RESEARCH ARTICLE

RELATIONSHIP BETWEEN WHOLE GRAIN INTAKE AND BODY WEIGHT STATUS AMONG COLLEGE STUDENTS

*,[1]Hephzibah Sherley Johanna C., Dr. Sheila John[1] and Dr. D. Estherlydia[2]

[1]Department of Home Science, Women's Christian College, Chennai
[2]Food Chemistry and Food Processing, Department of Chemistry, Loyola College, Chennai

ARTICLE INFO	ABSTRACT
	Adolescents who are obese are at higher risk for hyperlipidemia, hypertension, insulin resistance, type 2 diabetes as compared to normal weight peers. Especially college students are exposed to unhealthy eating habits leading to body weight gain. Whole grain food is important part of human nutrition providing a wide range of vitamins, minerals, antioxidants, phytosterols and other phytochemicals and could help in weight management among college students. The study is also aimed to find the relationship between whole grain intake and body composition of college students. One thousand adolescent girls were selected as random for the study and an ex post facto design was used to collect information on demographic profile and dietary habits. A subsample of 100 normal students and 100 overweight and obese students were selected to assess the relationship between whole wheat intake and body weight status. Results indicate that there was a significant association between BMI and consumption of maize ($p<0.05$) and whole wheat bread ($p<0.001$). Normal weight students had better knowledge and positive attitude towards whole grain intake compared to overweight students. Nutrition education had a positive impact on the knowledge and awareness of college students on whole wheat intake. Greater whole-grain consumption also inversely related to CVD risk factors including body weight

INTRODUCTION

Obesity is evolving as a major nutritional problem in developing countries, affecting a substantial number of adolescents and resulting in an increased burden of chronic disease (WHO, 2005). Adolescents who are obese are at higher risk for hyperlipidemia, hypertension, insulin resistance, type 2 diabetes as compared to normal weight peers (Freedman *et al*., 1999). Especially college students are exposed to unhealthy eating habits leading to body weight gain (Huang *et al*., 2003). Obesity in adolescence exists because of nutrient-poor, calorie-dense foods that cost less and are more accessible than more healthful choices, portion sizes and pricing strategies encourage overconsumption; colleges have become a commercial opportunity for the food industry; marketing to youth is powerful and relentless; physical activity is declining in everyday life. Changing such defaults involves addressing the key drivers of obesity and offers new hope of affecting large numbers of people (Brownell *et al*., 2008). Whole grain food is important part of human nutrition providing a wide range of vitamins, minerals, antioxidants, phytosterols and other phytochemicals. Regular consumption of whole grain cereals is associated with decreased risk of cardiovascular disease, diabetes, colon cancer and obesity. The dietary fiber in whole grain foods decreases weight, body-mass index, and the waist circumference by lowering the amount of accumulated body fat (Lucia *et al*., 2011). High-fiber content of most whole-grain foods helps prevent weight gain by increasing appetite control (Liu *et al*., 2003). Adolescence is a crucial period for establishing healthy behaviors. Many of the habits formed during this developmental stage will last well into adulthood (Challenges in Adolescent Health Care, 2007).

Corresponding author: Hephzibah Sherley Johanna C.,
Department of Home Science, Women's Christian College, Chennai

College students who are concerned about their body weight should be motivated to increase their intake of whole-grain foods through nutrition education programme (Nick *et al*., 2007). The study is also aimed to find the relationship between whole grain intake and body composition of college students. Guiding the college students by adopting a positive approach, towards addressing these factors through an intervention can help alleviate the risk of obesity and put them on the road to good health.

MATERIALS AND METHODS

The purpose of the study was to elicit the relationship between whole grain intake and body weight status of college girls. One thousand adolescent girls were selected at random from

Phase I: An ex post-facto approach was adopted to elicit information regarding the demographic profile and dietary habits of the adolescents.

Phase II: A sub sample of 100 overweight (≥ 25.00) and obese ($> 25.00-29.99$) adolescents and 100 adolescents with normal BMI ($18.50 – 24.99$) were selected and information regarding their knowledge and intake of whole grains and whole grain food frequency consumption.

