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ASSOCIATION BETWEEN DIETARY DIVERSITY AND NUTRITIONAL STATUS OF ADULTS (18-65 YEARS) AND CHILDREN (1-5 YEARS) IN URBAN AND RURAL COMMUNITIES OF THE NORTHWEST REGION OF CAMEROON

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ABSTRACT

Consuming diets of low diversity may lead to micronutrient deficiencies and non-communicable diseases (NCDs). Dietary diversity (DD) has become a popular indicator to assess the quality of diets as well as nutrient adequacy of food intake among adults and children. With the high prevalence of malnutrition in the Northwest Region (NWR) of Cameroon, the objective of this study was to determine the DD of the diet and nutritional status of adults (18-65 years) and children (1-5 years) in four selected rural (Mankon and Mendakwe) and urban (Mankon and Nkwen) communities. Cross-sectional study design was used with multistage sampling technique to select the participants and study sites. The study sample consisted of a total of 1248 participants. Nutritional status of adults was determined using body mass index (BMI) and waist circumference (WC), while weight-for-age, weight-for-height, height-for-age and mid-upper arm circumference (MUAC) were used for children. Dietary diversity (DD) of adults and children was determined using individual DD questionnaire. Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 25. A significant number of adults from Nkwen (urban) were either overweight (n=74; 47.4%) or obese (n=44; 28.2%) with 43.6% (n=68) from urban Mankon. A significant number of adults from rural Mankon were normal weight (49.4%; n=77), while 2.6% (n=4) from Mendakwe (rural) were underweight and 64.1% (n=100) were normal weight. Children in the rural areas were severely underweight (n=45; 14.4%), while children in the urban areas were either normal (n=158; 50.6%) or overweight (n=43; 13.8%). Mid-upper arm circumference (MUAC) values indicated that most children in both urban and rural areas were not acutely malnourished. The food groups that were consumed most across all age groups in all areas were grains, roots and tubers, fats and oils. The least consumed were fruit and vegetables, including vitamin A-rich plant foods as well as milk and milk products. There was a significant relationship between poor DD and weight-for-height (MAM) among 1-3 year old children in urban Nkwen (p=0.03) and urban Mankon (p=0.04). Although there was no significant association between DD, BMI and WC across all areas, most of the adults who had good DD were either of normal weight, overweight or obese. Overweight and obesity were more prevalent in the urban areas compared to the rural areas. There is a need to investigate the association between overall dietary intake and nutritional status and not specifically DD.

Key words: Malnutrition, nutritional status, dietary diversity, association, obesity, rural, urban, Cameroon

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INTRODUCTION

Macro- and micro-nutrient deficiencies due to the consumption of diets high in refined starch, few meats or meat alternatives and few fruits and vegetables have been a public health concern in many developing countries [1]. Malnutrition is a health problem caused by excessive food intake (overweight and obesity) or inadequate or imbalanced diets that do not contain all the nutrients needed for a good nutritional status [1, 2]. A diverse diet is needed to meet nutritional requirements and prevent malnutrition [2]. A poor nutritional status results in reduced productivity, weakened immune systems, poor cognitive development, risk of adverse pregnancy outcomes and an increased mortality rate, thus affecting economic growth [3] besides non-communicable diseases (NCDs). Malnutrition affects both adults and children in different forms such as over and undernutrition, as well as micronutrient deficiencies [4].

The Global Nutrition Report of 2021 reported that in Cameroon, the prevalence of stunting among children under five years of age was 29%, with 15% underweight and 4.3% wasted [5]. Micronutrient deficiencies such as iron, vitamin A and iodine are also very common in Cameroon [6]. Approximately 45% of pregnant women nationwide and 30% in the Northwest Region (NWR) have iron deficiency anaemia, leading to low birth weight, maternal morbidity, and mortality [6]. Iron deficiency anaemia also seriously impacts children and adults as it lowers immune status, decreases work performance and increases morbidity from infections. In addition, 70% of children under five years in Cameroon are anaemic, while 56% are anaemic in the NWR [6]. Vitamin A deficiency is also prevalent in Cameroon, occurring in 39% of children under the age of five years in 2014 [6].

Cameroon has shown limited progress towards achieving the diet-related non-communicable disease (NCD) targets set by a Global Nutrition Policy Review in 2016 to reduce premature mortality due to NCDs by 25% by 2025 [5]. Results from the Global Nutrition Report (2021) showed an increase in the prevalence of NCDs such as diabetes, hypertension, obesity and cardiovascular disease [5]. The prevalence of overweight (BMI ≥ 25 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) among adult women 18 years and above was 41.7% and 19.2%, respectively. In adult men, 25.2% were overweight and 7.5% were obese. In addition, 8.3% of adult women and 7.5% of adult men were diagnosed with diabetes, while 24.9% of adult males and 24.6% of adult females had hypertension [5]. There are strategies that can be implemented to address under and over malnutrition [1]. This includes prevention of diseases like human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) and malaria, mandatory food fortification and

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dietary diversity (DD). Dietary diversity (DD), which is defined as "the number of different foods or food groups consumed over a given reference period" [7], has been shown to improve nutrient intake and nutritional status [1]. Good DD is achieved when five or more food groups are consumed over an immediate 24-hour period [8].

Cameroon is experiencing a nutrition transition due to its political, social and economic changes resulting in increased urbanisation, with a potentially negative impact on health-related behaviour [9]. Thus, evaluating dietary quantity and quality is necessary. Dietary diversity has become a popular indicator of the diversity of diets and adequacy of nutrient intake among adults and children [10]. In Cameroon, few studies have been conducted on DD and its relationship with nutritional status [10]. Thus, the current study aimed to determine the association between DD (individual DD score) and nutritional status of adults (18-65 years) and children (1-5 years) in selected rural and urban communities in the NWR of Cameroon.

