Dietary Fibre and Energy Consumption as Predictors of Anthropometric Parameters in a Youthful Male Population: A Cross-sectional Study in Sissala East

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Abstract: Background: Despite the significant role of fiber and energy consumption in the development of overweight and obesity, associations between these dietary measures and the prevalence of obesity in Ghana are lacking. Hence, the objective of the survey was to determine a relationship between fiber and energy and the odds of obesity among a young male population from Sissala East Municipal. Methods: The present cross-sectional study was conducted using a randomly recruited 406 young male population (aged 20–29 years) in Sissala Municipality. Data were collected in November and December 2020. Dietary fiber and energy were obtained from the West African Food composition tables. Quantities of food consumed were assessed by using a 24-hour dietary recall approach. The proxies for general obesity and abdominal obesity were body mass index and waist circumference, respectively. Before data collection, permission was sought from the Municipal Health Directorate, and traditional heads in the communities. Results: In the unadjusted binary logistic regression models, the odds of general and abdominal obesity were significantly lower in the higher quartiles of dietary fiber, compared with quartile-one. Similarly, in the adjusted model, in which the effects of age, household size of the respondent, education, occupation, and marital were adjusted, there was still a significant inverse relationship between dietary fiber and the odds of general and abdominal obesity. Conversely, there was a significant positive association between dietary energy intake and the odds of general and abdominal obesity in both the unadjusted and adjusted models. Conclusion: From the findings, dietary fiber and energy were inversely and positively related to obesity [both general and abdominal], respectively. The intake of fiber rich diets might be beneficial for the prevention of obesity and ought to be promoted by the nutrition and health authorities.

Keywords: Fiber, Energy, General Obesity, Abdominal Obesity, Overweight

1. Background

In developing countries [1, 2], consumption of added sugars including diets that low in fiber is on the rise, concurrent with a high trend of obesity [1]. Previously, in Ghana, dietary energy is mainly obtained from refined grain products [3], which are low in dietary fiber. Although total daily energy intake in the country has been estimated to about 2295-2619 kcals per day [4], data on dietary fiber intake are scarce. Moreover, the relationships between obesity and dietary energy and fiber are limited. Notwithstanding, various studies have estimated the prevalence of obesity in the country. For example, a previous review suggests that 43% of adult Ghanaians are either obese or overweight [5].

Globally, obesity is linked to a higher mortality rate and several health conditions including metabolic syndrome, and various cancers [6–8]. Therefore, several efforts ought to be taken to reverse the increasing trends of obesity. The consumption of dietary fiber has a lot of health benefits [9, 10, 19, 11–18]. In line with this, the relationships between dietary fiber and body weight have received considerable

attention in nutrition research. Dietary fiber consumption delays intestinal transit, improves insulin sensitivity, and helps in the regulation of lipid oxidation to benefit body weight maintenance [20–22]. Furthermore, consumption of dietary fibers is linked with prolonged satiety hence, prevents the likelihood of excessive dietary energy ingestion [23, 24]. Additionally, numerous observational studies reported inverse associations between obesity and dietary fiber intake [25–31], however, in one study, a null association was reported [32].

Further, diets low in energy are associated with increased satiety [33] thus, a protective mechanism against obesity. However, additional data are required to clarify the relationship between energy intake and the odds of obesity because there are conflicting reports in the literature. For instance, in 5 observational studies, a positive association between energy intake and obesity was reported [34–38]. Also, a positive association between waist circumference and dietary energy intake was found [34, 38]. In contrast, in another study, energy intake did not show a significant association either with body mass index or waist circumference [39]. The relationships between dietary energy and fiber consumption and obesity are lacking in Ghana. The present results may not only be useful for the formulation of strategies to reverse the increasingly high prevalence of obesity in the country but will also bridge a longstanding research gap. The objective of the study was to assess the associations between dietary fiber and energy consumption and odds of obesity among a young male population from Sissala Eats, Ghana.

2. Methods and Materials

2.1. Study Design and Participants

In the present cross-sectional study, 406 young males (aged 20–29 years) were simple randomly selected. The sample size was based on standardized criteria for computing sample size in cross-sectional studies [40]. The participants were drawn from 5 communities [Tumu, Sakai, Kulfuo, Wallembelle, and Bugubelle] in Sissala East Municipality, Upper West Region, Ghana. Data were collected in November and December 2020. Participation in the survey was purely voluntary. Persons with known impaired health conditions that can affect the relationship between diet and obesity measures were excluded. For instance, a few potential respondents mentioned severe nausea and malaria hence, they were excluded from the study.