Phase III: Nutrition education programme was formulated conducted to create awareness and highlight the importance of proper food choices and the risk of obesity. The programme mainly focused on nutrition, health, whole grain foods benefits, and importance of proper food choices and risks of obesity. Booklets were distributed at the end of the programme. The impact of the nutrition education programme was assessed using a checklist.

Human Protection

The study protocol was reviewed by the delegated Independent Ethics Committee of Women's Christian College, Chennai and approval was

Table 1: Association of BMI and demographic profile of the adolescents

Particulars		BMI classification				χ^2	p value
		Under weight n=134	Normal weight n=565	Over weight n=266	Obese n=35		
		(%)	(%)	(%)	(%)		
Age (in years)	17 years	5.2	13.1	24.1	22.9	204.10	p < 0.001
	18 years	17.9	29.4	36.5	42.9		
	19 years	15.7	33.5	8.3	11.4		
	20 years	12.7	9.0	21.4	8.6		
	21 years	42.5	11.3	8.6	14.3		
	22 years	6.0	3.7	1.1	.0		
Family type	Nuclear	82.1	80.7	75.6	91.4	6.640	p < 0.05
	Joint	17.9	19.3	24.4	8.6		
	Extended	0	0	0	0		
Annual Family income (in Rs)	Higher income/The rich >2,15,000	36.6	18.8	48.1	40.0	152.48	p < 0.001
	Upper middle income/Consuming class 45,000-2,15,000	26.9	20.4	27.1	28.6		
	Middle middle income/Climbers 22-45,000	14.2	39.3	9.0	11.4		
	Lower middle income/Aspirants 16-22,000	17.9	13.1	6.0	14.3		
	Lower income/Destitute <16,000	4.5	8.5	9.8	5.7		

Table 2: Mean values of anthropometric measurements of the adolescents

Particulars	BMI				F	p value
	Under weight n=134	Normal weight n=565	Over weight n=266	Obese n=35		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Weight	42.3±4.7	54.8±7.5	72.7±7.3	90.8±8.0	848.48	p < 0.001
BMI	17.5±0.8	21.5±1.5	27.1±1.0	31.6±2.3	2236.54	p < 0.001
Waist circumference	62.4±5.2	69.8±4.6	79.3±6.4	94.3±11.0	501.16	p < 0.001

Table 3: Association of BMI dietary habits of the subjects

Particulars		BMI classification				χ^2	'P' value
		Under weight n=134	Normal weight n=565	Over weight n=266	Obese n=35		
		(%)	(%)	(%)	(%)		
Type of diet	Vegetarian	29.1	3.5	0.8	5.7		
	Vegan	0	0	0	0		
	Lacto-vegetarian	0	0	0	0	145.236	p < 0.001
	Ovo-vegetarian	1.5	1.9	0.0	2.9		
	Non-vegetarian	69.4	94.5	99.2	91.4		
Do you eat at regular timing	Yes	43.3	19.3	14.3	31.4		
	No	56.7	80.7	85.7	68.6	49.382	p < 0.001
Appetite	Good	53.0	30.8	39.5	25.7		
	Fair	29.9	37.0	30.1	25.7	33.213	p < 0.001
	Poor	17.2	32.2	30.5	48.6		
Food prepared	Home	12.7	12.2	6.8	8.6	6.378	p < 0.05
	Hotel	100.0	99.6	100.0	100.0	1.543	NS
	College mess	96.3	91.7	96.2	100.0	10.803	p < 0.05
	College canteen	92.5	75.6	73.3	60.0	26.381	p < 0.001
Number of main meals	3	64.2	35.0	36.8	42.9		
	2-3	26.1	56.6	59.8	51.4	53.583	p < 0.001
	<2	9.7	8.3	3.4	5.7		
Influence of food choices	Parents	20.1	31.7	29.7	42.9	9.719	p < 0.05
	Friends	69.4	72.6	73.3	65.7	1.448	NS
	Teachers	.0	1.4	7.9	.0	33.033	p < 0.001
	Media	52.2	83.7	74.1	97.1	70.881	p < 0.001
	Books	31.3	3.0	1.9	2.9	157.519	p < 0.001
	Dieting trends	5.2	.9	1.5	5.7	14.729	p < 0.001

obtained for conducting the study. The adolescents were informed about the aims, methods and procedures of the study prior to data collection. The research study was appropriately scrutinized by a qualified and experiences supervisor.

