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Metabolic syndrome within freshman students; Case study in Jazan Kingdom of Saudi Arabia (KSA)

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As well as many countries, in Kingdom of Saudi Arabia (KSA), non-communicable diseases are becoming an epidemic health problem. Scientific studies prove that these diseases are related to the nutritional types adopted in the last decades and which could be predicted by control of metabolic biomarkers during lifespan. Saudi Arabia has experienced marked nutritional changes and rapid urbanization in recent decades and in parallel incidence of health problems such as diabetes, obesity, hypertension, and cancers increases. This research was carried out to study the influence of canteen food on some metabolic biomarkers within freshman students in Jazan. For that, students were asked to answer questionnaires about their consumption from the canteen, socio and economic status, frequency and quality of their meals and some daily habits. Also, some metabolic biomarkers; body mass index (BMI); total cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), total protein (TP), albumin (Alb), triglyceride (TG), fasting blood glucose (FBG), uric acid (UA) and hemoglobin (Hb) levels were checked twice, at the first week of the first semester then again 14 weeks after. The results showed that these students eat regularly French fries, pizza and pasta. Sweets were consumed frequently and at high rates. However, vegetables and fruits were rarely consumed. For metabolic biomarkers, BMI and LD increased significantly. However, FBG, Alb, TP and HDL decreased significantly. As conclusion, our results proved that during freshman year, students' health could be influenced and some health biomarkers could be changed.

Key words: NCDs, nutrition, student, freshman, Saudi Arabia.

INTRODUCTION

During the last decades, non-communicable diseases (NCDs) become a threat to human health. NCDs are generally caused by physiological dysfunctions. They include various numbers of diseases such as: diabetes, obesity, heart diseases, immune system diseases, neurological diseases and cancer (Yadav et al., 2016). During, the last decades, NCDs rate increases all over the world and becomes a public health threat. Many studies were interested in NCDs and reported that in general, these diseases are chronic, which cause

disabilities for human, decrease his performance and are the principal cause of death (Goryakin et al., 2017).

Many studies are done on NCDs in order to understand their dynamics and to prevent their incidence (Hanson et al., 2011; Wagner and Brath, 2012; Piler et al., 2017). Three important agreements could be concluded from all these studies; first, NCDs are due to changes in human life-style: nutrition, eating behavior and physical activities. Second, the majority of them appear in the fourth decade of human life. Third, NCDs are supposed to start early, progressively and silently during human lifespan (Goryakin et al., 2017).

Several studies were interested in studying correlations between NCDs incidence, on one side, and nutritional types on the other side (van der Wilk and Jansen, 2005; Wagner and Brath, 2012; Gostin et al., 2017). Many studies were interested in childhood and adulthood nutritional types and their roles to induce/prevent NCDs (Habib and Saha, 2010; Balbus et al., 2013; Abdul Rahim et al., 2014; Abuosi et al., 2016). However, fewer studies were concerned by the adolescence (Allara et al., 2015). During adolescence, physical, psychological and physiological changes happen, which can influence the adopted nutritional type (Keown et al., 2009). As well, this stage can coincide with the freshman year. During this phase, students spend long time of the day at their university. Subsequently, both quality and quantity of their food could be influenced by the canteen of their university (Anderson et al., 2003).

A previous study showed that some students in the Academic Campus in Jazan University (Kingdom of Saudi Arabia) suffered vitamin D deficiency and anemia (Mahmoud and Ncibi, 2016). This research, concerned the study of the consumption of girls' Academic Campus in Jazan University from the university canteen and its influence on their metabolic biomarkers; (body mass index (BMI); total cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), total protein (TP), albumin (Alb), triglyceride (TG), fasting blood glucose (FBG), hemoglobin (Hb), and uric acid (UA) levels.

METHODOLOGY

Study design and sampling

This study was carried out in girls' Academic Campus in Jazan University, kingdom of Saudi Arabia. The target population was 162 level-1 students aged 18 to 21 years. This study was in the context of a research project financed by Jazan University. Its purpose was explained to the students and verbal and written consents were signed. All participants were consented to fill the questionnaires and are agreed to donate blood samples for analysis.

Ethical points and official approvals were obtained from the ethics committee of Jazan University, from the vice dean of the college of Girls' Academic Campus. Verbal and written consents were obtained from all the respondent students before participating in the study.

Study tool

First, foods provided by the university canteen were recorded. Second, two self-reported questionnaires were administered to all students. The first one was given at the beginning of the year. Information obtained from this questionnaire included: economic status, nutritional screening: frequency of their meals, nature of the most consumed aliments and fruits and vegetables consumption.

The second questionnaire was given after 14 weeks. Its questions focused on their eating behavior and their consumption from the canteen. The students were informed about the study and were given instructions on how to fill out the questionnaire completely.

Anthropometry measurements

Anthropometric measurements were performed by trained staff using standardized techniques and equipment according to the International Society for the Advancement of Kinanthropometry (Stewart et al., 2001). Participants were measured barefoot and in minimal clothing. Body weight was recorded to the nearest 0.1 kg with a digital balance (Beurer living GS5) and body height with a Holtain Stadiometer (Holtain, Crymych, UK) to the nearest 0.1 cm. These measurements were done twice; at the first week of the first semester, then 14 weeks after.