METHODOLOGY

Study design and sample selection

Cross-sectional survey study design was used to determine the nutritional status and DD of adults and children. The study sites were randomly selected using the simple random sampling procedure from a pool of areas where no similar nutritional studies have been carried out [11]. A research statistician used an online sample size calculator to determine the sample size [12]. To get results that reflected the target population in terms of gender and age as precisely as needed, a 95% confidence interval (1.96 confidence interval of a population of 2,180,309) in the NWR was assumed with a 5% margin of error [13]. In addition, a power analysis for a chi-square test indicated that the minimum sample size needed to yield a statistical power of at least 0.8 with an alpha of 0.5 and medium effect size of 0.5 was 601, based on the population size [12]. The study sample was 1248 adults and children, which was above the minimum of 601; 624 children and 624 adults per the two rural and two urban areas. Stratified random sampling was used to recruit study participants. Households that had adults (18-65 years) and children (1-5 years) were identified and listed for each study area. Every odd numbered household that had adults and children who met the inclusion criteria were allowed to participate independently of the other members of the population. Children (1-5 years) were only included in the study if their caregiver consented. Adults from the target age group of 18-65 years old were chosen because they are at increased risk for developing NCDs [14]. Children in the age group of 1-5 years were chosen

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because at this stage they grow and develop fast, their eating behaviour evolves and they are vulnerable to malnutrition [15]. Adults and children who did not fall within the target group at the time of data collection were excluded. Pregnant women were excluded because it is well accepted that BMI is not used during pregnancy [16]. All individuals who were invited to participate in the study, agreed to participate.

Data collection: Anthropometric measurements

Adults

The anthropometric measurements were taken from adults at all four study sites. This was done using the World Health Organization (WHO) Steps Surveillance [17] and Centers for Disease Control and Prevention (CDC) [18] procedures on how to take anthropometric measurements including weight, height and waist circumference (WC) [15]. Weight was measured in kilograms (kg) to the nearest 0.1 kg using an EatSmart Precision Plus Digital scale (EatSmart, Chicago, USA, 2010). Height was measured in metres (m) to the nearest 0.1 m using an HM200P PortStad Portable Stadiometer (Charder, USA, 2016). Waist circumference (WC) was measured in centimetres (cm) to the nearest 0.1 cm using a circumference diameter tape (Wintape Measuring Tape, co. Ltd, Guanghou, China, 2009). All measurements were taken in triplicate and the means calculated and recorded. Mean weight and height values were used to calculate BMI, which was classified using BMI cut-offs based on data from the WHO [17]. A WC >88 cm (35 in) in females and >102 cm (40 in) in males indicated an increased risk for co-morbidities, including obesity [17]. This was used to determine the risk for co-morbidities in this study.

Children

Anthropometric measurements were taken from children at all four study sites using the WHO Steps Surveillance [17] and CDC [18] procedures on how to take anthropometric measurements. Children in the study were weighed using an EatSmart Precision Plus Digital weight scale (EatSmart Chicago, USA, 2010) to the nearest 0.1 kg. Height was measured using an HM200P PortStad Portable Stadiometer (Charder, USA, 2016) in metres (m) to the nearest 0.1 m. A non-stretch fibre glass mid-upper arm circumference (MUAC) measuring tape [S0145620, United Nations Children's Fund (UNICEF) 2013] was used to take MUAC measurements from children to the nearest 0.1 cm. All measurements were taken in triplicate and the means were calculated and recorded. Mean weight and height measurements were used to calculate weight-for-age, weight-for-height and height-for-age. The WHO cut-offs (WHO Child Growth Standards 2012) were used to classify weight-for-age, weight-for-height and height-for-age in this study [17].

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Mid-upper arm circumference (MUAC) measurements were used to assess the severity of malnutrition in children [15].

Data collection: Dietary assessment

An individual DD questionnaire was used to assess dietary intake of adults (18-65 years) and children (1-5 years) from all four study sites.

Individual DD questionnaire

The questionnaire was adapted from the Food and Agriculture Organization (FAO) guidelines for measuring household and individual DD [8]. The FAO tool was developed for global use. Measuring individual DD is based on the number of foods or food groups consumed over a period of 24 hours from a list of 14 food groups [8]. Food groups are chosen because they are likely to be more representative of a diverse diet than individual food items [8]. The current study questionnaire consisted of nine food groups [19]: Grains/roots/tubers, vitamin A-rich plant foods, meat/poultry/seafood, foods cooked in fat/oil, milk and milk products, other fruits and vegetables, eggs, nuts/pulses/legumes and iron-rich foods [Moringa, cow pea and melon seeds (Egusi)]. The commonly consumed foods in the NWR were incorporated into each food group. A score of '1' was awarded for every food group consumed and '0' for groups not consumed. Half of the food groups consumed were used as a cut-off point for DD, which is five out of nine food groups consumed over a 24-hour period [8]. Therefore, good DD was achieved if five or more food groups were consumed over a period of 24 hours and poor DD was shown if less than five food groups were consumed over a 24-hour period.

Data analysis

Data were captured onto Microsoft Excel spreadsheets by the researcher and then transferred to the Statistical Package for Social Sciences (SPSS) version 25 for analysis by a statistician. Data were analysed using descriptive statistics including means, standard deviations and frequencies. A chi-square test of independence was used on cross-tabulations to determine whether a significant relationship existed between the two variables represented in the cross-tabulation. When conditions were not met, the Fisher's exact test was used. Significance was established at $p<0.05$.