Analysis of Data

The data obtained through the questionnaire was coded, classified and tabulated for further statistical analysis. Software programme SPSS version was used for statistical analysis. Frequency tables and cross tabulations were generated. Some of the statistical tests used for

Table 4: Association between Body weight and whole grain intake

Cereal and its products	Frequency of Consumption	Normal Weight (n=100)	Overweight (n=100)	χ^2	p value
Barley	High Consumers	69.0	68.0	3.579	0.167[NS]
	Moderate Consumers	13.0	21.0		
	Low Consumers	18.0	11.0		
Bran flakes	High Consumers	75.0	77.0	.276	0.871 [NS]
	Moderate Consumers	16.0	16.0		
	Low Consumers	9.0	7.0		
Brown rice	High Consumers	69.0	76.0	1.470	0.479 [NS]
	Moderate Consumers	20.0	17.0		
	Low Consumers	11.0	7.0		
Enriched wheat flour	High Consumers	36.0	28.0	2.551	0.279 [NS]
	Moderate Consumers	39.0	50.0		
	Low Consumers	25.0	22.0		
Maize	High Consumers	50.0	43.0	7.096	**0.029***
	Moderate Consumers	34.0	50.0		
	Low Consumers	16.0	7.0		
Multigrain Bread	High Consumers	51.0	65.0	4.025	0.134 [NS]
	Moderate Consumers	39.0	28.0		
	Low Consumers	10.0	7.0		
Oatmeal	High Consumers	54.0	51.0	1.354	0.508 [NS]
	Moderate Consumers	33.0	30.0		
	Low Consumers	13.0	19.0		
Popcorn	High Consumers	58.0	66.0	1.681	0.432 [NS]
	Moderate Consumers	31.0	27.0		
	Low Consumers	11.0	7.0		
Pasta	High Consumers	65.0	72.0	1.679	0.432 [NS]
	Moderate Consumers	30.0	22.0		
	Low Consumers	5.0	6.0		
Ragi	High Consumers	54.0	65.0	2.524	0.283 [NS]
	Moderate Consumers	39.0	30.0		
	Low Consumers	7.0	5.0		
Sorghum	High Consumers	79.0	86.0	2.154	0.341 [NS]
	Moderate Consumers	16.0	12.0		
	Low Consumers	5.0	2.0		
Whole wheat bread	High Consumers	46.0	64.0	10.090	**0.006****
	Moderate Consumers	43.0	22.0		
	Low Consumers	11.0	14.0		

** significant at p<0.001,* significant at p<0.05, NS- Not Significant

Table 5: Body weight and knowledge of whole grain servings per day

Knowledge		Normal Weight (n=100)	Overweight (n=100)
Eat 1 serving of whole grain food each day	Sure	49.0	53.0
	Somewhat sure	38.0	35.0
	Unsure	13.0	12.0
Eat 2-3 serving of whole grain food each day	Sure	29.0	29.0
	Somewhat sure	43.0	41.0
	Unsure	28.0	30.0
Eat whole grain bread instead of white bread	Sure	49.0	53.0
	Somewhat sure	26.0	28.0
	Unsure	25.0	19.0
Choose a whole grain cereal when you eat cereal	Sure	52.0	65.0
	Somewhat sure	31.0	21.0
	Unsure	17.0	14.0
Try a whole grain food that you never ate before	Sure	45.0	38.0
	Somewhat sure	34.0	38.0
	Unsure	21.0	24.0
Prepare a whole grain food that is new to you	Sure	36.0	38.0
	Somewhat sure	35.0	40.0
	Unsure	29.0	22.0

inferential study include the following Mean, Standard deviation, Chi square, ANOVA and "t" test.

