Bukombe district. In the districts of Bukombe and Njombe, 15.1 and 8.1% of infants aged 2-23.9 months experienced minimal dietary diversity, while 60.6 and 47.8% satisfied the threshold proportional to consuming solid, semi-solid, or soft meals.

According to Table 2, no infants in the Njombe district had an appropriate diet, whereas only 9.1% of infants in the Bukombe district did. More than half (70%) of 2-63.9-month-old children in the study areas consumed iron-rich or iron-fortified meals.

Infants and children's nutrition status

Table 3 displays the mean height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ). In both districts, the mean HAZ and WAZ were considerably lower for girls than for males. In Njombe district, the mean HAZ difference between males and females was statistically significant (p = 0.04) but not in Bukombe (p = 0.96). In contrast, the mean WAZ in Bukombe and (p = 0.62) showed no significant difference (p = 0.26). In the Njombe district, the mean WHZ was statistically substantially lower for males than for females (p = 0.04). HAZ, WAZ, and WHZ did not differ significantly among age groups in Bukombe (p = 0.96, p = 0.11, p = 0.49) or Njombe (p = 0.77, p = 0.92, p = 0.17). When comparing the districts of Bukombe and Njombe, there was a statistically significant drop in WAZ, HAZ, and WHZ (p = 0.001). The incidence of underweight was identical in the districts of Bukombe and Njombe (11%, p = 0.97). The incidence of stunting was significantly greater in the districts of Njombe (54%) than in those of Bukombe (38%). When comparing the districts of Bukombe and Njombe, there was a statistically significant drop in WAZ, HAZ, and WHZ (p = 0.001).

The incidence of underweight was identical in the districts of Bukombe and Njombe (11%, p = 0.97). The incidence of stunting was significantly greater in the districts of Njombe (54%) than in those of Bukombe (38%). In addition, the rate was higher among males (68%) than females (45%) in Njombe, but this difference was not statistically significant (p = 0.07). Njombe had a greater proportion of stunted new-borns (55% versus 20%) than Bukombe, although the difference was not statistically significant. The conclusions were roughly comparable to regional findings from the 2019 Tanzania National Nutrition Survey report.

Association of IYCF practices and child nutritional status

Stunting is associated with children aged 6-8.9 months who received solid, semi-solid, or soft foods; being underweight is associated with being a

Table 3. Mean WAZ, HAZ, WHZ and frequency of underweight, stunting and wasting between age, sex and districts.

Parameter	Bukombe Dc				Njombe Rural				P-value
	N	Normal (%) (≤2SD)	Underweight (%) (<-2SD)	Mean z-score (WAZ)	N	Normal (%) >-2SD	Underweight (%) (≤2SD)	Mean z-score (WAZ)	
Underweight									
Total	85	89.4	10.6[b]	-0.52 ± 1.21[a]	65	89.2	10.8[b]	0.62 ± 0.31	<0.001[a]; 0.97[b]
Male	40	87.5	12.5	-0.77 ± 1.12	25	88	12	-0.99 ± 0.92	
Female	45	91.1	8.9	-0.40 ± 1.21	40	90	10	0.38 ± 1.13	
p-value			0.59[b]	0.29[c]			0.80[b]	0.62[c]	
0-5 months	12	100	0	0.28 ± 0.63	4	100	0	-0.31 ± 1.25	
6-11 months	24	79.2	20.8	-0.63 ± 1.63	13	84.6	15.4	-0.75 ± 1.16	
12-24 months	44	90.9	9.1	-0.67 ± 1.05	37	89.2	10.8	-0.60 ± 1.20	
25-59 months	5	100	0	-0.51 ± 0.63	10	100	0	0.63 ± 0.41	
p-value			0.19[b]	0.11[d]			0.53[b]	0.92[d]	
Stunting				**HAZ**				**HAZ**	
Total	85	62.4	37.6[b]	-1.07 ± 1.89[a]	65	46.2	53.8[b]	-1.82 ± 1.33	<0.001[a]; 0.05[b]
Male	40	62.5	37.5	-1.06 ± 1.85	25	32	68	-2.16 ± 1.19	
Female	45	62.2	37.8	-1.08 ± 1.92	40	55	45	-1.60 ± 1.39	
p-value			0.98[b]	0.96[c]			0.07[b]	0.04[c]	
0-5 months	12	66.7	33.3	-0.31 ± 1.99	4	25	75	-2.48 ± 1.24	
6-11 months	24	45.8	54.2	-1.29 ± 2.20	13	53.8	46.2	-1.17 ± 0.99	
12-24 months	44	68.2	31.8	-1.21 ± 1.64	38	44.7	55.3	-1.82 ± 1.52	
25-59 months	5	80	20	-0.64 ± 2.04	10	50	50	-1.68 ± 1.04	
p-value			0.24[c]	0.42[e]			0.77[c]	0.77[e]	
Wasting				**WHZ**				**WHZ**	
Total	85	88.2	11.8[b]	0.12 ± 1.46[a]	65	98.5	1.5[b]	0.52 ± 1.12	<0.001[a]; 0.02[b]
Male	40	85	15	-0.02 ± 1.79	25	96	4	0.31 ± 1.12	
Female	45	91.1	8.9	0.28 ± 1.12	40	100	0	0.72 ± 1.12	
p-value			0.38[b]	0.08[c]			0.20[c]	0.01[d]	
0-5 months	12	91.7	8.3	0.81 ± 2.22	4	100	0	1.69 ± 0.90	
6-11 months	24	83.3	16.7	0.23 ± 2.28	13	100	0	0.25 ± 1.29	
12-24 months	44	90.9	9.1	-0.04 ± 1.56	38	97.4	2.6	0.57 ± 1.14	
25-59 months	5	80	20	-0.31 ± 1.57	10	100	0	0.47 ± 0.69	
p-value			0.72[b]	0.49[d]			0.86[b]	0.17[d]	

