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Toddlers' Dietary Diversity and Its Determinants in Different Agricultural Periods

Ousmane Ouédraogo[1]*, Ella Wendinpuikondo Raketa Compaoré[1,2], Emile Kou'santa Sabiba Amouzou[3], Mamoudou Hama Dicko[1]

1. Laboratoire de Biochimie, Biotechnologie, Technologie Alimentaire et Nutrition (LABIOTAN), Département de Biochimie-Microbiologie, Université Joseph KI-ZERBO, 03 BP 7021 Ouagadougou 03, Ouagadougou, Burkina Faso
2. Secrétariat Technique Chargé de l'amélioration de l'Alimentation et de la Nutrition des Mères et des Enfants (STAN), Ministère de la Santé du Burkina Faso
3. Laboratoire de Biochimie des Aliments et de Nutrition, Faculté des Sciences et Techniques, Université de Kara, BP: 43 Kara, Togo

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*Corresponding author:
Ousmane Ouédraogo,
Laboratoire de Biochimie,
Biotechnologie,
Technologie Alimentaire et
Nutrition (LABIOTAN),
Département de Biochimie-
Microbiologie,
Université Joseph KI-ZERBO,
03 BP 7021 Ouagadougou 03,
Burkina Faso
Tel: +226 71 23 73 20
Email: oousmane49@yahoo.com
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ABSTRACT

Background: Inadequate diet and illness were immediate causes of malnutrition. Dietary diversity helps to ensure adequate intake of essential nutrients and promotes good health. Challenge is to maintain adequate nutrients intake during all periods. The primary study objective was to determine the toddlers' dietary diversity and its determinants in different agricultural periods.

Methods: In this repeated cross-sectional study, a 24 hours open recall was used to collect all foods eaten by toddlers. These data were collected three times in households at the Centre-West region of Burkina Faso. The dietary diversity score (DDS) equals the number of food groups consumed. The toddler's dietary diversity was low when DDS<4 and minimum, when DDS≥4 as recommended by WHO. The associations between toddlers' DDS with periodicity, sociodemographic, and economic variables were determined.

Results: The means of toddlers' dietary diversity scores during agricultural mitigation, welding, and increase periods were 4.5 [4.3-4.6], 4.4 [4.2-4.5], and 4.8 [4.7-5.0], respectively.

During agricultural mitigation, welding and increase periods, 77%, 73% and 87% of toddlers reached the minimum dietary diversity score, respectively. This study revealed that toddlers' dietary diversity was associated with the province of residence, household market gardening practice, household head gender and age, toddlers' gender and age, giving toddlers' food from outside, and toddlers' meal frequency.

Conclusion: Toddlers' dietary diversity was associated with gender, age, feeding, and agricultural practices.

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Introduction

Nutritional deficiencies are not only the result of low food quantities consumed, but also of poor dietary quality and diversity. The level of dietary diversity was shown to be a good indicator of people's broader nutritional status in many situations (1, 2). Dietary diversity is the number of different food groups consumed by an individual or a household over a given period. It is a qualitative measure of food consumption that reflects household access to

a variety of foods and is also a proxy of nutrient adequacy of the diet of individuals (3).

Dietary assessment estimates are made at the individual or household levels, and their results presented as energy and nutrient adequacy, dietary quality, food patterns, intakes of specific foods and food groups, intakes of macronutrients and micronutrients and diet composition. These estimates are obtained via direct and indirect retrospective or prospective assessment methods. Validation studies conducted in low and middle-income countries have consistently shown that dietary diversity scores are associated with nutrient intake adequacy and nutritional status among women and toddlers (4-6).

The dietary diversity score was validated for several age groups/gender as constituting an approached adequacy measure for the diet nutrients content. These scores were correlated positively with micronutrient density adequacy to foods for children and toddlers (1). Some studies showed seasonal effects on children and women food nutrients intake in Africa (7-9) and Asia (10), both in rural and urban areas. Previous studies on children dietary diversity in Center-West region were not done according to three different periods on year. It is essential to evaluate the quality of the diet at a national and local level in different periods of the year. The present research aimed to identify toddlers' dietary diversity and its determinants during three periods of a year.

Materials and Methods

This repeated cross-sectional study was conducted in the Centre-West region located one hundred kilometers from Ouagadougou, the capital of Burkina Faso. This region includes the provinces of Boulkiemdé, Sanguié, Sissili, and Ziro. The Centre-West region's total population was estimated at 1,554,040 inhabitants (88,656 toddlers) with 46.1% of men and 53.9% women. This population has a distribution of 119,541 households with 87% living in rural areas against 13% in urban areas according to national institute of statistic and demography projections.

In a year, there were three distinct periods according to food availability. The first was extended from January to June called mitigation, when food is relatively abundant and is the gardening beginning. The second was extended from July to September called welding, when the majority of smaller farmers do not have food stock and work in the fields. The last one, called increase was extended from October to December, when farmers harvest or finish to harvest; furthermore, food is also abundant. The study was conducted in 2017 during the periods of mitigation, welding and increase in Burkina Faso.

The study type was a repeated cross-sectional study on toddlers' food consumption habits. The study population consisted of households, toddlers, and their parents. Stratified sampling was conducted in each province of the region. First, it was to draw the villages/area with probability sampling proportional to their population size, followed by a systematic draw random sampling of households per village/area. The number of toddlers was estimated with OpenEpi (Sullivan KM, Soe MM, 2013) proportion sample size calculation.

