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High Protein Intake and Likely Association with Non-Insulin Dependent Diabetes Mellitus (NIDDM)

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Abstract: Epidemiologic studies have demonstrated an association between Diabetes and macronutrients. An increase in the incidence of Diabetes prompted this investigation into the relationship between the dietary energy and of macro-nutrients intake and diabetes. A cross sectional, nested case-control study was conducted to examine the association of risk for NIDDM with energy and macro-nutrients consumption. One hundred subjects aged 40-82 years, stratified into diabetic cases and controls using fasting and 2 h post prandial Plasma Glucose levels constituted the sample size. The risk for Diabetes was measured using Pearson Correlation (r) and Odds Ratio (OR) with Epi info version 5. A 24-hour dietary recall generated quantitative estimates of their energy and macronutrients consumption. The results showed that percent protein (PP) energy significantly correlated with type 2 diabetes mellitus (r = 0.20, p<0.05). A PP>15.5% gave an OR = 1.19 (CI = 0.27-4.76) and was a risk factor for type 2 diabetes mellitus. A PP of <15.5% appeared to confer protection for the disease. It was concluded that among the study population, a high PP>15.5% was a risk factor for type 2 diabetes.

Key words: Non-insulin dependent diabetes mellitus, type 2 diabetes, high percent protein energy, macro-nutrient risk factors, Borno State, Nigeria

INTRODUCTION

Diabetes mellitus, especially the non-insulin dependent (NIDDM) or type 2, has been frequently seen in the community (Chibuzo, 1997), compared to previously (Esiere, 1988). Some research have indicated that the etiology of NIDDM is still unclear (Ghosh *et al.*, 2000; Watanabe *et al.*, 2000; Yin and Sun, 2010) and with the high rates of non-compliance to dietary prescriptions (Stone, 1966; Horwath and Worsley, 1991; Damkor, 2006), it became necessary to highlight the dietary factors that could predispose to NIDDM and probably throw more light to its prevention. This is especially relevant in this era of genomic medicine when the need to identify the influence of specific components and environmental factors on gene expression (Mahan and Escott-Stump, 2008) is being sought. Such information is unavailable or research work in the area is scanty especially in Nigeria.

It is a known fact that NIDDM is associated with such environmental factors as nutrition among other factors (Yin and Sun, 2010; Knowler *et al.*, 1978; Oli, 1983; Harrington and Philips, 2014; Malhotra, 1990; WHO, 1994). The disease is said to have considerable geographic variation (WHO, 1994). Hence, it is necessary to characterize the risk factors in the environment, especially if dietary modification and counseling are to be effective.

Many researchers have indicated that chemical substances in foods could be harmful to the body (Jarret, 1989; Feskens, 1992) but only few workers have looked at their relationship with NIDDM (Yin and Sun, 2010; Feskens, 1992; WHO, 2003; Tsunehara *et al.*, 1990; Marshall and Bessesen, 2002; Boyce and Swinburn, 1993; Marshall *et al.*, 1994; Steyn *et al.*, 2004; Sluijs *et al.*, 2010; Shimakawa *et al.*, 1993; Fagherazzi *et al.*, 2014; Fagherazzi *et al.*, 2014; Larsen *et al.*, 2011; Food and Nutrition Board, 2002).

Hence, this paper focuses on the dietary pattern, especially the energy, macronutrients and their energy densities, used in diabetic meal planning and known to be the basis for diabetic dietary modifications.

MATERIALS AND METHODS

Study design and sample population: A cross-sectional study in three hospitals in Borno State between December 1992 and August 1993 interviewed a total of 175 patients attending the out-patient sections of these hospitals using a structured questionnaire. Only 105 patients (comprising a 60% response rate) came back for their fasting and 2 h Post-Prandial blood glucose test used to classify subjects into cases and controls. This was because the subjects had eaten before attending the outpatient clinics and their coming back for the blood test was on their own volition, no coercion and the study

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has been informally approved by the Institution Review Board (IRB). The fact that the interview was done before blood classification also helped to minimize bias (Sackett, 1979) in the classification of cases and controls. However, only 100 Borno State indigenes 40-82 years old are included in this study, comprising 48 males and 52 females. The NIDDM cases are 12 and the non-cases (controls) are 88 and can be said to be a nested case-control in a cross-sectional study design. A detailed description of the demographic, anthropometric and plasma glucose levels of the sample population has been described elsewhere (Chibuzo *et al.*, 2000).