Underweighting, stunting and wasting Z-score values are obtainable as mean ± *SDs* with due regard to WHO references standard of 2006. Z-scores were obtained from software (INA for SMART) by entering the data for age, height and weight; WAZ means Weight for Age Z-score; HAZ means Height for Age Z-score; and WHZ means Weight for Height Z-score. About <-2SD were identified as Underweighted, Stunted and Wasted while Z >-2SD were considered as Normal. [a]The differences in mean Z-score were useful by *Paired sample t test*. [b]The *Chi squared test* was used for comparison of significance of proportional of underweight, stunted and wasting in Bukombe and Njombe districts as well as categorical variables among groups. [c]The comparisons of mean differences for continuous variables between two groups were done by using *Independent sample t test*. The mean differences for continuous between four infant age groups was assessed by using *One-way analysis of variance*.
Source: Authors

Table 4. Association of infant and young child feeding practices and nutritional status in both Bukombe district and Njombe district.

Core indicators	Underweight				Stunted			
	Underweighted	Normal	X^2	*Sig*	Stunted	Normal	X^2	*Sig*
EI (Breast milk)								
Yes	4 (10.0)	36 (90.0)	0.516	0.753	17 (42.5)	23 (57.5)	0.217	0.315
No	5 (12.2)	36 (87.8)			22 (53.7)	19 (46.3)		
Intr. (solid, semi/soft)								
Yes	1 (16.7)	5 (83.3)	0.731	0.906	1 (16.7)	5 (83.3)	0.025	0.013
No	1 (14.3)	6 (85.7)			6 (85.7)	1 (14.3)		
Min. (Dietary diversity)								
Yes	5 (31.3)	11 (68.8)	0.024	0.011	9 (56.3)	7 (43.8)	0.248	0.344
No	11 (9.2)	108 (90.8)			52 (43.7)	67 (52.3)		
Min. (meal frequency)								
Yes	7 (22.6)	24 (77.4)	0.133	0.140	15 (48.4)	16 (51.6)	0.358	0.571
No	2 (8.0)	23 (92.0)			14 (56.0)	11 (44.0)		
Min. (acceptable diet)								
Yes	2 (66.7)	1 (33.3)	0.064	0.014	2 (66.7)	1 (33.3)	0.527	0.596
No	7 (13.2)	46 (86.8)			27 (50.9)	26 (49.1)		
Cons. (Iron-rich/ fortified)								
Yes	8 (20.5)	31 (79.5)	0.188	0.194	20 (51.3)	19 (48.7)	0.583	0.981
No	1 (6.3)	15 (93.7)			8 (50.0)	8 (50.0)		
Optional indicators								
Cont. (BF at 2 years)								
Yes	2 (50.0)	2 (50.0)	0.080	0.023	2 (50.0)	2 (50.0)	0.586	0.748
No	1 (5.9)	16 (94.1)			7 (41.2)	10 (58.8)		
Age-appr. BF (0-23 months)								
Yes	9 (14.8)	52 (85.2)	0.212	0.227	31 (50.8)	30 (49.2)	0.266	0.314
No	1 (4.8)	20 (95.2)			8 (38.1)	13 (61.9)		
Predo. BF (<6 months)								
Yes	0 (0.0)	2 (100.0)	0.823	0.639	-	-	-	-
No	2 (10.0)	18 (90.0)			-	-		

Source: Authors

child aged 6-23 months who received four or more food groups out of seven or not, the minimum acceptable diet; and being a child aged 2-23 months who was still breastfeeding (Table 4). The findings were also linked to other studies with a common group, specifically the Tanzania National Nutrition Survey report from 2018 and the Tanzania Demographic and Health Survey report from 2015.