RESULTS AND DISCUSSION

Demographic Profile

Demographic characteristics include adolescent's's age, type of family, family's annual income based on National Council of applied Economic Research (NCAER, 2007). Table 1 indicates that a higher percent (42.9%) of obese adolescents were 18 years and 36.5 percent of overweight adolescents were 18 years of age. There is 1% significance between the age and BMI classification. It is evident that nuclear families had a higher percent of obese adolescents (91.4%) when compared to joint and extended family types. It might be proposed that in nuclear families there is reduced family interactions and greater independence which affects the food consumption pattern of the adolescents leading to increased risk of obesity. There is 5% significance with the family type and BMI classification.

Table 6: Body weight and the attitudes of the subjects towards whole grain consumption

Particulars		Agree a lot (%)	Agree a little (%)	Not sure (%)	Disagree a little (%)	Disagree a lot (%)
Whole grain foods taste good	Overweight/obese	24.0	59.0	11.0	2.0	4.0
	Normal	29.0	57.0	7.0	6.0	1.0
Whole grain foods costs too much	Overweight/obese	16.0	35.0	28.0	17.0	4.0
	Normal	9.0	39.0	35.0	14.0	3.0
Whole grain foods are difficult to prepare	Overweight/obese	27.0	8.0	31.0	19.0	10.0
	Normal	8.0	28.0	31.0	21.0	12.0
Wholegrain foods are difficult to find at the store	Overweight/obese	5.0	19.0	23.0	26.0	27.0
	Normal	9.0	18.0	26.0	19.0	28.0
The store where I shop sell a variety of whole grain foods	Overweight/obese	27.0	31.0	25.0	12.0	5.0
	Normal	33.0	27.0	28.0	8.0	4.0
Whole grain foods are convenient to eat	Overweight/obese	17.0	48.0	15.0	17.0	3.0
	Normal	22.0	46.0	20.0	12.0	.0
My family wants to eat whole grain foods	Overweight/obese	37.0	34.0	14.0	13.0	2.0
	Normal	26.0	44.0	20.0	7.0	3.0
I would buy whole grain foods if I knew they were healthful	Overweight/obese	64.0	27.0	6.0	1.0	2.0
	Normal	60.0	34.0	6.0	.0	.0
I would buy a food that took longer to prepare if I knew it was healthier	Overweight/obese	46.0	33.0	11.0	6.0	4.0
	Normal	33.0	32.0	22.0	10.0	3.0

Anthropometric Measurements

Height, body weight and waist circumference were ascertained as is presented in Table 2. Difference in the mean anthropometric measurements and BMI among the four categories of adolescents based on BMI the difference is significant. Results of the study on sample of 1000 adolescents indicate that there is a gradual increase in anthropometric measurements such as body weight and waist circumference and BMI. Adolescents in the obese category had a larger increase compared to study in the normal category. Waist circumference is the most frequently used measure of central obesity. Only one measurement is required per individual, and the cost of the equipment (a tape measure) is negligible (Savva, 2000). A number of studies have suggested that the accumulation of body fat around the waist (central or abdominal adiposity) may present a higher risk to health than fat deposited in other parts of the body. In adults, central adiposity is known to be associated with increased risk of a number of obesity-related conditions, including type 2diabetes, hypertension and heart disease. Although measures of central adiposity

Fig 1. Nutrition Knowledge and Awareness of the Participants before and after the Nutrition Education Program

are closely correlated with BMI, they have been shown to predict future ill health independently of BMI (WHO, 2000).

