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Effects of Dietary Patterns, Dietary Glycemic Load and Physical Activity Level on the Weight Status of Healthy Female Omani University Students

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ABSTRACT

The Glycemic Load (GL) of a food or mixed meal is defined as the amount of carbohydrates in grams contained in each serving of food or meal multiplied by its Glycemic Index (GI) and divided by 100. The dietary GL score for an entire day is calculated as the sum of the GL for all the individual food servings consumed. The present study was conducted to compare the changes in dietary patterns and to correlate the daily dietary GL intake and physical activity level in female university students with their weight gain/loss status over a period of 6 months. Two hundred healthy female university students (18-25 years of age) living in hostels at Sultan Qaboos University campus were randomly recruited for this study. The dietary food intake data was collected at two occasions (day 1 and after 6 months) using a semi-quantitative food frequency questionnaire in personal interviews. Anthropometric measurements including weight, height, Body Mass Index (BMI), waist and hip circumferences and waist to hip ratio as well as the physical activity level were evaluated. [1]The results showed that the dietary intake patterns of students changed from their usual home eating patterns while residing at the university campus. The subjects consumed low glycemic load diets, showed a slight reduction in body weight and maintained a normal BMI with a score of waist/hip ratio < 1, with no significant differences in the time spent for physical activity as well as the physical activity factor as determined by TANITA. The volunteers were consuming low GL-diets that appear to be a major determinant of their weight status independent of physical activity level.

Key words: Dietary patterns, glycemic load, physical activity, weight status, Omani female students

INTRODUCTION

In Oman, there has been a steep reduction in child and adult mortality and increase in life expectancy during the last 4 decades due to decline of various communicable diseases, including vaccine preventable diseases (Ganguly *et al*., 2009). However, adopting Western lifestyle and food

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consumption patterns have triggered for various non-communicable diseases among Omani adults, including obesity, type 2 diabetes (T2DM), hypertension and coronary heart diseases (Waly *et al.*, 2010; Mehana and Kilani, 2010). A sedentary lifestyle and lack of physical activity among Omani adults has been reported recently (Kilani *et al.*, 2012).

The food consumption patterns in Oman have changed from regular consumption of nutrient-dense foods such as fresh fruits and vegetables to higher consumption of red meat, milk and milk products, eggs, oils and fats, fast foods and sugary, sweet and salty snack foods (Musaiger and Miladi, 1995; Ali *et al.*, 2013). According to recent studies related to Omani population, the prevalence of T2DM, impaired glucose tolerance and obesity is accelerated in Oman (Al-Riyami *et al.*, 2000) and urban population has been found to have higher prevalence as compared to their rural counterparts (Al-Moosa *et al.*, 2006). Unhealthy dietary habits and sedentary lifestyle are the major factors for obesity which is the major etiological factor contributing to non-communicable diseases among adults which will continue to drain Oman's human and financial resources, if appropriate strategies are not developed and introduced to current health care system (Al-Lawati *et al.*, 2008).

Bread and rice are the two staple foods in Oman, the breads are commonly consumed in a variety of ways and are served almost at all 3 mealtimes, breakfast, lunch and dinner, whereas the rice is mainly served at lunchtime (Ali *et al.*, 2010). Different carbohydrate rich foods induce distinct blood glucose responses based on their physical forms, particle sizes, fiber contents and nutrient composition. The concept of Glycemic Index (GI) was proposed in 1981 (Jenkins *et al.*, 2002) and refers to a numeric physiologic classification of carbohydrate rich foods as compared to a standard carbohydrate source (glucose) for which the GI value is set at 100 (Jenkins *et al.*, 2002). The GI is defined as the incremental area under the blood glucose response curve (IAUC) after the consumption of 50 g of available carbohydrates from a test food divided by the incremental area under the curve after the consumption of 50 g of available carbohydrates from a standard food, either glucose or white bread (Jenkins *et al.*, 2002; Brand-Miller *et al.*, 2003).