The determinants of child nutrition status

According to the findings of this study (Table 5), the overall model of stunting accurately predicted the outcome ($p < 0.001$). The Nagelkerke R^2 = (0.288, 0.213) indicates that the independent factors included in the model could only predict 28.8 and 21.3%, respectively, of stunting and underweight. The likelihood of being stunted was negatively affected by household size, early breast milk initiation, and minimum meal frequency (-0.187, -0.464, 0.935), as well as by child age and early breast milk initiation (-0.024, -0.680). However, only maternal nutrition knowledge and feeding behaviours, particularly a minimum permissible diet, were statistically significant (p = 0.028).

Association between maternal nutrition knowledge, nutritional status and IYCFP within different ethnicity

The results (Table 6) show maternal nutritional knowledge had a higher average (2.52) among major ethnic groups

Table 5. Multivariate analysis of the determinants of child nutritional status.

Dependent variable	Stunted		Underweight	
Independent variable	***p***	**OR (95% CI)**	***p***	**OR (95% CI)**
Household size	0.696	0.83 (0.32-2.13)	0.695	1.27 (0.39-4.12)
Child sex (female)	0.289	2.22 (0.51-9.66)	-	-
Child age	0.857	1.01 (0.89-1.15)	0.776	0.98 (0.83-1.15)
Child birth weight	0.126	2.72 (0.76-9.77)	-	-
Child received all Vaccines (Yes)	0.309	2.39 (0.45-12.78)	-	-
Early initiation of breast milk (Yes)	0.469	0.63 (0.18-2.21)	0462	0.51 (0.08-3.10)
Min. Meal frequency (Yes)	0.200	0.39 (0.09-1.64)	-	-
Min. Acceptable Diet (Yes)	0.577	2.26 (0.13-39.34)	0.028	24.34 (1.41-418.92)
Time to the nearest health facility.	0.577	1.38 (0.45-4.26)	-	-
Maternal nutrition knowledge (Overall)	0.028	2.52 (1.11-5.73)	0.338	1.66 (0.59-4.67)
Maternal formal education (Yes)	0.237	4.64 (0.36-59.18)	-	-

Stunting: Overall Wald statistics = 21.435 (p <0.001); Omnibus Tests of Model Coefficients X^2 = 13.395 (p = 0.268); Hosmer and Lemeshow Test X^2 = 6.617 (p = 0.470), Cox and Snell R^2 =0.216; Nagelkerke R^2 = 0.288. Underweighting: Overall Wald statistics = 0.163 (p = 0.686); Omnibus Tests of Model Coefficients X^2 = 7.048 (p = 0.217); Hosmer and Lemeshow Test X^2 = 6.395 (p = 0.495), Cox and Snell R^2 =0.120; Nagelkerke R^2 = 0.213.
Source: Authors

Table 6. Association between maternal nutrition knowledge, nutritional status and IYCFP difference within ethnic groups.

Grouping variable	N	Test variable		Stat- value	Significance (*p-value*)
Group		**Mean**	**SD**		
Maternal nutrition knowledge on IYCFP					
Sukuma/Sumbwa	72	2.00	0.964	19.318	0.002[a]
Bena/Hehe	62	2.52	1.004		
Underweight (Weight for Age Z-score)					
Sukuma/Sumbwa	72	-0.48	1.22	0.345	0.474[a]
Bena/Hehe	62	-0.63	1.11		
Stunting (Height for Age Z-score)					
Sukuma/Sumbwa	72	-0.91	1.94	3.545	0.011[a]
Bena/Hehe	62	-1.85	1.33		
IDDS outcomes					
Sukuma/Sumbwa	59	1.17	0.378	6.849	0.010
Bena/Hehe	56	1.09	0.288		

IYCFP = Infant and Young Child Feeding Practices, IDDS = Individual Dietary Diversity Score. [a]Mann-Whitney U Test was used to observe the significant difference when *p-value* < 0.05.
Source: Authors

in Njombe district than in Bukombe district (2.00), with U = 19.32 and p = 0.002. This means that maternal nutrition knowledge among major ethnic groups (Bena and Hehe) was higher than among major ethnic groups in Bukombe (Sukuma and Sumbwa). The child stunted rate within major ethnic groups in Njombe was higher than the child stunted rate within major ethnic groups in Geita by a mean HAZ of (-1.85) and (-0.91), respectively (U = 3.55, p = 0.011). Young children within ethnic groups in the Bukombe district had a greater chance to acquire a minimum acceptable diet as per WHO recommendations compared to those in the Njombe district (mean scores = 1.17 and 1.09; p = 0.010).