The sample was esteemed at 330 for each survey period with 97% confidence levels. According to 2016 national nutrition survey, 88% of toddlers did not reach minimum dietary diversity. Confidence limits and design effect were 5% and 1.5, respectively. One toddler was selected per household. A grid (Kish and Wiegand, survey sampling 1968) was used to select one toddler in cases, where there were several toddlers in one household. The survey was performed exclusively on toddlers, whose parents provided written informed consent. Have been excluded, the sick toddlers and those whose parents were unable to answer the questions.

The study was approved by the Ethics Committee for Health Research of Burkina Faso. The study objectives were clearly explained to parents, selected household heads, and local authorities. Informed written consent was obtained from parents of toddlers. Seven previously trained supervisors and thirty-seven investigators had collected households and toddlers data in each household. Data collection, treatment and analysis were suitable to the World Health Organization (WHO) guidelines on indicators for assessing infant and young child feeding practices (11, 12) and the Food and Agriculture Organization (FAO) guide to measure dietary diversity at the household and the individual level (3).

A dietary diversity questionnaire was elaborated according to guidelines of WHO and FAO in accordance with the study objectives and country context. The face-to-face interview with parents of toddlers was used in households. A qualitative recall of all foods consumed by the toddlers during the previous 24 hours period was performed in each period. Each mother or caretaker was asked to recall all the dishes, snacks, or other foods he gave the toddler involved in the study, regardless of whether the food was eaten inside or outside the household. The atypical days, such as local feasts or celebrations, market and illness days were not included in the recall.

Based on the open recall, the interviewer checked which food groups were consumed using a predefined list of food groups. According to the West African and local food composition tables, a list of 19 food

items/groups was used (13). The corresponding foods were underlined in the list under the appropriate food group. For any food groups not mentioned, the respondent was asked if a food item from this group was consumed. One point was allocated for each food item or group consumed and zero if not consumed (3, 14). No minimal amount was required for a food item to be included. Data were collected during each agricultural period of 2017. The same households' toddlers (6 to 23 months) were surveyed in each period.

Data were computed and analyzed using IBM SPSS Statistics for Windows (IBM Corp. Version 20.0. Armonk, NY). The electro-household goods, fuel used for kitchen, household equipment, possession of animals, land possession, and household water sources were used for the socioeconomic status index determination using the SPSS principal component analysis (15, 16). Then households distributed in low, medium and high socioeconomic status. The dietary diversity score of toddlers (DDST) was equal to the number of food groups consumed by them. Based on given recommendations, the DDST included 7 food groups (3, 12).

These food groups included starches staples; vitamin A-rich fruits and vegetables; other vegetables and other fruits; offal, meat, and fish; legumes, nuts, and seeds; eggs; milk and dairy products. Toddlers who consumed daily at least 4 food groups on 7 reached the minimum dietary diversity (MDDS). The dietary diversity score (DDS) and food group consumption frequency were dependent variables and were examined as a function of periods, nutrient-rich foods (vitamin A and iron), and socio-demographic and economic factors.

For country specific micronutrients of interest (vitamin-A, and iron deficiencies) consideration, other food groups' consumption was explored as recommended by WHO and FAO. The vitamin A-rich foods of vegetable origin (VGVA) included dark green leafy vegetables, vitamin A-rich vegetables and roots, vitamin A-rich fruits, and red palm products. The vitamin A-rich foods of animal origin (ANIVA) included offal, eggs, milk, and dairy products. The vitamin A-rich foods of animal and/or vegetable origin (VITA) were one or both VGVA and ANIVA. The iron-rich foods included offal, meat, and fish (3).

DDST was divided into two classes, low dietary diversity score (LDDS), when DDS<4 and minimum dietary diversity score (MDDS) when DDS≥4. Toddlers' LDDS and MDDS were crossed with sociodemographic and economic variables to determine their association. Some variables were expressed as frequencies, percentages, and mean±standard deviation (SD). The Pearson Chi-Square test was performed to examine the association between DDS and dependent categorical variables to be included in the multinominal logistic regression analysis at p-value<0.2. This method was done to model a relationship between predictors' variables and toddlers' dietary diversity. The result was presented with an odds ratio (OR) and 95% confidence interval (CI). P-value<0.05 was considered statistically significant.

Results

The study was conducted in 34 villages and 3 towns. In agricultural mitigation, welding and increase periods, 419, 546, and 369 toddlers were involved, respectively. Figure 1 in this section represented the toddler's food items/groups consumption frequency