Ethical clearance

All methods in this study were carried out in accordance with the Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects. Ethical approval was obtained from the Biomedical Research Ethics Committee of the

University of KwaZulu-Natal, South Africa (Ref No. BE439/19) and the Regional Hospital Institutional Review Board Cameroon (Ref No. 072/APP/RDPH/RHB/IRB).

RESULTS AND DISCUSSION

Nutritional status of adults

A chi-square test of independence showed that the urban areas had more overweight and obese participants than the rural areas. A significant number of adults from Nkwen (urban) were either overweight (n=74; 47.4%) or obese (n=44; 28.2%) with 43.6% (n=68) from urban Mankon obese. A significant number of adults from rural Mankon were normal weight (49.4%; n=77), while 2.6% (n=4) from Mendakwe (rural) were underweight and 64.1% (n=100) were normal weight (Table 1). In addition, a significant number of adult females in the urban sites Nkwen (urban) (n=39; 53.4%) and urban Mankon (n=43; 69.4%) had larger WC (greater than 88 cm) than males in Nkwen (urban) (n=6; 7.7%) and urban Mankon (n=13; 14.0%), putting them at substantially increased risk for obesity-related diseases (Table 2). In addition, significant numbers of adult females and males in the rural sites of Mendakwe and rural Mankon had normal WC.

It is evident that over and undernutrition are prevalent in the NWR of Cameroon from the current study. This is in keeping with results from the World Food Program (WFP), which also mentioned that over and undernutrition were prevalent in Cameroon [20]. In Africa, the high prevalence of overweight and obesity has been attributed to the nutrition transition that has resulted from urbanization and westernization of lifestyle behaviour, which include poor dietary habits and sedentary lifestyles [21]. In addition, the results of this study showed that in general, females from the urban areas had larger WC than men compared to the rural areas. Women have a higher percentage of body fat than men and their resting fat metabolism is lower than in men, leading to an increased risk for obesity [22]. The direct consequences of being overweight or obese include a large WC, diabetes mellitus, cardiovascular disease, high blood pressure, osteoarthritis, dyslipidaemia and cancer [23].

Nutritional status of children

Many children in the rural areas were severely underweight (n=45; 14.4%), while most children in the urban areas were either normal (n=158; 50.6%) or overweight (n=43; 13.8%). In addition, most children in the rural areas had normal height (n=97; 31.1%), while a good number (n=63; 20.2%) in the urban areas were tall (Table 3). Most of the children had normal MUAC in urban Nkwen (n=147; 94%), urban Mankon (n=152; 97%), rural Mankon (n=142; 91.0%) and rural Mendakwe

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(n=154; 98.7%). A significant number of children had SAM in urban Nkwen (n=3; 1.9%) and MAM in rural Mankon (n=12; 7.7%) (Table 4).

In the last decade, undernutrition in children has received political and financial attention globally, including in Cameroon, while overnutrition in children is often overlooked and regarded as "healthy feeding" in most African countries [24]. Rural-urban differences in anthropometric status were observed among children under 5 years old in the current study. Urban Nkwen and Mankon recorded more overweight children than underweight and normal weight children, compared to their rural counterparts. Meanwhile, rural Mendakwe and Mankon had more normal weight and underweight children. This is in accordance with a study which found that in low- and middle-income countries, particularly in the urban areas, the distribution of childhood nutritional diseases is shifting from undernutrition to overnutrition [24]. Most of the children in both the urban and rural study sites in the current study were not acutely malnourished with a mean MUAC >12.5 cm, indicating a low prevalence of undernutrition. However, higher mean MUAC results were seen in children in the urban areas, compared to their rural counterparts. According to a study conducted similarly to the current study, there was a direct relationship between child Z scores and MUAC, where the higher the Z scores, the higher the MUAC; most of the children in the urban areas were overweight [25]. Most of the children in urban areas have sedentary lifestyles, low physical activity levels and high consumption of high calorie foods and drinks [26, 27]. This could be a possible reason for the high prevalence of overweight and obesity among children in urban Nkwen and Mankon. Children in rural areas are usually very active, either playing with friends, walking long distances to go to school or helping their parents on the farm, so they are at lower risk of being overweight [26]. In addition, the rural communities cannot afford to buy luxury food items such as sweets, biscuits and sweet fizzy drinks, which may explain why rural children consume less of these items compared to urban dwellers [26]. Most of the rural communities grow their own crops and rear animals and thus produce their own food [26]. This could be a possible reason for the low prevalence of overweight and higher prevalence of normal and underweight children in rural areas.

Dietary diversity (DD) among adults and children

A chi-square test of independence was applied to determine if the number of children and adults who had poor DD (consumed < 5 food groups) and good DD (consumed ≥ 5 food groups) was statistically different. Results showed that there was good DD among adults and children. However, a number of adults and children had poor DD in rural Mankon (n=83; 53.2% adults; 42.3%; n=66 children) and Nkwen (22.4%; n=35 adults; 19.9%; n=31 children) as shown in Table 5.

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Association between DD and weight-for-age (WFA), weight-for-height (WFH), height-for-age (HFA) and MUAC in children 1-5 years old

The findings of the current study indicate that there was a significant relationship between DD (individual DD score) and anthropometric status among children. There was a significant relationship between poor DD and weight-for-height (MAM) among 1-3 year old children in urban Nkwen (p=0.03) and urban Mankon (p=0.04) (Table 6).