The term Glycemic Load (GL) was introduced to predict the glycemic response of mixed meals and is calculated as:

$$\text{Glycemic response of mixed meals} = \frac{\text{GI} \times \text{Carbohydrate in a portion of food}}{100}$$

The GL is thought to be a healthier index to predict the glycemic responses from the habitual consumption of mixed meals (Atkinson *et al.*, 2004). Low glycemic index and glycemic load diets have been reported to be independently associated with reduced risk of obesity incidence, a major etiological factor for various non-communicable diseases among adults (Barclay *et al.*, 2008; Bhupathiraju *et al.*, 2014; Zelenskiy *et al.*, 2014). There are ethnic differences between the adolescents from different nations with regard to their lifestyle and food consumption patterns (intake of energy dense foods, whole grains, fruits and vegetables). The present study was planned as a prospective study to determine the daily dietary GL of mixed meals regularly consumed by female Omani university students residing in hostels at Sultan Qaboos University (SQU) campus for a period of 6 months. The overall goal was to evaluate the impact of daily dietary GL and physical activity level on the weight gain/loss status of the study participants.

MATERIALS AND METHODS

Study subjects and setting: A descriptive cross sectional study was conducted at Sultan Qaboos University (SQU). Two hundred healthy newly admitted female university students, residing in university hostels at SQU campus, were recruited on voluntary basis for this study. All the study subjects were neither married nor pregnant and were free of any liver disease, anemia and chronic diseases.

Study protocol: On 1st day of the study, all the subjects were interviewed in person to complete a study questionnaire. The same study questionnaire was repeated after 6 months (180 days) in personal interviews. The initial data collected at 1st day was compared with the data collected after 180 days. The questions asked were categorized into: (a) General characteristics of the study subjects: Age, socio-economic status, family income and residential status (rural or urban); (b) Assessment of the nutritional status of the study groups: The prospective daily dietary intake was recorded using an already validated semi-quantitative food frequency questionnaire (FFQ). The Food Processor software version 10.2 (ESHA Research, Salem, OR, USA) was used to calculate the average daily nutrient intakes (total energy intake, protein, fat and carbohydrates) as estimated from the number of servings consumed, portion sizes and nutrients content for all the reported foods by each study subject. The daily dietary glycemic load of mixed meals was determined from the amount of total carbohydrates consumed from the individual food items. (c) Anthropometric measurements included weight (kg), height (cm), body mass index (BMI, kg m^{-2}), waist and hip circumferences and waist/hip ratio; (d) Physical activity level assessment included routine exercise (duration and types), leisure activities and physical activity factor as determined by TANITA body fat composition analyzer (Model No. TBF-410 AS, Japan).

Statistical analysis: The collected data was coded, tabulated and expressed as Means±Standard Deviation (SD) for the continuous variables or for percentages of categorical variables. The GraphPad Prism software (version 5.0) was used to compute the unpaired Student's t-test, correlation coefficients (r) and Chi-squared test. The $p<0.05$ is considered as significant.

RESULTS AND DISCUSSION

The data on the general characteristic of study subjects as well as on the dietary intake and physical activity factor is presented in Table 1. The study subjects were homogenous in terms of age (23.4±4.6 years), family monthly income (623.48±43.8 Omani Riyals) and residential status. They were not consuming any vitamins or dietary nutritional supplements. The anthropometric measurements revealed significant ($p<0.05$) differences between the initial BMI (27.3±0.1) and the final BMI (24.6±0.1) as measured after 180 days of study. No significant ($p<0.05$) differences were observed in the waist to hip ratio (W/H ratio) for all the study subjects at the initial and final stage of the study and it was <1.0.