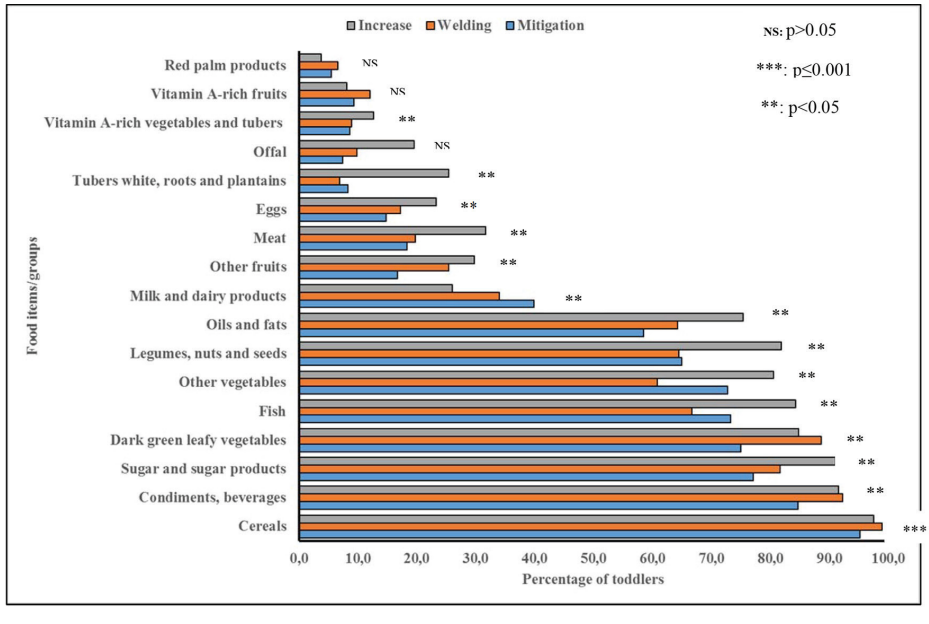

Figure 1: Foods items/groups consumed by toddlers during the year 2017. NS: Not significant.

as a function of periodicity.

During agricultural increase period, most toddlers consumed eggs, meat, offal, vitamin A-rich vegetables and tubers, tubers white, roots and plantains and other fruits than the two other periods.

Contrary, during the agricultural welding period, many toddlers consumed vitamin A-rich fruits and dark green leafy vegetables than the two other periods. Only milk and dairy products were consumed by many toddlers in the mitigation period than other ones. Table 1 illustrates the toddlers' food groups' consumption proportion, according to periodicity. Table 1 indicates that vitamin A-rich fruits and vegetable group were consumed by several toddlers in the welding period than other periods with a significant difference. The starchy staples group was the most consumed by toddlers during mitigation, increase and welding periods.

Four food groups were consumed by many toddlers during an increase period compared to welding and mitigation periods. Toddlers' consumption of all the seven food group used for DDS calculation was stable (no significant difference) across periods. According to toddlers' consumption of vitamin A-rich foods of animal origin, there was no significant difference between periods. A significant difference was found between periods and toddlers iron-rich foods consumption, so during the increase period, most toddlers consumed them than other ones.

Table 2 indicates the descriptive statistics of toddlers' DDS. The toddlers' DDS mean grow respectively during agricultural increase, mitigation, and welding periods. Figure 2 represents toddlers' DDS classes according to periods. During agricultural mitigation, welding and increase periods, 77%, 73% and 87% of toddlers reached the MDDS, respectively. Agricultural increase and mitigation periods were the periods whom most of the toddlers consumed diversified foods than the agricultural welding period with significant difference.

The chi-square test exploring the association between dietary diversity and dependent categorical variables to be included in the multivariate analysis was presented in Table 3 and 4.

According to Table 3, province, household market gardening practice, and possession of animals were associated significantly with toddlers' DDS. In this study, the market gardening practice was associated significantly with toddlers DDS during mitigation, increase, and welding periods. The province influenced significantly toddlers' DDS during periods of mitigation and welding but not to increase one.

In Table 4, household head gender and age influenced toddlers' dietary diversity significantly. Most females headed households' toddlers had high dietary diversity compared to other males' ones. There was no significant association with toddlers' DDS and areas of residence, households' socioeconomic status, and households' heads

Table 1: Periodicity and toddlers' food groups' consumption frequency and percentage

Food groups of toddlers	Mitigation (N=419)	Welding (N=546)	Increase (N=369)	P
	n (%)	n (%)	n (%)	
All starchy staples	399 (95.2)	540 (98.9)	360 (97.3)	≤0.001
Vitamin A-rich fruits and vegetables	326 (77.8)	489 (89.6)	315 (85.1)	≤0.001
Milk and dairy products	167 (39.9)	186 (34.1)	96 (25.9)	≤0.001
Offal, meat and fish	321 (76.6)	372 (68.1)	319 (86.2)	≤0.001
Eggs	62 (14.8)	94 (17.2)	86 (23.2)	≤0.001
Legumes, nuts and seeds	272 (64.9)	352 (64.5)	302 (81.6)	≤0.001
Other vegetables and other fruits	319 (76.1)	357 (65.4)	308 (83.2)	≤0.001
Consumption of ANIVA	197 (47.0)	223 (40.8)	158 (42.7)	0.25
Consumption of VITA	349 (83.3)	503 (92.1)	323 (87.3)	≤0.001
Consumption of iron	321 (76.6)	372 (68.1)	319 (86.2)	≤0.001

ANIVA: Vitamin A-rich foods of animal origin; VITA: Vitamin A-rich foods of animal and/or vegetable origin

Table 2: Descriptive statistics of toddlers' dietary diversity scores

DDST	Mitigation (N=419)	Welding (N=546)	Increase (N=369)	All (N=1334)
Mean [CI, 95%]	4.5 [4.3-4.6]	4.4 [4.2-4.5]	4.8 [4.7-5.0]	4.5 [4.4-4.6]
Median	5.0	5.0	5.0	5.0
Variance	3.1	2.9	2.2	2.8
Standard deviation	1.8	1.7	1.5	1.7
Minimum	0.0	0.0	0.0	0.0
Maximum	7.0	7.0	7.0	7.0