Dietary Habits

Most of overweight and underweight adolescents were non-vegetarians. Higher percent (85.7 %) of overweight adolescents did not consume their meals at regular timing. Not having meals at regular time can lead to over eating and snacking which in turn is responsible for increased caloric intake and obesity. Greater number of eating episodes each day was associated with a lower risk of obesity (Ma *et al.*, 2003). With regard to appetite of the adolescents only (48.6 %) of overweight adolescents had poor appetite, (25.7 %) of obese adolescents had a fair appetite while a majority of 53 percent and (39.5%) of healthy and overweight adolescents had good appetite. All adolescents consumed food prepared at hotel. Eating away from home can lead to bad food choices leading to risk of obesity. More than 50% of the adolescents in the overweight and obese categories had 2-3 meals per day while 64.2 percent of underweight adolescents consumed 3 meals per day. When the number of main meals increases the chances of snacking also increases leading to weight gain. More than 50% of the adolescent's food choices in all the four categories were influenced by friends and media. 31.3% of underweight subject food choices were influenced by books. As a matter of concern the role played by teachers to influence food choices was minimal. Students spend more than half their time in schools and colleges and teachers need to be role models to influence their wards for the better is the need of the hour to include issues relating to food in the curriculum to enlighten the students.
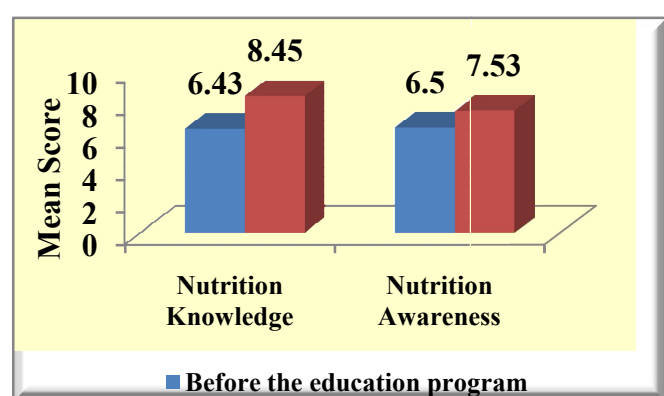
Whole grain intake

From Table 4 it is evident there was a significant association between BMI and consumption of maize and whole wheat bread. Whole-grain intake was significantly higher in normal weight students than in overweight and obese students (based on BMI). Among adolescents, results from several cross-sectional studies have shown an inverse association between whole and refined-grain intake and central obesity (Bradlee *et al.*, 2010) and between whole-grain intake and body mass index (BMI) (Steffen *et al.*, 2003). High intake of whole grain was positively associated with indicators of adiposity in other cross-sectional studies in adolescents where an inverse association was reported between whole grain intake and BMI and waist circumference (Zanovec *et al.*, 2010). As seen in table 5 and table 6 college students with normal had better knowledge and positive attitude towards whole grain intake compared to overweight students. Kantor *et al.*, (2001) in their study identified that increased intake of whole-grain foods may be limited by a lack of consumer awareness of the health benefits of whole grains, difficulty in identifying whole-grain foods in the marketplace, higher prices for some whole-grain foods, consumer perceptions of inferior taste and palatability, and lack of familiarity with preparation methods.

Nutrition Education Program

From Figure 1, the results of the test of significance reveal that there is a significant increase in nutrition knowledge and nutrition awareness among the subjects after the nutrition education program (P<0.001). The mean score on nutrition knowledge before the education program was found to be 6.43 ± 1.9 to a maximum score of 10 and this has increased to 8.45 ± 1.0 after the nutrition education program. The mean score on nutrition awareness before the education program was found to be 6.50 ± 1.3 to a maximum score of 10 and this has increased to 7.53 ± 0.9 after the nutrition education program. This indicates nutrition education program was effective and useful and improved their knowledge and awareness in nutrition.

Conclusion

Whole grains include various bioactive components such as dietary fiber, phytoestrogens, minerals, antioxidants, vitamin E, and folate, which may act synergistically to reduce risk of chronic disease (Hur and Reicks, 2012). Greater whole-grain consumption also inversely related to CVD risk factors including body weight, abdominal obesity, and insulin resistance (Koh-Banerjee and Rimm, 2003). Various epidemiologic cohort studies have demonstrated that a 2- or 3-serving-per-day increase in whole grain consumption is associated with a 20–30% decrease in type 2 diabetes, even after adjustment for confounders such as age, gender, and BMI (Venn and Mann, 2004). Adolescents should be made aware of the problems related to improper dietary habits and sedentary lifestyle which have a negative impact on their health and well being. Adolescents being the most vulnerable age group to changing trends ,if advised on the consequences of eating energy dense foods versus nutrient dense foods and the positive impact of an active lifestyle can bring out a significant positive change in lifestyle and aid in weight management. Awareness about the health benefits of whole grain foods and its importance in the diet for good health. Addressing the potential risk factors identified in this study for obesity can aid in the prevention, control, treatment of obesity among adolescents and improve their quality of life. Further studies can be conducted to ascertain the supplementation of whole grain foods in the diet of adolescents in managing body weight.