Children 1-3 years and 4-5 years old who had poor DD and consumed less than five food groups over the previous 24 hours were moderately wasted (low weight-for-height) and also moderately underweight. Poor DD, which is common in developing countries among children under 5 years, causes undernutrition and impacts greatly on child growth and development [28]. A study conducted in Tanzania on children 6 months to 2 years of age, showed that as the number of food groups consumed decreased, the likelihood of suffering from wasting, stunting and underweight increased [29]. This was similar to the results of the current study as wasting was related to poor DD and being moderately underweight was related to poor DD in children 1-3 years old. Another study on the association between DD and nutritional status of children in Ghana, indicated that children who had low DD were wasted, which agrees with the current study results [30]. Additionally, the results indicate that there was no statistically significant relationship between DD and stunting and DD and MUAC for children. Another study on DD and nutritional status among children under 5 years of age in rural Burkina Faso, found that there was no association between DD and MUAC, similar to the findings of the current study [31, 32]. Thus, DD was a good predictor of dietary quality and micronutrient density in children as it had a positive impact on their nutritional status.

Although the children generally had good DD, their diets were low in dairy products, meat and meat alternatives and fruits and vegetables (Figure 2). This agrees with findings from other African countries like Ghana, Nigeria and Senegal, as children under 5 years consumed mostly starchy foods, with a low intake of protein, fruits, vegetables and dairy products [33]. The low consumption of fruits, vegetables, dairy and animal food sources among children reflects a monotonous diet [34]. In addition, the low consumption of fruits and vegetables may be because of a lack of time by caregivers to peel fruits and prepare vegetables for children [35]. There is a wide variety of fruits and vegetables grown in the NWR and sold at very affordable prices for everyone to access, although consumption is low [30]. A low consumption of dairy and animal food sources by the children in the current study, especially from rural households, could be due to cost, as these products

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may be more expensive, compared to meat alternatives like beans and groundnuts [30]. So, most caregivers would prefer to buy meat alternatives for their children. Such diets would most likely lack the essential amino acids, which are vital for growth and development of children [30]. It has been observed that when households cannot afford sufficient food, they adjust by either eating less healthy foods or reducing the quantity of food consumed [30]. A possible reason for the good DD despite the monotonous diets could be that the caregivers had very limited nutritional knowledge and less time to prepare balanced diets for children [10, 36]. It was reported that Cameroonians lacked knowledge on the nutritional benefits of different food products, the meaning of a balanced diet and how to prepare foods to maintain their nutritional value [10, 36]. Thus, it is possible that the population of the NWR may have a similar problem. Therefore, parents and caregivers need to be encouraged to make time to prepare balanced meals for their children, inclusive of all food groups in their correct proportions. It is also important for caregivers to be educated on the nutritional benefits of different food products and the importance of including micronutrient-rich foods and animal food products in the diets of children as this may be an approach to reduce the burden of undernutrition.

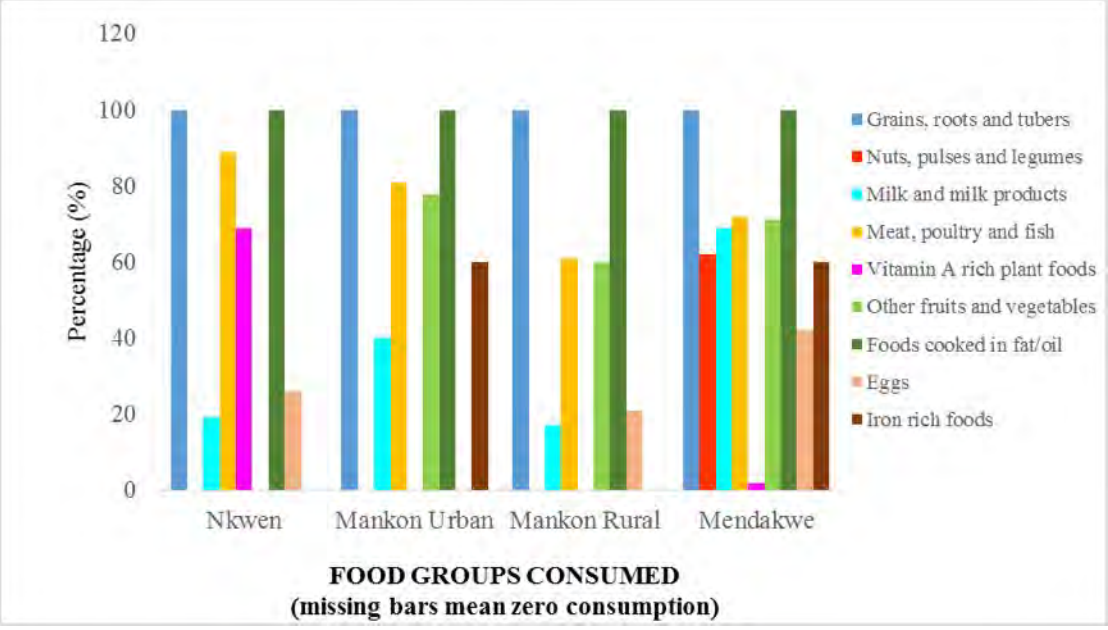

Figure 1: Food group types consumed by adults at all four study sites (N=624)