Significant ($p<0.05$) differences were observed in the daily energy intake of participants at the beginning and at the end of the 6 months study period (Table 1). Similarly the total daily carbohydrates, fat and protein intake varied significantly ($p<0.05$) after 6 months of adaptation to the new on campus eating patterns. The daily intake of total carbohydrates and fats reduced whereas the protein and fibre intake increased significantly ($p<0.05$) with new eating patterns at the university hostels (Table 1). The results indicated that the median daily dietary glycemic load was significantly lower at the end of 180 days of study as compared to the initial values (Table 1).

Table 1: General characteristics, dietary intake and physical activity factor of study subjects

Parameters	Initial (day 0)	Final (day 180)
Age	23.4±4.6	23.9±4.3
BMI (kg m^{-2})	27.3±0.1[a]	24.6±0.1[b]
Waist/Hip ratio	<1.0	<1.0
Residence status	52% from rural areas, 48% from urban areas	
Family monthly income (Omani Riyals)	623.480±43.8	
Vitamins and dietary supplements intake	None	None
Daily energy intake (kcal day^{-1})	2760.3±29.5[a]	2537.1±26.7[b]
Daily total carbohydrates intake (g day^{-1})	305.2±38.1[a]	276.9±33.3[b]
Mono and disaccharides (g day^{-1})	95.4±17.2	98.6±21.5
Added sugar (g day^{-1})	4.3±1.3	5.7±1.8
Total fat (g day^{-1})	98.7±11.2[a]	68.7±19.4[b]
Total fiber (g day^{-1})	21.5±3.4[b]	25.7±3.7[a]
Protein (g day^{-1})	62.1±13.6[b]	98.5±37.8[a]
Median daily dietary glycemic load	198.3±16.7[a]	179.8±17.4[b]
Physical activity duration (<30 min day^{-1})	17.6±3.7	18.9±3.1
Physical activity factor (TANITA) Scale: 1 (lowest) to 9 (highest)	4.84±1.45	4.93±1.55

[a,b]Different alphabets in the same row means significantly different ($p<0.05$)

The differences observed in daily energy and nutrient intake as well as in median daily dietary glycemic load may be attributed to the changes in the dietary patterns on the university campus as the menus offered in the university hostels were different than the traditional eating patterns at home. These differences may also be attributed to the differences in smell, taste, liking and disliking of university menus as well as the way of presentation and time of serving of these meals in the university cafeterias. The energy and nutrient intake of the students on traditional dietary patterns and university menus was however, within the Recommended Dietary Allowances (RDA) as specified for this specific age category (Hellwig *et al*., 2006).

Determining the glycemic index of foods *in vivo* has now become an international standard for measuring the glycemic response of foods (Bao *et al*., 2011; Brand-Miller and Buyken, 2012). Foods with variable glycemic index and Glycemic Load (GL) have been reported to produce varying glycemic and insulinemic responses (Franz *et al*., 2004; Augustin *et al*., 2002). It has been suggested that foods with a high GL increase the risk of type 2 diabetes, in particular among vulnerable groups (Pi-Sunyer, 2002). A diet high in carbohydrates with high Glycemic Index (GI) and Glycemic Load (GL) values are regarded as lipogenic and have been linked to increase the risk of coronary heart disease development, whereas low GI foods and GL-diets have been shown to be associated with high HDL-cholesterol concentrations in adult women (Leeds, 2002). High GL-diets have certain important effects on body weight and increase the postprandial glycemia as indicated by prospective observational studies (Leeds, 2002; Foster-Powell *et al*., 2002). There is a synergistic effect between low physical activity and consumption of high GL-diets in increasing the risk of developing type-2 diabetes mellitus (T2DM) and cardiovascular diseases (Foster-Powell *et al*., 2002; Duncan *et al*., 2003; Hermansen *et al*., 2006).