2.2. Lifestyle and Sociodemographic Factors

Data were collected on demographic variables [household assets, occupation, age, household size marital status, parity, educational status, and physical activity] by using structured questionnaires through face-to-face interviews. The economic status of participants' households was examined by collecting data on household assets ownership. A list of assets owned by a respondent

household was enumerated. Also, the make-up of the rooms [made of cow dung, thatch, cement, tiles, and zinc] was inspected. From the above assets and the room makeup indicators, a proxy index was calculated to reflect the wealth status of the household from which the respondent was recruited. Additionally, the physical activity (PA) of participants was assessed using the international PA questionnaire short form [41]. Results from a previous study show the international PA questionnaires are valid for use across different cultures [42]. With these questionnaires, the duration in minutes and number of days within the previous week a person spent doing moderate-intensity and vigorous-intensity activities and walking were recorded. The overall PA (MET-minutes/week) was calculated by adding up the sub-totals for moderate, vigorous, and walking activities. Further, dietary energy and fiber were obtained from the West African Food composition table [43]. To enhance the quality of dietary recall, a multiple-pass approach was employed [44, 45].

2.3. Anthropometric Assessment

A German-made Seca weighing scale (serial number (1881017060375) was used to measure body weight (kg). Also, a United Nations Children Emergency Fund height board was used to evaluate the height (cm) of participants. Body mass index was derived from the ratio of weight (kg) to height (m^2). The absence of overweight/general obesity was considered as a body mass index ≤ 24.9 kg/m^2. Also, the presence of overweight/obesity was considered to be body mass index of ≥ 25 kg/m2 [46]. A non-stretchable fiber-glass tape was used to measure waist circumference according to the World Health Organization standards [47]. Abdominal obesity was defined based on the International Diabetes Federation recommendation thus, waist circumference ≥ 94 cm [7, 48].

3. Results

Table 1 below represents the characteristics of participants according to obesity based on body mass index (a proxy for general obesity). Averagely, participants without obesity or overweight were significantly (P=0.002) younger than participants with overweight or obesity thus, 23.73±2.59 years and 24.53±2.58 years, respectively. Moreover, higher quartiles of dietary fiber (P < 0.001) were significantly associated with normal body weight. However, a higher proportion of participants with either overweight or obesity were classified under the highest quartile of dietary energy, when compared with participants without either overweight/obesity (P < 0.001). In contrast, the study failed to reveal a significant difference in household size, education, occupation, marital status, and ethnicity among participants who were obese and those who were not obese.

Table 1. *Characteristics of participants according to obesity based on body mass index.*

Variables	Frequency	Overweight and Obesity Present		P-value
		No (n=241)	Yes (n=165)	
Age (years	406	23.73±2.59	24.53±2.58	0.002**
Household size	406	8.04±6.24	7.03±5.32	0.090**
Education				
At most primary	326	192 (58.9)	134 (41.1)	0.800*
At least junior high	80	49 (61.3)	31 (38.8)	
Occupation				
Farming and trading	343	200 (58.3)	143 (41.7)	0.332*
Salary worker	63	41 (65.1)	22 (34.9)	
Marital Status				
Married	89	195 (61.5)	122 (38.5)	
Single	317	46 (51.7)	43 (48.3)	0.112*
Ethnicity				
Sissala	350	204 (58.3)	146 (41.7)	
Dagaaba	25	18 (72.0)	7 (28.0)	0.359‡
Kasina/Gurusi	14	7 (50.0)	7 (50.0)	
Others (Ashanti, Frafra, Kusasi)	17	204 (58.3)	146 (41.7)	
Fiber (g/day)				
Quartile-one	101	42 (41.6)	59 (58.4)	
Quartile-two	102	64 (62.7)	38 (37.3)	P < 0.001‡
Quartile-three	102	59 (57.8)	43 (42.2)	
Quartile-four	101	76 (75.2)	25 (24.8)	
Energy (kcal/day)				
Quartile-one	101	76 (75.2)	25 (24.8)	
Quartile-two	102	59 (57.8)	43 (42.2)	P < 0.001‡
Quartile-three	102	64 (62.7)	38 (37.3)	
Quartile-four	101	42 (41.6)	59 (58.4)	

‡Pearson Chi-Square; *Fisher's Exact Test (in 2 by 2 table); **Independent-Samples T-Test; P < 0.05 means significant association. Overweight and Obesity [body mass index ≥ 25 kgm^{-2}].