DISCUSSION

The purpose of this systematic cross-sectional study was to analyse the prevalence of IYCF practises indicators as suggested by WHO/UNICEF and nutrition status among children less than five years old, as well as to identify factors related to child nutrition outcomes. The study examines the relationship between infants aged 6-8 months who consumed solid, semi-solid, or soft foods, infants aged 6-23.9 months who consumed a minimum of dietary diversity and an acceptable diet, infants aged 21-23.9 months who continued breastfeeding, and stunting or underweight status. However, after correcting for potential confounding variables, the study revealed the drivers of child nutrition status in Tanzanian regions with a high prevalence of stunting. In conclusion, the study revealed variations in the nutritional status of children in the Njombe and Bukombe areas among the various ethnic groups.

Child health information

The child health information showed a significant improvement in the prevalence of high-impact health interventions. This indicated that there is community awareness to seek out maternal and child health services and also facilities' readiness to provide those services. According to WHO and UNICEF (2021), access to recommended routine immunization, vitamin A supplementation, and proximity to health facilities all contribute to a better chance of survival for children under the age of five. This argument was strongly supported by several other studies with similar cohorts in dissimilar study areas (Greenspan et al., 2019; Hambidge and Krebs, 2018; Chan et al., 2020; Barker et al., 2018; WHO, 2016).

Infant and young child feeding (IYCF) practices

Based on findings from Table 2, the prevalence of IYCF practises did not comply with WHO and UNICEF's acceptable criteria. About half (51.7%) of children were not breastfed within 1 h after birth; only 11.6% had minimum dietary diversity; and about 4.6% had a minimum acceptable diet. Some of the results of this study are almost the same as the latest report from the Tanzania National Nutrition Survey of 2018. In that report, 51.6% of infants in the Njombe and Geita regions did not start breastfeeding within an hour of birth. On average, infants ate foods from 3.2 food groups, which showed that the majority (59.8%) had less than optimal minimum dietary diversity, while only 25.2% had a minimum acceptable diet.

Child chronic undernutrition is more prevalent in Njombe and Bukombe districts, which have poor infant and young child feeding practises. More than half of children under the age of two are at risk of diseases related to growth and development and nutritional diseases due to the lack of colostrum and diets essential for protecting the child from contamination (Rollins et al., 2016; Demilew et al., 2017; UNICEF, 2020).

Infants and children's nutrition status

The results indicated that there were more children with stunted growth in the Njombe district (54.4%) than in the Bukombe district (37.8%) while the number of underweight and wasted children did not change significantly. This study found that children under the age of 12 months were more stunted than children of other ages, and that stunting was more prevalent among boys than girls. Some of the causes of stunting in infants aged 0-11.9 months may include insufficient prenatal care, non-exclusive breastfeeding, and inadequate complementary feeding practises by age and gender. These results are consistent with numerous other studies from Tanzania and other nations (Ahmed et al., 2016; Chirande et al., 2015; Khamis et al., 2020; Sunguya et al., 2019; Seboka et al., 2021; Ziba et al., 2018). Due to the variation in child, maternal, and household socioeconomic characteristics, the nutritional status of children in regions with a high rate of malnutrition was not assessed. The results were highly correlated with current studies assessing chronic malnutrition developments and factors in Tanzania, which similarly highlighted the same threat characteristics (Kejo et al., 2018; Khamis et al., 2020; Mrema et al., 2021; Sunguya et al., 2019). In addition, the children's suboptimal IYCF practises increase the likelihood that their nutritional health is substandard.

Association of IYCF practices and nutritional status

Overall, the results indicated that IYCF practises were still poor in the study areas. Only 29.7% of the children reach the minimum dietary diversity. This means that 70.3% of children under the age of five had a lower chance of eating at least one type of fruit or vegetable, one type of staple food, or one type of animal food. Stunting was found in 53.7% of newborns who were not breastfed within the first hour of life. Children with unaccepted IYCF practises had a higher risk of being undernourished. The findings are also related to other similar studies conducted in different areas (Anin et al., 2020; Meshram et al., 2019; Mya et al., 2019; Karn et al., 2019; Donkor et al., 2021). Inadequate IYCF practises not only increase the likelihood of being stunted or wasted, but they are also a risk factor for child mortality (URT, 2018; Derso et al., 2017).

Determinants of child nutrition status

Non-maternal nutritional information was significantly associated with an increased chance of having children with stunted growth, according to this study ($p = 0.028$). In addition, the minimally acceptable diet is more likely to impact the child's nutritional status. One of the major challenges to child development is nutritional status.