The present results showed that the study subjects consumed low GL-diets while on the campus that helped in body weight reduction and they showed significantly lower BMI values as compared to their initial BMI at the beginning of the study with their traditional eating patterns. Although the physical activity level of these volunteers is considered as low, the consumption of low GL-diets appeared to be a major determinant of their weight status independent of their physical activity

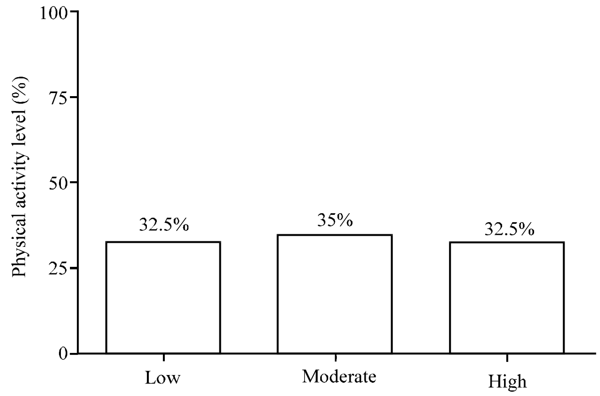

Fig. 1: Physical activity level among the study subjects (n = 200)

level. These findings address the usefulness of consumption of low GL-diets in normal healthy subjects. There is a growing body of evidence on the beneficial effects of eating low GL meals in relation to lowering the risk of non-communicable chronic diseases such as diabetes mellitus, coronary heart diseases and cancer (Jarvi *et al*., 1999; Henry *et al*., 2008; Ebbeling *et al*., 2005; Gnagnarella *et al*., 2008; Grau *et al*., 2011; Hu *et al*., 2013). These observational studies indicate that the habitual consumption of low GL-diets that may be more likely to reflect a fiber rich diet rather than only the low GL-diets. Our results are in line with these findings as the daily fibre intake of the study subjects while consuming the on campus university menu was found to be 25.7±3.7 g day^{-1}.

The data on the average physical activity level as collected by the questionnaire and on the physical activity factor as measured by the bioelectrical impedance analysis using TANITA-scale did not show any significant ($p<0.05$) differences in the values at the initial and final stages of the study. Figure 1 represents the level of physical activity (low, moderate or high) among the study subjects. The results indicated that 32.5% had low, 35% moderate and 32.5% had high physical activity level. However, no significant differences were observed in the physical activity level of students at the initial and final stage of the study as indicated by Chi-squared analysis ($\chi^2 = 1.703$, $p<0.05$). Regular exercise has been shown to have both short-term and long-term beneficial effects on glucose metabolism (Atkinson *et al*., 2004). It has been reported that moderate routine exercise can improve the glucose homeostasis and insulin sensitivity among the sedentary healthy adults (Snowling and Hopkins, 2006; Umpierre *et al*., 2011). It has been suggested that overweight adolescents who adopted a regular physical activity lifestyle had the greatest improvements in their serum glucose concentrations and this effect was independent of change in body weight (Nelson *et al*., 2002).

Overall the dietary GL was found to be directly associated with changes in body weight among the study subjects ($r = 0.73$), whereas the dietary GL was not correlated with physical activity level ($r = 0$). The study noted that low GL-meals were served in SQU-campus cafeterias and this was a major determinant of the weight status of study subjects, independent of their dietary habits and physical activity level. The present study highlights the need for conducting further epidemiological studies with larger cohorts as well as for long term well-designed randomized control trials in order to provide the necessary clarity on the potential clinical and public health significance of low GI and GL-diets and physical activity level in relation to maintenance of normal body weight and human health. The physiological response to exercise can vary with ethnicity; however, in this study the participants were not significantly different in terms of their ethnicity and physical activity level as the female university students at SQU-campus have the same routine living with least physical activity level.

CONCLUSION

Overall the results of this study indicated that the dietary intake patterns of female university students changed from their usual traditional home eating patterns while residing on campus in university hostels. The consumption of low glycemic load diets was found to be associated with a slight reduction in body weight that helped to maintain a normal BMI with waist/hip ratio of <1. The impact of low glycemic load diets on body weight reduction and maintaining the normal BMI values was independent of time spent on physical activity. It is suggested that low GL-diets appear to be a major determinant of weight status independent of physical activity level.

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