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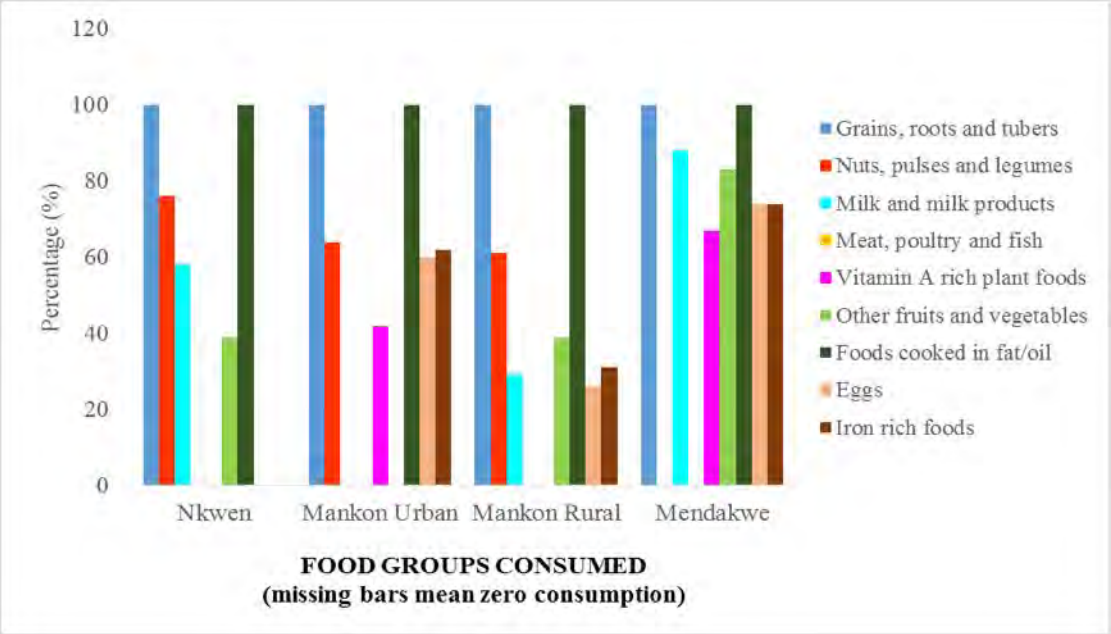

Figure 2: Food group types consumed by children at all four study sites (N=624)

Association between DD and BMI and WC for adults (18-65 years)

The results indicated that there was no association between DD and BMI and DD and WC in adults. Body mass index (BMI) was not associated with poor or good DD (Tables 7 and 8). However, although not statistically significant, the results showed that those who had good DD were likely overweight or obese. Participants who were overweight or obese generally had larger WC, particularly females. Nationwide data on the relationship between DD and nutritional status is not available in Cameroon [10]. However, different studies in some developing and developed countries have shown that greater DD is associated with increased body weight and subsequently overweight and obesity [2].

A diverse diet is needed to meet nutritional requirements and prevent malnutrition [2]. Results from a study on diverse diets showed that although nutrient requirements were met, a diverse diet led to overweight or obesity in young adults because of uncontrolled portion sizes [2]. The current study results are similar to a study conducted in Monduli district, Tanzania, which showed that adults who consumed a diverse diet consisting of five food groups and more over a period of 24 hours, had a higher BMI and WC, and were either overweight or obese [37]. In addition, a study conducted in Zambia indicated that participants who had good DD (more than 5 food groups consumed over a period of 24 hours) consumed more energy and were at higher risk of general and central obesity, than people with low DD [38].

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Although most of the participants in the current study achieved good DD (Table 5), the food groups that were mostly consumed were the grain, fat, and oil groups. Fruits and vegetables and the milk groups were the least consumed (Figure 1). Based on these results, it is possible that their diets were high in refined carbohydrates, with a high intake of fats and oils, moderate intake of animal food products, low intake of milk and milk products and little or no fruits and vegetables. These dietary habits may have contributed to overweight and obesity in the NWR. These findings are in line with a study conducted in four regions of the country including the NWR on dietary assessments of women 14-49 years using an FFQ [39]. The results of the study by Mbobda *et al.* [39], showed that the diets were high in starch, fats and oil, but low in dairy, protein, fruits and vegetables. The main reason for this as mentioned earlier could be that there is a considerable lack of nutritional knowledge as well as a lack of using the little knowledge they have regarding healthy dietary practices and habits in Cameroon [10,36]. Another study conducted in Yaounde, Cameroon, showed that a lack of time affected the consumption of fruit and vegetables in this part of Cameroon [35]. Study participants complained of a lack of time to buy, prepare and cook vegetables. This is a possible factor that could affect DD in the NWR, where participants may lack time to buy, prepare, cook and eat healthy food.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

The current study investigated whether or not there was an association between DD and nutritional status in children and adults, separately. More than half of the adults and children in both the urban and rural study areas consumed foods from more than five food groups over the previous 24-hour period, indicating good DD. The food types most consumed were starch, cereals and grains with a moderate intake of animal food sources and little or no fruit, vegetables and dairy. This study showed that good DD was associated with reduced body wasting in 1-3-year-old children. For the adults, although not statistically significant, good DD was likely linked with overweight and obesity. This implies that good DD may not be associated with healthy eating, especially for adults, whereas for children it was associated with an improved nutritional status. Thus, DD needs to be promoted with careful consideration to achieve an increased intake of selected food items. Increasing the intake of foods high in fibre and micronutrients will likely result in positive nutritional and health outcomes in the communities studied.