Moreover, mothers' nutritional knowledge impacts improved feeding practises. Children under the age of five have a greater chance of surviving if IYCF practises are optimal. Humanity and civilization have been adversely affected by inadequate nourishment. In the most current Tanzania national nutrition survey reports from 2019 and the Tanzania Demographic and Health Survey from 2015, it was shown that the mother's nutritional knowledge and newborn and young child feeding practises influenced nutritional outcomes. The findings are comparable to those of other studies in many domains (Agize et al., 2017; Campbell et al., 2018; Fadare et al., 2019; Kebede et al., 2020; Mtongwa et al., 2021; Kejo et al., 2018; Lappan et al., 2020; Mbogori and Murimi, 2019; Meshram et al., 2019; Mishu et al., 2020; Rakotomanana et al., 2020; Karn et al., 2019).

The relationship between maternal nutrition knowledge, nutritional status, and IYCF practises varies by ethnicity

This study found that more than half of the IYCF practises of children under five in places with a high rate of chronic malnutrition were not as good as they could be. When ethnicity was taken into account, there was also a statistically significant difference in the variety of diets between the Njombe and Bukombe districts. With similar results in Tanzania (Powell et al., 2017), they found that ethno-nutrition knowledge about IYCF practises is likely to affect the optimal feeding practises accepted by the World Health Organization and, therefore, the nutrition status of children. Other studies (Hamner et al., 2021; Gatica-Domnguez et al., 2020; Le et al., 2019; Robinson et al., 2019; Nguyen et al., 2016; Veghari and Vakili, 2016; Jones et al., 2015; Rana et al., 2018; Rashid et al., 2018) revealed that socio-economic disparity and nutritional services seeking behaviour may explain a large amount of difference in ethnicity and nutrition status. Njombe and Geita are among Tanzania's multi-ethnic regions with the highest prevalence of malnutrition (URT, 2012, 2016). The nutrition status in ethnic Njombe regions has worsened by 53.8%, while it has decreased by 36.7% in ethnic Geita regions (URT, 2018).

Conclusion

A lack of proper feeding practices among young children was observed despite the availability of nutrition services and a diet rich in different foods. The majority of mothers with HAZ, WAZ, and WHZ anthropometric failures was not IYCF-competent and hence was not providing adequate nutrition to their infants and children. Ethnic groups will be able to choose and implement the healthiest and most successful infant and young child feeding practises when ethical concerns are addressed and community health worker (CHW) clinics are improved. More socioeconomic and biological study of IYCF and child nutrition is needed. Since there is a variation in IYCF practises and child nutrition status among ethnic groups, there is a need for more information about what works.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Agize A, Jara D, Dejenu G (2017). Level of Knowledge and Practice of Mothers on Minimum Dietary Diversity Practices and Associated Factors for 6-23-Month-Old Children in Adea Woreda, Oromia, Ethiopia. BioMed Research International 2017(7204562):1-9.

Ahmed MM, Hokororo A, Kidenya BR, Kabyemera R, Kamugisha E (2016). Prevalence of undernutrition and risk factors of severe undernutrition among children admitted to Bugando Medical Centre in Mwanza, Tanzania. BMC Nutrition 2(1):1-6.

Anin SK, Saaka M, Fischer F, Kraemer A (2020). Association between infant and young child feeding (Iycf) indicators and the nutritional status of children (6-23 months) in Northern Ghana. Nutrients 12(9):1-18.

Asoba GN, Sumbele IUN, Anchang-Kimbi JK, Metuge S, Teh RN (2019). Influence of infant feeding practices on the occurrence of malnutrition, malaria and anaemia in children ≤5 years in the Mount Cameroon area: A cross sectional study. PloS one 14(7):1-17.

Barker M, Dombrowski SU, Colbourn T, Fall CH, Kriznik NM, Lawrence WT, Stephenson J (2018). Intervention strategies to improve nutrition and health behaviours before conception. The Lancet 391(10132):1853-1864.

Campbell RK, Aguayo VM, Kang Y, Dzed L, Joshi V, Waid J, Gupta SD, Haselow N, West KP (2018). Infant and young child feeding practices and nutritional status in Bhutan. Maternal and Child Nutrition 14(4):e12762

Chan G, Storey JD, Das MK, Sacks E, Johri M, Kabakian-Khasholian T, Portela A (2020). Global research priorities for social, behavioural and community engagement interventions for maternal, newborn and child health. Health Research Policy and Systems 18(97):1-12.