DDST: Dietary diversity score of toddlers

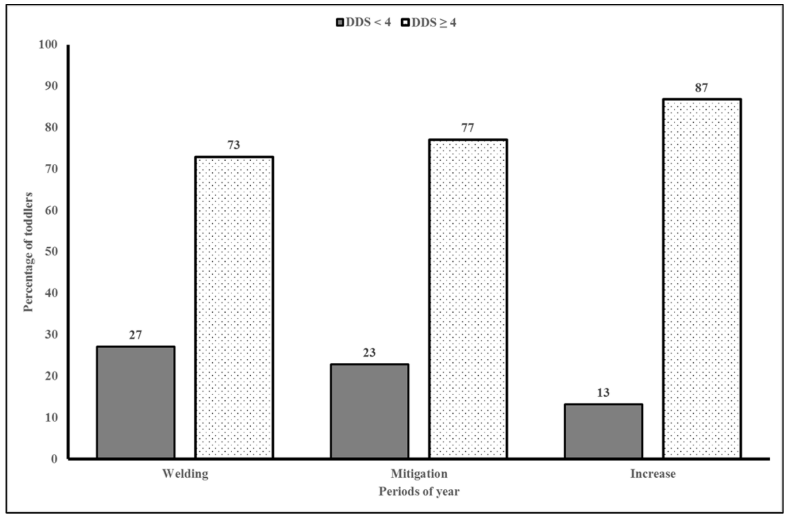

Figure 2: Classes of toddlers' dietary diversity scores across the periods. DDS: dietary diversity score.

Table 3: Toddlers DDS as a function of geographic and households characteristics

Parameters	Variable		Mitigation			Welding			Increase			All		
			LDDS	MDDS	P	LDDS	MDDS	P	LDDS	MDDS	P	LDDS	MDDS	P
Province	Boulkiemdé	n	20	134	***	63	173	**	21	137	*	104	444	*
		%	13.0	87.0		26.7	73.3		13.3	86.7		19.0	81.0	
	Sanguié	n	37	109		35	95		13	87		85	291	
		%	25.3	74.7		26.9	73.1		13.0	87.0		22.6	77.4	
	Sissili	n	33	47		17	85		10	63		60	195	
		%	41.3	58.8		16.7	83.3		13.7	86.3		23.5	76.5	
	Ziro	n	6	33		27	51		5	33		38	117	
		%	15.4	84.6		34.6	65.4		13.2	86.8		24.5	75.5	
Areas	Urban	n	5	25	*	25	78	*	7	38	*	37	141	*
		%	16.7	83.3		24.3	75.7		15.6	84.4		20.8	79.2	
	Rural	n	91	298		117	326		42	282		250	906	
		%	23.4	76.6		26.4	73.6		13.0	87.0		21.6	78.4	
Household market gardening practice	No	n	83	222	***	125	287	***	44	233	**	252	742	***
		%	27.2	72.8		30.3	69.7		15.9	84.1		25.4	74.6	
	Yes	n	13	101		17	117		5	87		35	305	
		%	11.4	88.6		12.7	87.3		5.4	94.6		10.3	89.7	
Household possession of animal	No	n	1	7	*	7	16	*	3	5	**	11	28	*
		%	12.5	87.5		30.4	69.6		37.5	62.5		28.2	71.8	
	Yes	n	95	316		135	388		46	315		276	1019	
		%	23.1	76.9		25.8	74.2		12.7	87.3		21.3	78.7	
Household socioeconomic status	Low	n	39	108	*	48	134	*	18	97	*	105	339	*
		%	26.5	73.5		26.4	73.6		15.7	84.3		23.6	76.4	
	Medium	n	25	108		51	139		18	109		94	356	
		%	18.8	81.2		26.8	73.2		14.2	85.8		20.9	79.1	
	High	n	32	107		43	131		13	114		88	352	
		%	23.0	77.0		24.7	75.3		10.2	89.8		20.0	80.0	

*P>0.05; **P<0.05; ***P≤0.001. DDS: dietary diversity score, LDDS: low dietary diversity score, MDDS: minimum dietary diversity score

educational level. According to the Chi-Square test, toddlers' characteristics like gender, age, meals frequency, and outside food consumption were significantly associated with their DDS during the year 2017.

Toddlers' DDS predictors' associated factors according to multinominal logistic regression results were presented in Table 5. This study revealed that toddlers living in households who did not practice market gardening had three times more risk to have low DDS during mitigation, four times during welding, and three times during increase. The province influenced toddlers' DDS. Respectively, Sissili and Sanguié provinces toddlers had five and

Table 4: Toddlers DDS as a function of household heads characteristics and those of themselves