Table 2. *Characteristics of participants according to obesity based on waist circumference.*

Variables	Frequency	Overweight and Obesity Present		P-value
		No (n=221)	Yes (n=185)	
Age (years	406	23.85±2.62	24.30±2.60	0.084**
Household size	406	7.83±6.25	7.39±5.44	0.451**
Education				
At most primary	326	176 (54.0)	150 (46.0)	0.802*
At least junior high	80	45 (56.3)	35 (43.8)	
Occupation				
Farming and trading	343	180 (52.5)	163 (47.5)	0.074*
Salary worker	63	41 (65.1)	22 (34.9)	
Marital Status				
Married	89	177 (55.8)	140 (44.2)	0.335*
Single	317	4449.4)	45 (50.6)	
Ethnicity				
Sissala	350	188 (53.7)	162 (46.3)	
Dagaaba	25	15 (60.0)	10 (40.0)	0.748‡
Kasina/Gurusi	14	7 (50.0)	7 (50.0)	
Others (Ashanti, Frafra, Kusasi)	17	11 (64.7)	6 (35.3)	
Fiber (g/day)				
Quartile-one	101	36 (35.6)	65 (64.4)	
Quartile-two	102	58 (56.9)	44 (43.1)	P < 0.001‡
Quartile-three	102	53 (52.0)	49 (48.0)	
Quartile-four	101	74 (73.3)	27 (26.7)	
Energy (kcal/day)				
Quartile-one	101	74 (73.3)	27 (26.7)	
Quartile-two	102	53 (52.0)	49 (48.0)	P < 0.001‡
Quartile-three	102	58 (56.9)	44 (43.1)	
Quartile-four	101	36 (35.6)	65 (64.4)	

‡Pearson Chi-Square; *Fisher's Exact Test (in 2 by 2 table); **Independent-Samples T-Test; P < 0.05 means significant association. Overweight and Obesity [waist circumference ≥ 94 cm].

Table 2 illustrates the characteristics of participants according to obesity status based on waist circumference (a proxy for abdominal obesity). The results revealed an inverse association between abdominal obesity and dietary fiber (P < 0.001). Conversely, energy showed a positive association with abdominal obesity (P < 0.001). The study failed to support a relationship between participants' obesity and age, household size, education, occupation, marital status, and ethnicity.

Table 3 below outlines the results of binary logistic regression predicting the odds of general obesity with respect to quartiles of dietary fiber and energy. In the unadjusted model, the odds of general obesity were significantly lower in the higher quartiles of fiber intake, compared with the quartile-one. Similarly, in the adjusted model, in which the effects of age, respondent, household size of the respondent,

education, occupation, and marital were adjusted, there was still a significant inverse relationship between dietary fiber and the odds of general obesity.

Further, there was a positive association between energy intake and the odds of general obesity. For example, the odds of overweight and general obesity were significantly higher among participants classified under the fourth quartile when compared with those classified under the quartile-one [4.27 (2.34-7.79); P < 0.001]. Moreover, the relationship was still significant upon an adjustment for the effects of age, respondent, household size of the respondent, education, occupation, and marital were adjusted, there was still a significant inverse relationship between dietary fiber intake and the odds of overweight and abdominal obesity [4.58 (2.44-8.58); P < 0.001].

Table 3. *Odds of general obesity according to quartiles of dietary fiber and energy intake.*

Predictor	Unadjusted model		Adjusted model	
	OR (95%CI)	P-value	OR (95%CI)	P-value
Fiber (g/day)				
Quartile-one (n=101)	Reference			
Quartile-two (n=102)	0.42 (0.24-0.74)	0.003	0.44 (0.24-0.80)	0.008
Quartile-three (n=102)	0.52 (0.30-0.91)	0.021	0.52 (0.29-0.93)	0.029
Quartile-four (n=101)	0.23 (0.13-0.43)	P< 0.001	0.22 (0.12-0.41)	P<0.001
Energy (kcal/day)				
Quartile-one (n=101)	Reference			
Quartile-two (n=102)	2.22 (1.22-4.03)	0.009	2.36 (1.28-4.36)	0.006
Quartile-three (n=102)	1.81 (0.99-3.30)	0.055	1.99 (1.06-3.74)	0.032
Quartile-four (n=101)	4.27 (2.34-7.79)	P<0.001	4.58 (2.44-8.58)	P<0.001

n: number of participants classified under the quintile; OR: Odds Ratios; Overweight and Obesity defined as body mass index ≥ 25 kgm^{-2}; Adjusted model: adjusted for the effects of age of respondent, household size of respondent, education, occupation, marital status dichotomized. Q: quartile. Binary logistic repressions model was used to assess odds general obesity.

Table 4 below outlines the odds of abdominal obesity according to quartiles (Q) of dietary fiber and energy. In the unadjusted model, the odds of overweight and abdominal obesity were significantly lower in the higher quartiles of fiber intake, when compared with the quartile-one. Similarly,

in the adjusted model, in which the effects of age, respondent, household size of the respondent, education, occupation, and marital were adjusted, there was still a significant inverse relationship between dietary fiber intake and the odds of overweight and abdominal obesity.