Chirande L, Charwe D, Mbwana H, Victor R, Kimboka S, Issaka AI, Baines SK, Dibley MJ, Agho KE (2015). Determinants of stunting and severe stunting among under-fives in Tanzania: Evidence from the 2010 cross-sectional household survey. BMC Pediatrics 15(1):1-13.

Connelly LM (2016). Cross-sectional survey research. Medsurg Nursing 25(5):369.

Dattalo P (2018). Determining sample size using fast and slow thinking. Journal of Social Service Research 44(2):180-190.

Demilew YM, Tafere TE, Abitew DB (2017). Infant and young child feeding practice among mothers with 0 - 24 months old children in Slum areas of Bahir Dar City. International Breastfeeding Journal 12(26):1-9.

Denscombe M (2017). EBOOK*: The good research guide: For small-scale social research projects*. McGraw-Hill Education (UK). 396pp.

Derso T, Tariku A, Biks GA, Wassie MM (2017). Stunting, wasting and associated factors among children aged 6-24 months in Dabat health and demographic surveillance system site: A community based cross-sectional study in Ethiopia. BMC Pediatrics 17(1):1-9.

Development Initiatives Poverty Research Limited (DIPR) (2020). 2020 Global Nutrition Report: Action on equity to end malnutrition. Bristol, UK 168 p.

Donkor WE, Adu-Afarwuah S, Wegmüller R, Bentil H, Petry N, Rohner F, Wirth JP (2021). Complementary feeding indicators in relation to micronutrient status of Ghanaian children aged 6-23 months: Results from a national survey. Life 11(9):1-17.

Fadare O, Amare M, Mavrotas G, Akerele D, Ogunniyi A (2019).

Mother's nutrition-related knowledge and child nutrition outcomes: Empirical evidence from Nigeria. PLoS ONE 14(2):1-17.

Fanzo J, Hawkes C, Udomkesmalee E, Afshin A, Allemandi L, Assery O, Baker P, Battersby J, Bhutta Z, Chen K, Corvalan C (2018). Shining a light to spur action on nutrition. Global Nutrition Report, Japan 165 p.

Ferguson CJ (2016). An effect size primer: a guide for clinicians and researchers. Psychological Association 40(5):532-538.

Gatica-Domínguez G, Mesenburg MA, Barros AJD, Victora CG (2020). Ethnic inequalities in child stunting and feeding practices: Results from surveys in thirteen countries from Latin America. International Journal for Equity in Health 19(1):1-13.

Greenspan JA, Chebet JJ, Mpembeni R, Mosha I, Mpunga M, Winch PJ, McMahon SA (2019). Men's roles in care seeking for maternal and newborn health: A qualitative study applying the three delays model to male involvement in Morogoro Region, Tanzania. BMC Pregnancy and Childbirth 19(1):1-12.

Hambidge KM, Krebs NF (2018). Strategies for optimizing maternal nutrition to promote infant development. Reproductive Health 15(1):93-99.

Hamner HC, Beauregard JL, Li R, Nelson JM, Perrine CG (2021). Meeting breastfeeding intentions differ by race/ethnicity, infant and toddler feeding practices study-2. Maternal and Child Nutrition 17(2):1-10.

Hashmi AH, Nyein PB, Pilaseng K, Paw MK, Darakamon MC, Min AM, Charunwatthana P (2019). Feeding practices and risk factors for chronic infant undernutrition among refugees and migrants along the Thailand- Myanmar border : a mixed-methods study. BMC Public Health 19(1):1-16.

Jones KM, Power ML, Queenan JT, Schulkin J (2015). Racial and ethnic disparities in breastfeeding. Breastfeeding Medicine 10(4):186-196.

Karn S, Adhikari DP, Paudyal N, Aryal B, Adhikari RK, Steffen MM (2019). Child Undernutrition and Feeding Practices in Nepal: Trends, Inequities, and Determinants. DHS Further Analysis Reports No. 122. Rockville, Maryland, USA 84 p.

Kebede DT, Bekalo DB, Mekuriaw DM (2020). Multivariate analysis of correlates of children nutritional status in Harar region, Ethiopia. International Journal of Scientific Reports 6(3):101-110.

Kejo D, Mosha TC, Petrucka P, Martin H, Kimanya ME (2018). Prevalence and predictors of undernutrition among underfive children in Arusha District, Tanzania. Food Science and Nutrition 6(8):2264-2272.

Khamis AG, Mwanri AW, Kreppel K, Kwesigabo G (2020). The burden and correlates of childhood undernutrition in Tanzania according to composite index of anthropometric failure. BMC Nutrition 6(1):1-13.

Kothari C (2017). Research methodology methods and techniques by CR Kothari. Published by New Age International (P) Ltd., Publishers 398 p.