Dietary data collection and calculation of the energy and macronutrients intake: The dietary intake of the population was obtained from a 24 h Dietary Recall interview in the local language of kanuri/hausa, by asking the subjects to narrate all they had eaten in a twenty-four hour period, including snacks.

The quantity consumed was obtained using the National Dairy Council Food Models (National Dairy Council, 1974). The energy and macronutrients were calculated from a compiled Energy and Macronutrients Data base (EMDB) (Chibuzo, 1997). The EMDB was compiled from available Food Composition Tables (FCTs) (FAO, 1968; Holland *et al.*, 1991; McCance and Widdowson, 1991; N-Squared Computing, 1993). The meals with no previously known energy and macronutrients composition had to be prepared and the recipe conversion factors (Olusanya, 1977) method used to obtain their energy and macronutrients content. This entailed weighing all ingredients used in the meal preparation, obtaining the yield and conversion factor from 100/yield. The conversion factor is used to multiply each of the raw ingredients that went into preparing the cooked meal which was taken as the raw amount in the prepared meal. The proportional value of the raw ingredients that went into making 100 g of the prepared meals were obtained from the FCTs and the total for energy, protein, carbohydrate and fat for each of the unknown meals were put in the EMDB.

Statistical analysis: A correlation (r) analysis using a continuous data, except for NIDDM, was performed on the Total Energy (TK), Total Protein (TP), Total Fat (TF), Total Carbohydrate (TC) and their respective energy density levels, as Percent Protein (PP), Percent Fat (PF) and Percent Carbohydrate (PC) energy, respectively. NIDDM was dichotomized as I for cases and O for non-cases (controls) and was compared with dichotomous dietary variables based on number of cases and controls in each cut-off population mean. The EPI-Info version 5 and SAS were the computer soft wares used in data analysis. The "r" values range from -1 to +1. The associated risk of the dietary variables as "1"having the cut-off exposure variable or "0" not having the exposure variable, with the disease was determined by Odds Ratio (OR). An OR>1, is indicative of associated risk, an OR<1, shows its protective nature and an OR = 1, shows no associated risk. "Exact Statistics" in the Epi-Info was used to calculate the Confidence Intervals (CI) (Dean *et al.*, 1990).

RESULTS

The results of the study are presented in Table 1 to 3. Table 1 shows the mean values of energy and macronutrients intake for the population, stratified by cases and controls, males and females. The significant ($p<0.05$) mean values were the amount of carbohydrate (391.5 g for female cases and 254.9 g for their control counterparts), protein percent of total calorie (19% for all cases and 15.1% for all controls; 20.3% for male cases and 15.3% for their control counterparts) and fat percent (30.5% for male cases and 19.2% for their control counterparts).

However, a correlation analysis of the energy and macronutrients with the disease (Table 2) shows that the protein percent was the only significant variable. The mean values for percent protein obtained for all cases (19%) and all controls (15.1%) were significantly different ($p<0.05$), as well as the values of 20.3% for male cases and 15.3% for male controls. This could be indicative that a percent protein of 15% (or less than 15.5% found for all population) has less associated risk for the disease while an amount >15.5% has associated risk, especially for the males. The level of 17.7% was recorded for the female cases while 14.9% was recorded for their control counterpart (although not significant). A percent protein level <15.5% seems to be consistently associated with non-disease state.

The energy and macronutrients consumption for the total population irrespective of disease status were 1641.3 Kcal, 62.6 g protein, 34.2 g fat, 262 g carbohydrate with 15.5% protein, 20.3% fat and 62.4% carbohydrate as percent of total calorie (Table 3). This population mean was used to determine the associated risk for all of the variables. Since percent protein was the only significant variable associated with the disease, an amount greater than 15.5% had an odds ratio (OR) of 1.19 (CI 0.27-4.76) and an OR>1 has associated risk. The range of protein percent for the cases was 17.7-20.3%. It was 14.9-15.3% for the controls. Hence, a high percent protein of total calorie above the population mean of 15.5% has associated risk and is significantly correlated with diabetes mellitus.