Parameters	Variable		Mitigation			Welding			Increase			All		
			LDDS	MDDS	P	LDDS	MDDS	P	LDDS	MDDS	P	LDDS	MDDS	P
Household head gender	Male	n	90	266	**	123	342	*	38	285	**	251	893	*
		%	25.3	74.7		26.5	73.5		11.8	88.2		21.9	78.1	
	Female	n	6	57		19	62		11	35		36	154	
		%	9.5	90.5		23.5	76.5		23.9	76.1		18.9	81.1	
Household head education	Illiterate	n	69	243	*	98	254	*	35	218	*	202	715	*
		%	22.1	77.9		27.8	72.2		13.8	86.2		22.0	78.0	
	Literate	n	27	80		44	150		14	102		85	332	
		%	25.2	74.8		22.7	77.3		12.1	87.9		20.4	79.6	
Household head age groups	≤35	n	34	93	*	52	107	*	17	88	*	103	288	**
		%	26.8	73.2		32.7	67.3		16.2	83.8		26.3	73.7	
	36-45	n	27	84		38	105		15	81		80	270	
		%	24.3	75.7		26.6	73.4		15.6	84.4		22.9	77.1	
	46-55	n	20	57		23	86		9	74		52	217	
		%	26.0	74.0		21.1	78.9		10.8	89.2		19.3	80.7	
	≥56	n	15	89		29	106		8	77		52	272	
		%	14.4	85.6		21.5	78.5		9.4	90.6		16.0	84.0	
Toddlers' gender	Male	n	56	158	*	56	201	**	34	145	**	146	504	*
		%	26.2	73.8		21.8	78.2		19.0	81.0		22.5	77.5	
	Female	n	40	165		85	203		15	175		140	543	
		%	19.5	80.5		29.5	70.5		7.9	92.1		20.5	79.5	
Toddlers' age groups	06-11	n	54	112	***	40	155	***	27	94	**	121	361	***
		%	32.5	67.5		20.5	79.5		22.3	77.7		25.1	74.9	
	12-15	n	26	103		78	120		8	81		112	304	
		%	20.2	79.8		39.4	60.6		9.0	91.0		26.9	73.1	
	16-17	n	5	29		5	43		1	34		11	106	
		%	14.7	85.3		10.4	89.6		2.9	97.1		9.4	90.6	
	18-23	n	11	79		19	86		13	111		43	276	
		%	12.2	87.8		18.1	81.9		10.5	89.5		13.5	86.5	
Toddlers' meals frequency	≤2	n	50	72	***	21	37	***	7	15	**	78	124	***
		%	41.0	59.0		36.2	63.8		31.8	68.2		38.6	61.4	
	3	n	26	130		39	197		31	187		96	514	
		%	16.7	83.3		16.5	83.5		14.2	85.8		15.7	84.3	
	≥4	n	20	121		82	170		11	118		113	409	
		%	14.2	85.8		32.5	67.5		8.5	91.5		21.6	78.4	
Toddlers street food consumption	No	n	85	228	***	135	301	***	43	239	**	263	768	***
		%	27.2	72.8		31.0	69.0		15.2	84.8		25.5	74.5	
	Yes	n	11	95		5	103		6	80		22	278	
		%	10.4	89.6		4.6	95.4		7.0	93.0		7.3	92.7	

*P>0.05; **P<0.05; ***P≤0.001. DDS: dietary diversity score. LDDS: low dietary diversity score, MDDS: minimum dietary diversity score

three risk to have low dietary diversity during the mitigation period compared to toddlers living in other provinces.

Households head gender and age groups influenced toddlers' dietary diversity significantly. Most of the females headed households' toddlers had high dietary diversity compared to other males' ones. During mitigation period, toddlers living in males headed households had three times more risk to have low dietary diversity score compared to females ones (Table 5). Toddlers living in married and literate headed households also had high dietary diversity compared to single and illiterate ones, but significant difference was not found according to the logistic regression model.

Households' heads age was associated with toddlers' dietary diversity during the welding period. For example, toddlers living in households headed by someone less than 35-year-old had two times the risk to have low dietary diversity compared to those of 56 years old and over (Table 5). Most of the girls had high DDS compared to boys. Boys had three times the risk to have low DDS comparatively to girls during an increase period (Table 5). When a

Table 5: Toddlers LDDS and associated factors final model according to logistic regression

Parameters	Variable	Mitigation		Welding		Increase		All	
		OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Province	Ziro®	1		1		1		1	
	Sanguié	3.11 (1.09-8.89)	**	1.36 (0.65-2.86)	*	2.13 (0.58-7.75)	*	1.71 (1.04-2.80)	**
	Boulkiemdé	1.01 (0.35-2.93)	*	1.27 (0.64-2.52)	*	1.477 (0.45-4.90)	*	0.95 (0.59-1.52)	*
	Sissili	5.35 (1.78-16.06)	**	0.23 (0.10-0.54)	***	1.24 (0.31, 4.91)	*	0.86 (0.52-1.45)	*
Market gardening practice	Yes®	1		1		1		1	
	No	3.05 (1.49-6.26)	**	3.78 (1.97-7.27)	***	2.63 (0.92-7.57)	**	2.79 (1.85-4.18)	***
Possession of animal	Yes®	1		1		1		1	
	No	0.32 (0.02-4.50)	*	2.99 (0.94-9.49)	*	2.84 (0.57-14.18)	*	1.45 (0.67-3.17)	*
Household head gender	F®	1		1		1		1	
	M	2.60 (1.02-7.17)	**	1.02 (0.53-1.96)	*	0.59 (0.25-1.43)	*	1.15 (0.75-1.76)	*
Household head age groups	≥56®	1		1		1		1	
	≤35	1.93 (0.87-4.29)	*	2.25 (1.19-4.25)	**	1.56 (0.57-4.25)	*	1.82 (1.20-2.76)	**
	36-45	1.40 (0.64-3.10)	*	1.10 (0.57-2.11)	*	1.71 (0.62-4.71)	*	1.35 (0.88-2.06)	*
	46-55	1.91 (0.81-4.48)	*	0.761 (0.38-1.53)	*	0.98 (0.33-2.94)	*	1.05 (0.67-1.66)	*
Toddlers' gender	F®	1		1		1		1	
	M	1.28 (0.75-2.19)	*	0.64 (0.401-1.005)	*	3.35 (1.64-6.87)	***	1.08 (0.81-1.43)	*
Toddlers' age groups	18-23®	1		1		1		1	
	6-11	2.35 (1.07-5.16)	**	1.05 (0.53-2.11)	*	2.43 (1.09-5.45)	**	1.87 (1.25-2.81)	**
	12-15	1.40 (0.60-3.26)	*	2.16 (1.11-4.17)	**	0.99 (0.36-2.74)	*	2.05 (1.35-3.11)	***
	16-17	0.74 (0.21-2.65)	*	0.31 (0.10-0.98)	**	0.36 (0.04-2.99)	*	0.56 (0.27-1.17)	*
Toddlers' meals frequency	≥4®	1		1		1		1	
	≤2	3.15 (1.55-6.44)	**	0.90 (0.42-1.94)	*	3.17 (0.89-11.33)	*	1.88 (1.27-2.78)	***
	3	0.82 (0.40-1.68)	*	0.31 (0.19-0.53)	***	1.69 (0.74-3.87)	*	0.59 (0.42-0.82)	**
Toddlers' street food consumption	Yes®	1		1		1		1	
	No	1.84 (0.84-4.06)	*	11.94 (4.52-31.52)	***	2.04 (0.75-5.60)	*	4.02 (2.49-6.48)	***