Lappan SN, Harman T, Pavela G, Hendricks PS (2022). Relationship Between Food Security Status in a Caregiver's Family of Origin and Current Feeding Practices Among Low-Income, Single, Female Primary Caregivers. Family and Community Health 45(4):257-266.

Le TT, Le TTD, Do NK, Nadezhda VS, Andrej MG, Nguyen TTT, Duong TAD (2019). Ethnic variations in nutritional status among preschool children in northern Vietnam: A cross-sectional study. International Journal of Environmental Research and Public Health 16(21):1-11.

Mbogori T, Murimi M (2019). Effects of a nutrition education intervention on maternal nutrition knowledge, dietary intake and nutritional status among food insecure households in Kenya. International Journal Of Community Medicine and Public Health 6(5):1831-1837.

Meshram II, Mallikharjun RK, Balakrishna N, Harikumar R, Arlappa N, Sreeramakrishna K, Laxmaiah A (2019). Infant and young child feeding practices, sociodemographic factors and their association with nutritional status of children aged <3 years in India: Findings of the National Nutrition Monitoring Bureau Survey 2011-2012. Public Health Nutrition 22(1):104-114.

Mihretie Y (2018). Maternal knowledge on complementary feeding practice and nutritional status of children 6-23 Month in Jigjiga Town. Global Journal of Nutrition and Food Science 1(1):1-12.

Mishu AA, Chowdhury S, Bipasha MS, Raisa TS, Zayed NM (2020). Maternal nutritional status as determinants of child malnutrition under age 5 in Bangladesh: a multivariate approach. International Journal of Management 11(8):1-9.

Mondragon B, Guarneros GT, Jimenez TA (2017). Ethical evaluation of mental health social research: Agreement between researchers and ethics committees. Journal of Empirical Research on Human Research Ethics 12(3):161-168.

Mrema JD, Elisaria E, Mwanri AW, Nyaruhucha CM (2021). Prevalence and Determinants of Undernutrition among 6- To 59-Months-Old Children in Lowland and Highland Areas in Kilosa District, Tanzania: A cross-sectional study. Journal of Nutrition and Metabolism 202:9.

Mtongwa RH, Festo C, Elisaria E (2021). A comparative analysis of determinants of low birth weight and stunting among under five children of adolescent and non-adolescent mothers using 2015/16 Tanzania Demographic and Health Survey (TDHS). BMC Nutrition 7(1):1-10.

Mya KS, Kyaw AT, Tun T (2019). Feeding practices and nutritional status of children age 6-23 months in Myanmar: A secondary analysis of the 2015-16 Demographic and Health Survey. PLoS ONE 14(1):1-13.

Nguyen TT, Nguyen PH, Hajeebhoy N, Nguyen HV, Frongillo EA (2016). Infant and young child feeding practices differ by ethnicity of Vietnamese mothers. BMC Pregnancy and Childbirth 16(1):1-9.

Pajula J, Tohka J (2016). How many is enough? Effect of sample size in inter-subject correlation analysis of fMRI. Computational intelligence and neuroscience 2016:1-1.

Powell B, Bezner Kerr R, Young SL, Johns T (2017). The determinants of dietary diversity and nutrition: Ethnonutrition knowledge of local people in the East Usambara Mountains, Tanzania. Journal of Ethnobiology and Ethnomedicine 13(1):1-12.

Rakotomanana H, Hildebrand D, Gates GE, Thomas DG, Fawbush F, Stoecker BJ (2020). Maternal knowledge, attitudes, and practices of complementary feeding and child undernutrition in the Vakinankaratra Region of Madagascar: A mixed-methods study. Current Developments in Nutrition 4(11):1-11.

Rana MM, Van HN, Ngoc TN (2018). Effectiveness of a community-based infant and young child feeding support group programme among ethnic minorities in Vietnam. Field Exchange 58:71-74.

Rashid V, Engberink MF, Van Eijsden M, Nicolaou M, Dekker LH, Verhoeff AP, Weijs PJ (2018). Ethnicity and socioeconomic status are related to dietary patterns at age 5 in the Amsterdam born children and their development (ABCD) cohort. BMC Public Health 18(115):1-10.

Robinson K, Fial A, Hanson L (2019). Racism, bias, and discrimination as modifiable barriers to breastfeeding for African American Women: A scoping review of the literature. Journal of Midwifery and Women's Health 64(6):734-742.

Rollins NC, Bhandari N, Hajeebhoy N, Horton S, Lutter CK, Martines JC, Victora CG (2016). Why invest, and what it will take to improve breastfeeding practices?. The Lancet Breastfeeding Series Group 387(10017):491-504.