It should however be noted that an energy intake below the population mean of 1641.3 Kcal has associated risk (OR = 1.02 CI 0.25-4.39); fat Intake less than 34.2 g and percent fat <20.3% have associated risk (OR = 3.63 CI 0.07-35.59 and 1.52 CI 0.37-7.39, respectively). A carbohydrate intake of >262.8 g or 62.4% of total calorie,

Table 1: Mean intakes of energy, macronutrients and their densities stratified by NIDDM and gender

	NIDDM cases			NIDDM controls		
Variables	12	6	6	88	42	46
N-value	All	M	F	All	M	F
Energy (Kcal)	1508±709.8	1082±492.9	1934.8±655.2	1660.3±844.8	1698.7±945.0	1625.4±750.8
Protein (g)	63.7±35.0	60.1±46.4	67.3±22.6	62.4±36.5	64.8±39.9	60.2±33.4
Carbohydrate	226.8±195.9	142.1±90.3	391.5±197.5^{a}	264.0±149.7	274.1±161.3	254.9±139.5^{a}
Fat (g)	29.1±18.0	32.2±22.3	26.0±13.8	34.9±23.9	33.8±24.9	36.0±23.1
Nutrient density						
Protein (%Kcal)	19.0±12.6^{b}	20.3±8.9^{c}	17.7±16.4	15.1±5.2^{b}	15.3±5.0^{c}	14.9±5.4
Carbohydrate (%Kcal)	61.9±19.7	54.1±21.8	69.7±15.4	62.8±13.5	64.0±13.4	61.6±13.7
Fat (%Kcal)	21.1±15.3	30.5±16.3^{c}	11.8±4.3	20.1±11.0	19.2±11.0^{c}	21.0±11.1

Code: N value = number in each group M = male F = female

Values with superscripts a-c, in a row, differ significantly at p<0.05 among cases and controls, males and females

Table 2: Correlation of NIDDM with energy, the macronutrient nutrients and their densities

S/No.	1	2	3	4	5	6	7	8
1	1	-	-	-	-	-	-	-
2	-0.06	1	-	-	-	-	-	-
3	0.01	0.77^{a}	1	-	-	-	-	-
4	-0.08	0.55^{a}	0.59^{a}	1	-	-	-	-
5	0.01	0.91^{a}	0.58^{a}	0.27^{b}	1	-	-	-
6	0.20^{c}	-0.08	0.51^{b}	0.17	-0.25^{c}	1	-	-
7	0.03	-0.26^{b}	-0.04	0.57^{a}	-0.48^{a}	0.26^{b}	1	-
8	-0.01	0.13	-0.21^{c}	-0.50^{a}	0.44^{a}	-0.56^{a}	-0.79^{a}	1

Code (S/No): 1 = NIDDM 2 = Total Kcal (TK) 3 = Total Protein (TP) 4 = Total Fat (TF)

5 = Total Carbohydrate (TC) 6 = Percent Protein Energy (PP) 7 = Percent Fat Energy (PF) 8 = Percent Carbohydrate Energy (PC)

Significance levels of values with superscript a, b, c are for p<0.001, p<0.01 and p<0.05, respectively

Only NIDDM was dichotomous as NIDDM case = 1, control = 0, all other variables were continuous

have associated risk (OR = 1.35 CI 0.33-5.49 and OR = 1.45 CI 0.35-7.06, respectively).

DISCUSSION

Percent protein (PP) intake of >15.5% was an associated risk for NIDDM among the 40-82 year old adults in the study population. PP was the only macronutrient variable that was a significantly (p<0.05) consistent associated risk for NIDDM in cases when compared with the controls. The consumption of a PP >15.5% appears to indicate an increased pattern of protein consumption when compared to the previously reported intake in the same community of 10.6% (Oguntona *et al.*, 1987). This previous lower intake was documented at a time when the prevalence of diabetes in Borno, State, Nigeria was less than 1% (Esiere, 1988).