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Table 1: Body mass index classification for adults 18-65 years by study site (N=624)

BMI classification					
Site	**Underweight (< 18.5 kg/m²) n (%)***	**Normal (18.5-24.9 kg/m²) n (%)***	**Overweight (25.0-29.9 kg/m²) n (%)***	**Obese (≥ 30.0 kg/m²) n (%)***	**P value#**
Nkwen (urban) (n=156)	1 (0.6)	37 (23.7)	74 (47.4)	44 (28.2)	
Mankon (urban) (n=156)	0 (0)	41 (26.3)	47 (30.1)	68 (43.6)	
Mankon (rural) (n=156)	1 (0.6)	77 (49.4)	55 (35.3)	23 (14.7)	
Mendakwe (rural) (n=156)	4 (2.6)	100 (64.1)	41 (26.3)	11 (7.1)	**0.001**

BMI=Body mass index; *Percentage of total sample per site (n=156); #Chi-square test, p values in bold are statistically significant

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Table 2: Waist circumference classification across all four sites for adults 18-65 years (N=617)

	WC classification								
	Females (n=275)[Ψ]				Males (n=342)[Ψ]				
Site	Normal (<80 cm) n (%)*	At risk[a] (80-88 cm) n (%)*	Increased risk[b] (>88 cm) n (%)*	P value[#]	Site	Normal (<94 cm) n (%)*	At risk[a] (94-102 cm) n (%)*	Increased risk[b] (>102 cm) n (%)*	P value[#]
Nkwen (urban) (n=73)	13 (17.8)	21 (28.8)	39 (53.4)	<0.05	Nkwen (urban) (n=78)	53 (67.9)	19 (24.4)	6 (7.7)	<0.05
Mankon (urban) (n=62)	10 (16.1)	9 (14.5)	43 (69.4)		Mankon (urban) (n=93)	57 (61.3)	23 (24.7)	13 (14.0)	
Mankon (rural) (n=63)	18 (28.6)	21 (33.3)	24 (38.1)		Mankon (rural) (n=93)	68 (73.1)	15 (16.1)	10 (10.8)	
Mendakwe (rural) (n=77)	38 (49.4)	22 (28.6)	17 (22.1)		Mendakwe (n=78)	76 (97.4)	2 (2.6)	0 (0)	

WC=Waist circumference
[a]Increased risk for obesity and related diseases
[b]Substantially increased risk for obesity and related diseases
*Percentage of total male/female per urban/rural site
[#]ANOVA test
p values in bold are statistically significant
[Ψ]n does not equal to 276 for females and 348 for males due to missing data

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Table 3: Weight-for-height, weight-for-age and height-for-age classification for children in the urban and rural areas (N=624)

URBAN AREAS (n=312)								
Weight-for-height			**Weight-for-age**			**Height-for-age**		
Classification	**n (%) ***	**P value#**	**Classification**	**n (%) ***	**P value#**	**Classification**	**n (%) ***	**P value#**
Severe wasting	3 (1.0)	0.165	Severely underweight	26 (8.3)	<0.001	Severely stunted	151 (48.4)	<0.001
Moderate wasting	9 (2.9)		Moderately underweight	85 (27.2)		Moderately stunted	42 (13.5)	
Normal	139 (44.6)		Normal	158 (50.6)		Normal	56 (17.9)	
Overweight	161 (51.6)		Overweight	43 (13.8)		Tall	63 (20.2)	
RURAL AREAS (n=312)								
Severe wasting	6 (1.9)	0.165	Severely underweight	45 (14.4)	<0.001	Severely stunted	135 (43.3)	<0.001
Moderate wasting	6 (1.9)		Moderately underweight	115 (36.9)		Moderately stunted	53 (17.0)	
Normal	172 (55.1)		Normal	124 (39.7)		Normal	97 (31.1)	
Overweight	128 (41.0)		Overweight	28 (9.0)		Tall	27 (8.7)	

*Percentage of total sample per urban/rural area (n=312); #Chi-square test, p values in bold are statistically significant

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Table 4: Mid-upper arm circumference classification for children 1-5 years by site (n=156)

MUAC classification				
Site	**SAM (<11.0 cm) n (%) ***	**MAM (11.5 cm-12.5 cm) n (%) ***	**NAM (>12.5 cm) n (%) ***	**P value#**
Nkwen (urban) (n=156)	3 (1.9)	6 (3.8)	147 (94.2)	0.014
Mankon (urban) (n=156)	0 (0)	4 (2.6)	152 (97.4)	
Mankon (rural) (n=156)	2 (1.3)	12 (7.7)	142 (91.0)	
Mendakwe (rural) (n=156)	0 (0)	2 (1.3)	154 (98.7)	

n-number of participants
*Percentage with poor or good DD
#P values in bold are statistically significant with the use of an independent samples test

Mid-upper arm circumference (MUAC) above 12.5cm = not acutely malnourished (NAM)
MUAC between 11.5cm-12.5cm = moderate acute malnutrition (MAM)
MUAC below 11.5cm = severely malnourished (SAM)

Table 5: Individual dietary diversity for adults (18-65 years) and children (1-5 years) across all sites (n=156)

ADULTS		
Sites	**Good DD[a] n (%)#**	**Poor DD[b] n (%)#**
Nkwen	121 (77.4)	35 (22.4)
Urban Mankon	148 (94.9)	8 (5.1)
Rural Mankon	73 (46.8)	83 (53.2)
Mendakwe	132 (84.6)	24 (15.4)
CHILDREN		
Nkwen	125 (80.1)	31 (19.9)
Urban Mankon	137 (87.8)	19 (12.2)
Rural Mankon	90 (57.7)	66 (42.3)
Mendakwe	152 (97.4)	4 (2.6)

[a]Good DD is defined as the consumption of more than or equal to five food groups over a 24-hour period
[b]Poor DD is defined as the consumption of less than five groups over a 24-hour period