Seboka BT, Hailegebreal S, Yehualashet DE, Demeke AD (2021). Tracking progress in anthropometric failure among under-five children in Ethiopia : a geospatial and multilevel analysis. Archives of Public Health 79(103):1-17.

Sunguya BF, Zhu S, Mpembeni R, Huang J (2019). Trends in prevalence and determinants of stunting in Tanzania : an analysis of Tanzania demographic health surveys (1991-2016). Nutrition Journal 18(1):1-13.

UNICEF (2018). Breastfeeding; A Mother's Gift for Every Child. United Nations Children's Fund (UNICEF), Nutrition Section, Programme Division, New York, NY 10017, USA 20 p.

UNICEF (2020). Nutrition, for Every Child: UNICEF Nutrition Strategy 2020–2030. United Nations Children's Fund (UNICEF). UNICEF, New York, NY 10017, USA 110 p.

United Republic of Tanzania (URT) (2007). National Sample Census of Agriculture *2002/2003.* Regional Report: Iringa Region. National Bureau of Statistics, Ministry of agriculture and Food Security, Ministry of Water and Livestock Development, Ministry of Cooperatives and Marketing, Presidents Office, Regional Administration and Local Government, Ministry of Finance and Economic. Zanzibar 344 p.

United Republic of Tanzania (URT) (2012). Basic demographic and

socio-economic profile, Tanzania Zanzibar 245 p.
United Republic of Tanzania (URT) (2013). 2012 Population and Housing Census, Population Distribution by Administrative Areas, NBS&CGS.
United Republic of Tanzania (URT) (2015). Tanzania Demographic Health Survey and Malaria Indicator Survey 2015-2016. Ministry of Health, Community Development, Gender, Elderly and Children Dar es Salaam, Ministry of Health Zanzibar, National Bureau of Statistics Dar es Salaam, Office of Chief Government Statistician Zanzibar, ICF Rockville, Maryland USA 24 p.
United Republic of Tanzania (URT) (2016). Njombe District Council Socio-Economic Profile. National Bureau of Statistics, Dar es Salaam 155 p.
United Republic of Tanzania (URT) (2018). Tanzania National Nutrition Survey 2018. Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], Tanzania Food and Nutrition Centre (TFNC), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS) [Zanzibar] and UNICEF. Dares Salaam, Tanzania 144 p.
Vasileiou K, Barnett J, Thorpe S, Young T (2018). Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period. BMC Medical Research Methodology 18(148):1-18.
Veghari G, Vakili M (2016). Trend of Stunting, Overweight and Obesity among Children Under Five Years in a Rural Area in Northern Iran, 1998-2013: Results of three cross-sectional studies. Archives of Iranian Medicine 19(6):397-402.
Walker R, Huxley L, Juttner M, Burmeister E, Scott J, Aitken LM (2017). A pilot randomized controlled trial using prophylactic dressings to minimize sacral pressure injuries in high-risk hospitalized patients. Clinical Nursing Research 26(4):484-503.
World Health Organization (WHO) (2016). Interagency list of medical devices for essential interventions for reproductive, maternal, newborn and child health. World Health Organization, Geneva 176 p.
World Health Organization (WHO) (2018). Global Nutrition Report: Shining a light to spur action on nutrition. [https://doi.org/h ttp://dx.doi.org/10.2499/9780896295643] site visited on 20/6/2021.
World Health Organization (WHO) (2021). Infant and Young Child Feeding. World Health Organization. Available at: [https://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding] site visited on 15/02/2023
WHO, UNICEF (2021). Indicators for assessing infant and young child feeding practices: definitions and measurement methods. World Health Organization and the United Nations Children's Fund (UNICEF). Geneva 122 p.
WHO/UNICEF/ WB (2019). Levels and Trends in Child Malnutrition. World Bank Group, Washington DC. 16 p.
Ziba M, Kalimbira AA, Kalumikiza Z (2018). Estimated burden of aggregate anthropometric failure among Malawian children Estimated burden of aggregate anthropometric failure among Malawian children. South African Journal of Clinical Nutrition 31(2):20-23.

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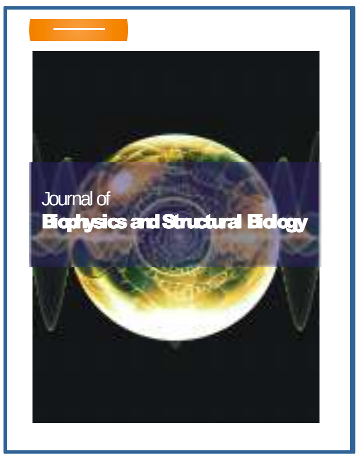

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