*P>0.05; **P<0.05; ***P≤0.001; OR: odds ratio; CI: confidence interval; ®: reference. LDDS: low dietary diversity score

toddler grows up, his DDS increases also.

During the welding period, toddlers of 6-11 months old had twice the risk to have low DDS compared to those older. Similarly, during the increase period, toddlers of 6-11 months old had also twice the risk to have low DDS compared to those older. It was the same finding when toddler meals frequency increases. During a mitigation period, giving at lower two meals to toddlers increases three times his risk to have low dietary diversity compared to those receiving over. When the toddlers received food from outside, their dietary diversity improves. In the welding period, receiving food from outside contributes significantly to improve toddlers' dietary diversity.

Discussion

A single food can not contain all the essential nutrients and cover the nutritional needs of people (17). A variety of foods is necessary to reach

all people's nutritional needs. Nutritional food quality improves with the increase in the number of foods products and food groups consumption (18). The present study indicates that during the three periods of the year, most of toddlers consumed cereals, condiments/beverages, sugar/sugar products, dark green leafy vegetables, fish, other vegetables, legumes/nuts/seeds, and oils/fats. Similar observations were found in other developing countries (9, 19).

Our findings agree with those of Joanne et al. who found that the main sources of energy in diets of children residing in a rural area of Burkina Faso were starchy dishes (20). Contrary to other studies conducted in coastal countries (7, 21), in the present study, most of the fish consumed was dried and in few quantities. Compared to increase and mitigation periods (dry season), more toddlers consumed dark green leafy vegetables and vitamin A-rich fruits in the welding period (rainy season). This finding was similar to those found in Ghana (7).

The toddlers' consumption of legumes, nuts, and seeds increased significantly in the periods of increase, mitigation and welding. Contrary to Ghana, children's legumes and nuts consumption increased significantly in the rainy season compared to the dry season (7). A few proportions (less than 50%) of toddlers consumed eggs, meat, offal, fruits (vitamin A-rich or not), red palm products, milk and dairy products, tubers white, roots and plantains, vitamin A-rich vegetables and tubers during the year 2017. The few consumption of these food groups might be due to their availability/accessibility during the year and preference or cultural beliefs. That can be explained by food preference, values, and cultural beliefs (22), financial causes (23) and individual personality, character, and attitude (24, 25).

This study revealed that the toddlers' DDS mean decreased respectively in an increase, mitigation and welding periods. Similarly to previous studies, toddlers' dietary diversity varied according to the periods of the year (7, 9, 10, 26). The Centre-West region toddlers' DDS mean was high than the result of those in the Central region of Ghana (27), harvest and pre-harvest season in South-West Ethiopia (9) and in India (28). Of course, the achievement of the minimum dietary diversity of toddlers did not guarantee the adequacy of food intake of micronutrients, especially if the quantity of food consumed was too small compared to the recommendations (17).

The Centre-West region toddlers' DDS was lower compared to that (5.7±1.2) of preschool children in poor, rural, and ethnic minority areas of Central South China (29). This difference can explain by age difference. The present study toddlers were aged 6 to 23 months, contrary to the preschool children aged three or five years in China study. The difference might be because the China study setting was only rural, and children's sociodemographic characteristics were different. According to DDS classes (low and minimum), more toddlers had a minimum DDS in the increase period compared to the mitigation and welding periods, with significant difference. This difference can explain by food availability during the increase and mitigation periods and the livestock breaking during the welding period.

It was also learned from this study that the province, household market gardening practice, household head gender, household head age, infant gender, giving toddlers food from outside, toddlers' age and meals frequency was associated with toddlers' DDS. Like other studies on children or women, toddlers' DDS varied (+/-) according to periods (30). Moreover, like other studies results, older toddlers' age was associated with minimum dietary diversity (31, 32). Indeed, when the toddler grows up, his dietary diversity increases also.

Toddlers living in households headed by a young man had more risk to have low dietary diversity compared to those over old. In line with the present study, Herrador et al., found that a child living in a household headed by the female and younger than 40 years old, had greater chances to have a more diverse diet in rural settings (33). Like the present study, some authors noted the significant association between dietary diversity and gardening or farm production diversity (34, 35). Likewise, the present study finding was confirmed by other studies on significant association with toddlers feeding and their dietary diversity (36).

The current study finding was similar to other studies that noted gender as a predictor of dietary diversity (37, 38). Most girls had high dietary diversity compared to boys. According to Keding et al., the households headed by a women had higher DDS than those headed by a men. Similar studies noted the association of geographical situation and people's dietary diversity (39). This can be explained partially by province development difference and market access. A significant association was not found between toddlers' dietary diversity and households' socioeconomic status firstly and secondly between toddlers' dietary diversity and the households head education level. The educated household head knows the importance of a balanced diet for their toddlers.