REFERENCES

Bradlee ML, Singer MR, Qureshi MM, Moore LL. (2010) Food group intake and central obesity among children and adolescents in the Third National Health and Nutrition Examination Survey (NHANES III).Public Health Nutr.13(6):797-805.

Brownell KD, Schwartz MB, Puhl RM, Henderson KE, Harris JL. (2009) The need for bold action to prevent adolescent obesity. J Adolesc Health. Sep;45(3 Suppl):S8-1 7.

Challenges in Adolescent Health Care: Workshop Report. 2007. Washington, D.C.: Committee on Adolescent Health Care Services and Models of Care for Treatment, Prevention, and Healthy Development. Board on Children, Youth, and Families, Division of Behavioral and Social Sciences and Education.

Freedman DS, Serdula MK, Srinivasan SR, Berenson GS. (1999) Relation of circumferences and skinfold thickness to lipid and insulin concentrations in children and adolescents: the Bogalusa Heart Study. Am J Clin Nutr. Feb; 69(2):308-17.

Huang TT, Harris KJ, Lee RE, Nazir N, Born W, Kaur H. (2003). Assessing Overweight, Obesity, Diet, and Physical Activity in College Students. J Am Coll Health, 52(2):83-86.

Hur IY, Reicks M. (2012) Relationship between whole-grain intake, chronic disease risk indicators, and weight status among adolescents in the National Health and Nutrition Examination Survey, 1999-2004. J Acad Nutr Diet. Jan;112(1):46-55.

Kantor LS, Variyam JN, Allshouse JE, Putnam JJ, Lin BH. (2001) Kantor LS, Variyam JN, Allshouse JE, Putnam JJ, Lin BH. J Nutr. Feb;131(2S-1):473S-86S.

Koh-Banerjee P, Rimm EB. (2003) Whole grain consumption and weight gain: a review of the epidemiological evidence, potential mechanisms and opportunities for future research. Proc Nutr Soc; 62:25–9.

Liu., Willett, W.C., Manson, J.A.E., Frank, B.H., Rosmer. B. and Colditz. G. (2003). Relation between changes in intakes of dietary fiber and grain products and changes in weight and development of obesity among middle-aged women. American Journal of Clinical Nutrition. 78: 920-6.

Lucia Mikušová, Ernest Šturdík, Andrea Holubková. (2011). Whole grain cereal food in prevention of obesity. Acta Chimica Slovaca, Vol. 4, No. 1, 95 – 114.

Ma Y, Bertone ER, Stanek EJ, Reed GW, Hebert JR, Co hen NL, Merriam PA, Ockene IS.(2003) Association between Eating Patterns and Obesity in a Free-living US Adult Population, American Journal of Epidemiology; 158(1).85-92.

Nick Rose, Kathy Hosig, Brenda Davy, Elena Serrano, Linda Davis (2007) Whole-Grain Intake is Associated with Body Mass Index in College Students Journal of nutrition education and behavior volume 39, issue 2, 90-94.

Savva S, Tornaritis M, Savva M. (2000) Waist circumference and waist-to-height ratio are better predictors of cardiovascular disease risk factors in children than body mass index. International Journal of Obesity Related Metabolic Disorders; 24(11):1453-1458.

Steffen LM, Jacobs DR Jr, Murtaugh MA, Moran A, Steinberger J, Hong CP, Sinaiko AR. (2003) Whole grain intake is associated with lower body mass and greater insulin sensitivity among adolescents. Am J Epidemiol. Aug 1; 158(3):243-50.

Venn BJ, Mann JI. (2004) Cereal grains, legumes and diabetes. Eur J Clin Nutr. Nov; 58(11):1443–1461.

WHO (2005) Assessment of burden of non- communicable diseases. A project supported by WHO, India. WHO.

WHO (2000). Obesity: Preventing and managing the global epidemic, WHO Technical Report Series 894. World Health Organisation: Geneva.

Zanovec M, O'Neil CE, Nicklas TA,Cho S. (2010) Whole-grain consumption is associated with diet quality and nutrient intake in adults: the National Health and Nutrition Examination Survey, 1999-2004. JADA.110 (10):1461-8.

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