#Percentage of total sample per site (n=156)

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Table 6: Association between DD and weight-for-age, weight-for-height and height-for-age across all sites

			Weight-for-Age n (%)							
Site	**Age group (years)**	**DDS**	**Severely underweight (-3SD)**	**Moderately underweight (-2SD)**	**Underweight (-1SD)**	**Normal (Median)**	**Overweight (+1SD)**	**Obese Class I (+2SD)**	**Obese Class II (+3SD)**	**P value†**
Nkwen	1-3	Poor[a]	2 (9.1)	3 (13.6)	5 (22.7)	4 (18.2)	2 (9.1)	3 (13.6)	3 (13.6)	
		Good[b]	10 (12.5)	6 (7.7)	11 (14.1)	9 (11.5)	15 (19.2)	12 (15.4)	15 (19.2)	0.727
	4-5	Poor	1 (11.1)	0 (0)	4 (44.4)	1 (11.1)	2 (22.2)	1 (11.1)	0 (0)	
		Good	4 (8.5)	10 (21.3)	10 (21.3)	8 (17.0)	11 (23.4)	2 (4.3)	2 (4.3)	0.569
Mankon Urban	1-3	Poor	0 (0)	2 (11.1)	3 (16.7)	5 (27.8)	5 (27.8)	2 (11.1)	1 (5.6)	
		Good	9 (7.4)	11 (9.0)	13 (10.7)	24 (19.7)	26 (21.3)	18 (14.8)	21 (17.2)	0.650
	4-5	Poor	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
		Good	0 (0)	3 (20.0)	3 (20.0)	3 (20.0)	3 (20.0)	2 (13.3)	1 (6.7)	0.669
Mankon Rural	1-3	Poor	3 (5.2)	12 (20.7)	7 (12.1)	10 (17.2)	9 (15.5)	13 (22.4)	4 (6.9)	
		Good	9 (12.0)	7 (9.3)	13 (7.3)	12 (16.0)	16 (21.3)	12 (16.0)	6 (8.0)	0.356
	4-5	Poor	0 (0)	2 (25.0)	3 (37.5)	0 (0)	2 (25.0)	1 (12.5)	0 (0)	
		Good	3 (20.0)	3 (20.0)	4 (26.7)	4 (26.7)	1 (6.7)	0 (0)	0 (0)	0.205
Mendakwe	1-3	Poor	0 (0)	0 (0)	0 (0)	0 (0)	1 (50.0)	0 (0)	1 (50.0)	
		Good	14 (17.5)	9 (11.3)	20 (25.0)	15 (18.8)	5 (6.3)	5 (6.3)	12 (15.0)	0.225
	4-5	Poor	0 (0)	0(0)	1 (50.0)	1 (50.0)	0 (0)	0 (0)	0 (0)	
		Good	24 (33.3)	14 (19.4)	14 (19.4)	10 (13.9)	7 (9.7)	3 (4.2)	0 (0)	0.559

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			Weight-for-height n (%)					
Site	**Age group**	**DDS**	**Severe Acute Malnutrition OR Severely Wasted (-3SD)**	**Moderate Acute Malnutrition OR Moderately Wasted (-2SD)**	**Normal (Median)**	**Overweight (1SD)**	**Obese (2SD)**	**P value†**
Nkwen	1-3	Poor	1 (4.5)	2 (9.1)	11 (50.0)	4 (18.2)	4 (18.2)	
		Good	1 (1.3)	0 (0)	44 (56.4)	7 (9.0)	26 (33.3)	0.03
	4-5	Poor	1 (11.1)	1 (11.1)	4 (44.4)	1 (11.1)	2 (22.2)	
		Good	0 (0)	1 (2.1)	21 (44.7)	9 (19.1)	16 (34.0)	0.154
Mankon Urban	1-3	Poor	0 (0)	2 (11.1)	4 (22.2)	4 (22.2)	8 (44.4)	
		Good	0 (0)	3 (2.5)	48 (39.3)	10 (8.2)	61 (50.0)	0.04
	4-5	Poor	0 (0)	0 (0)	0 (0)	1 (100.0)	0 (0)	
		Good	0 (0)	0 (0)	7 (46.7)	4 (26.7)	4 (26.7)	0.56
Mankon Rural	1-3	Poor	0 (0)	1 (1.7)	20 (34.5)	6 (10.2)	31 (53.4)	
		Good	1 (1.3)	1 (1.3)	25 (33.3)	13 (17.3)	35 (46.7)	0.755
	4-5	Poor	0 (0)	0 (0)	2 (25.0)	0 (0)	6 (75.0)	
		Good	0 (0)	0 (0)	7 (46.7)	2 (13.3)	6 (40.0)	0.338
Mendakwe	1-3	Poor	0 (0)	0 (0)	1 (50)	0 (0)	1 (50.0)	
		Good	0 (0)	2 (2.5)	55 (68.8)	9 (11.3)	14 (17.5)	0.536
	4-5	Poor	0 (0)	0 (0)	2 (100)	0 (0)	0 (0)	
		Good	3 (4.2)	0 (0)	51 (70.8)	13 (18.1)	5 (6.9)	0.846