Table 4. *Odds of abdominal obesity/overweight according to quartiles (Q) of dietary fiber and energy intake.*

Predictor	Unadjusted model		Adjusted model	
	OR (95%CI)	P-value	OR (95%CI)	P-value
Fiber (g/day)				
Quartile-one (n=101)	Reference			
Quartile-two (n=102)	0.42 (0.24-0.74)	0.003	0.41 (0.23-0.76)	0.005
Quartile-three (n=102)	0.51 (0.29-0.90)	0.020	0.49 (0.27-0.88)	0.018
Quartile-four (n=101)	0.20 (0.11-0.37)	P < 0.001	0.19 (0.10-0.35)	P < 0.001
Energy (kcal/day)				
Quartile-one (n=101)	Reference			
Quartile-two (n=102)	2.53 (1.41-4.56)	0.002	2.59 (1.43-4.70)	0.002
Quartile-three (n=102)	2.08 (1.15-3.75)	0.015	2.20 (1.19-4.05)	0.011
Quartile-four (n=101)	4.95 (2.72-9.02)	P < 0.001	5.31 (2.84-9.94)	P < 0.001

n: number of participants classified under the quintile; OR: Odds Ratios; Overweight and Obesity defined as waist circumference ≥ 94 cm; Adjusted model: adjusted for the effects of age of respondent, household size of respondent, education, occupation, marital status dichotomized; Q: quartile. Binary logistic repressions model was used to assess odds abdominal obesity

Generally, a positive relationship between energy intake and the odds of abdominal obesity was observed. Specifically, the odds of overweight and abdominal obesity were

significantly higher in participants classified under the fourth quartile when compared with those classified under the quartile-one [4.95 (2.72-9.02); P < 0.001]. The relationship

was still significant upon an adjustment for the effects of age, respondent, household size of the respondent, education, occupation, and marital were adjusted, there was still a significant inverse relationship between dietary fiber intake and the odds of overweight and abdominal obesity [5.31 (2.84-9.94); P < 0.001].

4. Discussion

In most Sub-Saharan African nations, there is an increase in added sugar consumption parallel to a high prevalence of obesity [1]. Although there are no direct studies in Ghana which evaluated the associations between fiber intake and the odds of obesity, the intake of refined cereal and grain products was found to increase the risk of abdominal obesity among University students [49]. These refined cereal and grain products are not only low in dietary fiber concentration but are also high glycemic index products [50].

In line with the inverse relationships between dietary fiber and general and abdominal obesity as found in the present study, 3 previous cross-sectional studies conducted in Egypt [25], Belgium [26], and Finland [27] reported similar results. Moreover, in a meta-analysis of randomized clinical trials among overweight and obese adults, dietary fiber supplementation when compared with the placebo caused significant reductions in body fat and body mass index [28]. Several mechanisms may have explained the favorable body weight measurements associated with the intake of dietary fiber. For instance, dietary fiber consumption is linked with a delay in intestinal transit and helps modulate glucose and lipid oxidation, which are favorable for body weight regulation [20–22, 51–53]. Further, dietary fibers prolong satiety and prevent excessive dietary energy intake [23, 24]. The present findings support a positive relationship between energy intake and the odds of general and abdominal obesity. Similarly, in 5 observational studies, positive associations between dietary energy intake and obesity in adults were reported [34–38].

This study has both strengths and weaknesses. An important strength is that it is one of the few studies designed to evaluate the intake of dietary fiber and energy and general and abdominal obesity in a young male population in Ghana. However, the study may have weaknesses. For example, dietary intake was determined by using a 24-hour recall approach. For this method, there was the chance of misreporting of dietary intake due to cognitive challenges such as forgetfulness [44, 54, 55]. However, several measures were taken to enhance the quality of dietary reports by following a standardized multi-pass system [44, 45]. First, participants were asked to mention the names of all foods they consumed in the last 24-hour period of the study. Second, they were allowed to provide more details on the type and preparation of food. Third, the participants also mentioned the quantities of food items consumed. Forth, they were probed for snacks or drinks and other food items that they may have consumed. The multi-pass approach was shown to substantially improve the accuracy of dietary reporting [56, 57].

5. Conclusion

The study revealed an inverse relationship between dietary consumption and both general and abdominal obesity. Further, the odds of obesity were found to increase directly with dietary energy intake. The findings may be useful in the development of nutrition strategies for the prevention of obesity in the country. The Sissala East municipal health directorate ought to promote the consumption of whole grains and cereal products due to their high fiber content.

Competing Interests

I declare that there are no competing interests.

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