Perhaps this result might be due to the homogeneity of the sample according to parent educational level and socioeconomic status. Contrary to the present study, similar study found association

between DDS and household socioeconomic (33). Some nutrition-sensitive and specific programs across the country ministerial sectors are necessary to increase agricultural production diversity, and access to nutritious foods. As for strengths, the study noted some advantages such as the 24 hours recall was observed to be less prone to errors and required less effort to the interviewees. The determination of dietary diversity score is quick and easy.

Likewise, the study design was longitudinal and permitted to compare toddlers' diet quality from three periods in the same households. As limitations, this study was conducted in one region of Burkina Faso; therefore, the results cannot be generalized at the national level. The future study must consider the quantity of food consumed with larger sample size at the country level. To improve toddlers' nutrition, multisector interventions formulation and implementation are necessary.

Conclusion

Toddlers' diet was dominated mainly by starchy staples; it varied according to the periods of the year and was also influenced by some sociodemographic and economic characteristics. During the agricultural increase, mitigation and welding periods, respectively the percentage of toddlers who reached the minimum dietary diversity decrease. Most of the girls had high dietary diversity compared to boys. However, household head age and gender are crucial to improve toddlers' dietary diversity. In period of livestock breaking (welding), parents give toddlers dark green leafy vegetables, vitamin A-rich fruits, and other foods that contribute to improve their dietary diversity. Outside foods consumption contributes significantly to improve toddlers' dietary diversity. Additional, giving at least three meals by day during all periods of year is good practice to improve toddlers DDS.

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Conflict of Interest

None declared.

References

1 Moursi MM, Arimond M, Dewey KG, et al. Dietary diversity is a good predictor of the micronutrient density of the diet of 6- to 23-month-old children in Madagascar. *J Nutr.* 2008;138:2448-53. DOI:10.3945/jn.108.093971. PMID:19022971.

2 Mehrabani D, Vahedi M, Eftekhari MH, et al. Food avoidance in patients with ulcerative colitis: a review. *Int J Nutr Sci.* 2017;2:189-95.

3 Gina K, Terri B, Marie Claude D. Guidelines for measuring household and individual dietary diversity. Rome. Rome, Italy: Food and Agriculture Organization of the United Nations; 2013.

4 Steyn NP, Nel J, Labadarios D, et al. Which dietary diversity indicator is best to assess micronutrient adequacy in children 1 to 9 y? *Nutrition*. 2014;30:55-60. DOI: 10.1016/j.nut.2013.06.002.

5 Gewa CA, Murphy SP, Weiss RE, et al. Determining minimum food intake amounts for diet diversity scores to maximize associations with nutrient adequacy: an analysis of schoolchildren's diets in rural Kenya. *Public Health Nutr.* 2014;17:2667-2673. DOI: 10.1017/s1368980014000469. PMID:24690343.

6 Mehrabani G, Aminian S, Mehrabani G, et al. Dietetic plans within the multiple sclerosis community: a review. *Int J Nutr Sci.* 2019;4:14-22.

7 Abizari AR, Azupogo F, Nagasu M, et al. Seasonality affects dietary diversity of school-age children in northern Ghana. *PLoS One*. 2017;12. DOI: 10.1371/journal.pone.0183206. PMID:28806418.

8 Caswell BL, Talegawkar SA, Siamusantu W, et al. A 10-Food Group Dietary Diversity Score Outperforms a 7-Food Group Score in Characterizing Seasonal Variability and Micronutrient Adequacy in Rural Zambian Children. *J Nutr.* 2018;148:131-9. DOI:10.1093/jn/nxx011. PMID:29378046.

9 Wondafrash M, Huybregts L, Lachat C, et al. Dietary diversity predicts dietary quality regardless of season in 6–12-month-old infants in south-west Ethiopia. *Public Health Nutrition*. 2016;19:2485-2494. DOI: 10.1017/S1368980016000525. PMID:27041122.

10 Stevens B, Watt K, Brimbecombe J, et al. The role of seasonality on the diet and household food security of pregnant women living in rural Bangladesh: a cross-sectional study. *Public Health Nutr.* 2017;20:121-129. DOI:10.1017/s136898001600183x. PMID:27573667.

11 WHO, UNICEF, IFPRI, et al. Indicators to assess the infant and young child feeding practices. Part 1: Definitions. Geneva: World Health Organization; 2008.