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			Height-for-age n (%)						
Site	**Age group**	**DDS**	**Severely stunted (-3SD)**	**Moderately stunted (-2SD)**	**Stunted (-1SD)**	**Normal (Median)**	**Tall (+1SD)**	**Very Tall (+2SD)**	**P value†**
Nkwen	1-3	Poor	12 (54.5)	0 (0)	0 (0)	1 (4.5)	2 (9.1)	5 (22.7)	
		Good	30 (38.5)	8 (10.3)	4 (5.1)	3 (3.8)	6 (7.7)	20 (25.6)	0.601
	4-8	Poor	4 (44.4)	0 (0)	0 (0)	1 (11.1)	2 (22.2)	2 (22.2)	
		Good	24 (51.1)	7 (14.9)	2 (4.3)	6 (12.8)	1 (2.1)	2 (4.3)	0.065
Mankon Urban	1-3	Poor	66 (54.1)	1 (5.6)	3 (16.7)	0 (0)	0 (0)	3 (16.7)	
		Good	10 (55.6)	3 (2.5)	10 (8.2)	4 (3.3)	4 (3.3)	30 (24.6)	0.755
	4-8	Poor	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
		Good	4 (26.7)	4 (26.7)	0 (0)	1 (6.7)	2 (13.3)	1 (6.7)	0.799
Mankon Rural	1-3	Poor	33 (56.9)	3 (5.2)	3 (5.2)	6 (10.3)	5 (8.6)	7 (12.1)	
		Good	39 (52.0)	7 (9.3)	2 (2.7)	10 (13.3)	9 (6.8)	12 (9.0)	0.309
	4-8	Poor	5 (62.5)	1 (12.5)	0 (0)	0 (0)	1 (12.5)	0 (0)	
		Good	8 (53.3)	2 (13.3)	3 (20.0)	2 (13.3)	0 (0)	0 (0)	0.261
Mendakwe	1-3	Poor	1 (50.0)	1 (50.0)	0 (0)	0 (0)	0 (0)	0 (0)	
		Good	36 (45.0)	9 (11.3)	8 (10.0)	6 (7.5)	4 (5.0)	13 (15.9)	0.772
	4-8	Poor	0 (0)	2 (100.0)	0 (0)	0 (0)	0 (0)	0 (0)	
		Good	44 (61.1)	9 (12.5)	7 (9.7)	8 (11.1)	2 (2.8)	1 (1.4)	0.067

n-number of participants
DD-Dietary diversity
*Percentage with poor or good DD
SD-standard deviation

†P value in bold is statistically significant with use of the chi-square test
[a]Poor DD is defined as the consumption of less than five food groups over a 24-hour period
[b]Pood DD is defined as the consumption of more than or equal to five food groups over a 24-hour period

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Table 7: Association between DD and MUAC in children 1-5 years; DD and WC in adults 18-65 years old across all sites (N=624)

Mid-upper arm circumference (MUAC)			
Site	**N**	**DD**	**MUAC Mean (SD)**
Nkwen	125 (80.1)	Good[b]	15.9 cm (1.8)
	31 (19.9)	Poor[a]	15.4 cm (1.9)
Mankon Urban	137 (87.8)	Good	15.6 cm (1.8)
	19 (12.2)	Poor	15.5 cm (1.9)
Mankon Rural	90 (57.7)	Good	15.2 cm (1.9)
	66 (42.3)	Poor	15.2 cm (1.8)
Mendakwe	152 (97.4)	Good	15.6 cm (1.5)
	4 (2.6)	Poor	15.3 cm (1.7)
Waist circumference (WC)			
Site	N	DD	WC Mean (SD)
Nkwen	121 (77.6)	Good	89.3 cm (9.9)
	35 (22.4)	Poor	86.4 cm (17.6)
Mankon Urban	148 (94.9)	Good	91.9 cm (10.6)
	8 (5.1)	Poor	90.4 cm (12.8)
Mankon Rural	73 (46.8)	Good	87.5 cm (12.1)
	83 (53.2)	Poor	85.1 cm (12.1)
Mendakwe	132 (84.6)	Good	80.5 cm (10.0)
	24 (15.4)	Poor	81.6 cm (8.2)

n-number of participants
*Percentage with poor or good DD
[a]Poor DD is defined as the consumption of less than five groups over a 24-hour period
[b]Good DD is defined as the consumption of more than or equal to five food groups over a 24-hour period

Mid-upper arm circumference (MUAC) above 12.5cm = not acutely malnourished (NAM)
MUAC between 11.5cm-12.5cm = moderate acute malnutrition (MAM)
MUAC below 11.5cm = severely malnourished (SAM)

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Table 8: Association between DD and BMI by study site in adults 18-65 years old (N=624)

		BMI classification n (%)*				
Area	**DD**	**Underweight**	**Normal**	**Overweight**	**Obese**	**P value†**
Nkwen (urban)	Poor‡	0 (0)	8 (22.9)	18 (40.2)	9 (25.7)	
	Good§	1 (0.8)	29 (24.0)	56 (51.4)	35 (28.9)	0.907
Mankon (urban)	Poor	0 (0)	1 (12.5)	2 (25.0)	5 (62.5)	
	Good	0 (0)	40 (27.0)	45 (30.4)	63 (42.6)	0.654
Mankon (rural)	Poor	0 (0)	43 (51.8)	27 (32.5)	13 (15.7)	
	Good	1 (1.4)	34 (46.6)	28 (38.4)	10 (13.7)	0.685
Mendakwe (rural)	Poor	1 (4.2)	13 (54.2)	7 (29.2)	3 (12.5)	
	Good	3 (2.3)	87 (65.9)	34 (25.8)	8 (6.1)	0.371

n-number of participants
DD-Dietary diversity
BMI-body mass index
*Percentage with good or poor DD; †P value in bold is statistically significant with use of the chi-square test
‡Poor DD is defined as the consumption of less than five food groups over a 24-hour period
§Good DD is defined as the consumption of more than or equal to five food groups over a 24-hour period

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