The findings of this study suggests that a PP level >15.5% may be a risk factor for the development of NIDDM. Although Gannon (Gannon *et al.*, 2003) and his colleagues found that 5 weeks of high protein (PP>30%) consumption was associated with a reduction in blood glucose levels in people with NIDDM, Larsen *et al.* (2011) found no superior long-term benefit of a high protein (PP>30%) diet. In support of the findings of this study, a 14 year prospective trial (Fagherazzi *et al.*, 2014) found that the consumption of dietary acid (linked to a high protein diet) was associated with an increased risk for the development of NIDDM.

The findings of this study suggests that a PP level <15.5% will confer protection for the development of NIDDM. The acceptable minimum PP for a healthy population is 10% and although an upper limit of 35% was recommended (Food and Nutrition Board, 2002), the guidelines acknowledge that there is insufficient evidence to support this upper limit.

Moreover, the beneficial effect of a high percent protein (Gannon *et al.*, 2003) may be due to the fact that diabetic subjects in poor metabolic control may have increased protein requirement (Franz *et al.*, 2002). Hence, a PP <15.5 as suggested by the results from this study population may be adequate and seems to support a recommendation for the general population of 10-15% (Lichtenstein *et al.*, 2006). More so as the findings of a study (Fagherazzi *et al.*, 2014) found that over time, a high PP diet of >20% of energy was associated with a higher risk of getting type 2 diabetes in both overweight/obese and normal-weight women (Fagherazzi *et al.*, 2014).

The PP >15.5 was a risk factor for NIDDM and was similar to the findings of a study that showed the long term ingestion of the high dietary acid load (Fagherazzi *et al.*, 2014) increased the risk for NIDDM. The similarity in the findings between these two studies could be a reflection of the fact that in either study, the usual food habits of the population was obtained and analyzed. This is in contrast to studies in which the consumed standardized diets (Gannon *et al.*, 2003; Larsen *et al.*, 2011) containing a PP >30% were possibly diets that differed from the usual food consumption patterns of the studied populations.

The conflicting results may also be indicative of the need for studies to not only be designed to examine the

Table 3: Population mean energy, macronutrients, their densities and associated risk for NIDDM of subjects 40-82 years consuming below or above the mean

		No. exposed (Below mean intake)				No. unexposed (Above mean intake)				ODDS ratio and 95% confidence Interval (CI)	
Variables	Means*	Case	%	Control	%	Case	%	Control	%	Below mean intake	Above mean intake
Energy (Kcal)	1641.3	7	58	51	58	5	42	37	42	1.02 (0.25-4.39)	0.98 (0.23-3.03)
Protein (g)	62.6	6	50	52	59	6	50	32	41	0.69 (0.17-2.83)	1.44 (0.35-5.86)
Protein-energy (%)	15.5	7	58	55	63	5	42	33	38	0.84 (0.21-3.65)	1.19 (0.27-4.76)
Fat (g)	34.2	10	83	51	58	2	17	37	42	3.63 (0.07-35.59)	0.28 (0.03-1.42)
Fat-energy (%)	20.3	8	67	50	57	4	33	38	43	1.52 (0.37-7.39)	0.66 (0.14-2.69)
Carbohydrate (g)	262.8	6	50	51	58	8	50	37	42	0.73 (0.18-2.69)	1.35 (0.33-5.49)
Non-fiber Energy (N.F.E.%)	62.4	4	33	37	42	8	67	51	58	0.69 (0.14-2.83)	1.45 (0.35-7.06)

*Population mean values are used and are similar to those of the controls 40-82years of age which are respectively, 1660.3 Kcal, 62.4 g, 15.1%, 34.9 g, 20.1%, 264 g and 62.8%
There were no prior existing guidelines for the population

energy and macronutrients composition of diets but also to explore the role of other food components as potential risk factors in the development of disease. This is especially true since in this study, the negative and positive predictive values for percent protein >15.5% were 62.5 and 41.7%, respectively, indicating that there may be factors other than energy and macronutrient composition in the associated risk for the disease.

Conclusion: High dietary percent protein >15.5 was associated with type 2 diabetes among the studied population of Borno State indigenes aged 40-82 years. There is the need to investigate the associated risk between components of the diet other than the Macronutrients and Energy as risk factors for the development of NIDDM.

Implications of research and practice: The findings of this study will help to guide meal planning and dietary management of persons with diabetes, especially in the era of evidence-based nutrition practice.

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