12 WHO, UNICEF, IFPRI, et al. Indicators for assessing infant and young child feeding practices. Part 2: Measurement. Geneva: Whorld Health Organization; 2010.
13 Barbara S, Ruth CU, Victor NE, et al. West African food composition table. Food and Agriculture Organization; 2012.
14 WHO, UNICEF, USAID, et al. Indicators for assessing infant and young child feeding practices. Part 3 Country Profiles. Geneva: World Health Organization; 2010.
15 Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. *Health Policy Plan*. 2006;21. DOI:10.1093/heapol/czl029. PMID:17030551.
16 Fotso JC, Kuate-Defo B. Measuring socioeconomic status in health research in developing countries: Should we be focusing on households, communities or both? *Soc Indic Res*. 2005;72:189-237. DOI:10.1007/s11205-004-5579-8.
17 FAO, FHI360. Minimum Dietary Diversity for Women: A Guide for Measurement. Rome: FAO; 2016:82.
18 Martin-Prével Y, Allemand P, Wiesmann D, et al. Moving forward on choosing a standard operational indicator of women's dietary diversity. Rome: FAO; 2015.
19 Ukegbu Ekebisi. Assessing Dietary Diversity Score and Nutritional Status of Rural Adult Women in Abia State, Nigeria. *Food Sci Nutr Technol*. 2016;1.
20 Arsenault JE, Nikiema L, Allemand P, et al. Seasonal differences in food and nutrient intakes among young children and their mothers in rural Burkina Faso. *J Nutr Sci*. 2014;3:e55-e. DOI:10.1017/jns.2014.53. PMID:26101623.
21 Chau D, Takehito T, Masashi K, et al. Consumption of animal source foods and dietary diversity reduce stunting in children in Cambodia. *Int Archives Med*. 2013;6:3-11. DOI:10.1186/1755-7682-6-29.
22 Heidkamp RA, Ayoya MA, Teta IN, et al. Complementary feeding practices and child growth outcomes in Haiti: an analysis of data from Demographic and Health Surveys. *Matern Child Nutr*. 2015;11:815-828. DOI:10.1111/mcn.12090. PMID:24118777.
23 Brinkman HJ, de Pee S, Sanogo I, et al. High Food Prices and the Global Financial Crisis Have Reduced Access to Nutritious Food and Worsened Nutritional Status and Health. *J Nutr*. 2010;140:153S-161S. DOI:10.3945/jn.109.110767. PMID:19939996.
24 Frank B, Enkawa T, Schvaneveldt SJ. The role of individualism vs. collectivism in the formation of repurchase intent: A cross-industry comparison of the effects of cultural and personal values. *J Economic Psychol*. 2015;51:261-278.
25 Marieke DM, Geert H. Cross-Cultural Consumer Behavior: A Review of Research Findings. *J Int Consumer Market*. 2011;23:181-192.
26 Powell B, Bezner Kerr R, Young SL, et al. The determinants of dietary diversity and nutrition: ethnonutrition knowledge of local people in the East Usambara Mountains, Tanzania. *J Ethnobiol Ethnomed*. 2017;13:23. DOI:10.1186/s13002-017-0150-2. PMID:28449682.
27 Bandoh DA, Kenu E. Dietary diversity and nutritional adequacy of under-fives in a fishing community in the central region of Ghana. *BMC Nutrition*. 2017;3. DOI: 10.1186/s40795-016-0120-4.
28 Agrawal S, Kim R, Gausman J, et al. Socio-economic patterning of food consumption and dietary diversity among Indian children: evidence from NFHS-4. *Eur J Clin Nutr*. 2019. DOI: 10.1038/s41430-019-0406-0. PMID:30809007.
29 Bi J, Liu C, Li S, et al. Dietary Diversity among Preschoolers: A Cross-Sectional Study in Poor, Rural, and Ethnic Minority Areas of Central South China. *Nutrients*. 2019;11:558. DOI:10.3390/nu11030558. PMID:30845662.
30 Savy M, Martin-Prével Y, Traissac P, et al. Dietary diversity scores and nutritional status of women change during the seasonal food shortage in rural Burkina Faso. *J Nutr*. 2006;136. DOI:10.1093/jn/136.10.2625. PMID:16988137.
31 Amugsi DA, Mittelmark MB, Oduro A. Association between Maternal and Child Dietary Diversity: An Analysis of the Ghana Demographic and Health Survey. *PLoS One*. 2015;10:e0136748. DOI:10.1371/journal.pone.0136748. PMID:26305458.
32 Reinbott A, Jordan I. Determinants of Child Malnutrition and Infant and Young Child Feeding Approaches in Cambodia. *World Rev Nutr Diet*. 2016;115:61-67. DOI: 10.1159/000444609. PMID:27197522.
33 Herrador Z, Perez-Formigo J, Sordo L, et al. Low Dietary Diversity and Intake of Animal Source Foods among School Aged Children in Libo Kemkem and Fogera Districts, Ethiopia. *PLoS One*. 2015;10:e0133435. DOI:10.1371/journal.pone.0133435. PMID:26203904.
34 Hirvonen K, Hoddinott J, Minten B, et al. Children's Diets, Nutrition Knowledge, and Access to Markets. *World Develop*. 2017;95:303-315. DOI:10.1016/j.worlddev.2017.02.031.

35 Sibhatu KT, Krishna VV, Qaim M. Production diversity and dietary diversity in smallholder farm households. *Proc Natl Acad Sci U S A*. 2015;112:10657-10662. DOI: 10.1073/pnas.1510982112. PMID:26261342.

36 Solomon D, Aderaw Z, Tegegne TK. Minimum dietary diversity and associated factors among children aged 6–23 months in Addis Ababa, Ethiopia. *Int J Equity Health*. 2017;16:181. DOI:10.1186/s12939-017-0680-1.

37 Mohammed ME, Niguse TA, Tafesse LA. Determinants of Dietary Diversity Score among Children Age between 6-23 Months in Bench Maji Zone, Southwest Ethiopia. *Ped Health Res*. 2018;3:1-6. DOI: 10.21767/2574-2817.100035.

38 Ochieng J, Afari-Sefa V, Lukumay PJ, et al. Determinants of dietary diversity and the potential role of men in improving household nutrition in Tanzania. *PLoS One.* 2017;12:e0189022. DOI: 10.1371/journal.pone.0189022. PMID:29232413.

39 Khanal V, Sauer K, Zhao Y. Determinants of complementary feeding practices among Nepalese children aged 6–23 months: findings from demographic and health survey 2011. *BMC Pediatrics.* 2013;13:131. DOI:10.1186/1471-2431-13-131. PMID:23981670.