The participant's body mass index (BMI) was calculated as follows (WHO, 2000): BMI = the weight in kilograms divided by the height in meters squared. Student was considered as underweight if her BMI is less than 18.5 kg/m^2; normal if BMI = 18.5 to 24.99 kg/m^2; overweight if BMI = 25 to 29.99 kg/m^2; having mild obesity if BMI = 30 to 34.99 kg/m^2; and having severe obesity if BMI > 35 kg/m^2.

Biochemical assessment

Blood samples were taken twice; at the first week of the first semester, then again after 14 weeks. For blood samples, the students were asked to fast overnight and not consume any food except for clear water after supper/dinner, giving the blood samples in the college clinic in the morning of the following day.

Estimations of Total cholesterol (Tchol), LDL, HDL, TP, Alb, TG, FBG and Hb levels were made using clinical chemistry auto-analyzer. After the reports the blood analysis were obtained, the students were informed individually about their BMI and laboratory results were advised accordingly.

Statistical analysis

Statistical package for social sciences (SPSS), version 22Data was used to analyze the results. Data was expressed as mean and standard deviation (Mean ± SD). Data were subjected to Shapiro-Wilk's test ($p>0.05$).

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Table 1. Socio-demographic characteristics of students (n=162).

Age	18-21 years old (%)
Social situation	
Miss	135(83.3)
Married no children	17(10.5)
Married with children	10(6.2)
Monthly income	
<5000 RS	45(28.0)
>5000<10000 RS	69(42.9)
>10000 RS	47(29.2)

to study the normality distribution of different results, paired student's t test ($p<0.05$) for statistical significance then Pearson correlation test ($p<0.05$; $p<0.01$) to explore the degree of relationship between weight gain parameter on one hand, and others biochemical parameters on the other hand.

RESULTS

Socio-demographic results

In this study, the students were 18 to 21 years old. Questionnaire results showed that 83.3% of these students are single. 16.7% are married and 37% of them have children. Concerning their economic status, the results showed that 28% of the students are from low-income families, 42.9% from middle-income families and 29.2% from high-income families (Table 1).

Cafeteria items and students' consumption

Items given at the cafeteria were enumerated at the beginning of this study. These foods could be divided to 5 groups; meals, sandwiches, sweets, drinks and snacks (Table 2). For meals, questionnaire answers showed that French fries are the most consumed (74.2%), followed by pizza (55.9%), Chicken burgers and French fries (54.2%) and Pasta (51.7%). For sandwiches, answers revealed that Falafel with full-fat cheddar cheese sandwiches are the most consumed (47.2%). Then toast with full-fat cheddar cheese and tuna sandwiches are 45.64 and 38.6% respectively. Concerning vegetables consumption, results showed that they are rarely consumed. Thus, both in meals and sandwich choices, items containing vegetables are ranked last with low percentages (as example 11.2 and 6.6% respectively for Stir-fried vegetables, grilled vegetables).

Also, results reported a frequent consumption of sweets such as Sweet galaxy, Sweet Twix, Basbousa, and Sweet Orio, which are prepared in the cafeteria. Soft drinks, coffee and tea are consumed in a high rate in contrast with canned fruit juices. For snacks consumption, our results revealed that more than 58% of the students, consumed chocolate, biscuits and chips as snacks while they are in college.

Daily food habits and physical activity

In this part of the research, some daily habits of the students were studied. Results (Table 3) showed that although 42.59% of the students have irregular meals consumption, the vast majority of them (80.25%) have breakfast at least three times per week.

Concerning vegetables and fruits, more than half of students eat vegetables either fresh or cooked and fruits twice or less than two times per week (55.55, 53.08, and 54.93%, respectively). Also, results demonstrated that 62% of these students don't practice any physical activity.

Sample characteristics

A shapiro-wilk's test ($p>0.05$) (Razali and Wah, 2011) and a visual inspection of their histograms, normal Q-Q plots and box plots showed that the different concerned parameters (weight gain, Tchol, LDL, HDL, TP, Alb, TG, FBG and Hb) were approximately normally distributed (Table 6).

BMI results

The results (Table 4) showed that after 14 weeks, the mean weight of the entire student increased significantly ($p \leq 0.05$). Number of underweight and normal weight students decreased while numbers of obese, mid-obese and severe-obese students increased. In this study, weight change was assumed to 98 ± 77 g/week.

Biochemical parameters

Metabolic biomarkers (TP, TG, TChol, LDL, HDL, FBG, UA, Hg and Alb) were estimated at the beginning of the study and 14 weeks after. Results (Table 5) showed that FBG, Alb, and TP levels decreased significantly. TG and Hb levels decreased while TChol increased, both changes are not statistically significant. However, LDL increased and HDL decreased, both changes were significant While UA level didn't change.

Weight gain was recorded within 60% of the students (97 students) concerned by this study. This increase (1.74±1.04 kg) is significant compared to their weights at the first week. Daily habits and biochemical parameters of these students were examined. Questionnaire answers revealed that 54% of these students ate, irregularly, more than three meals per day. 75% of them neglected their breakfast and 65.28% of them have no physical activity.

Table 2. List of cafeteria items and students' consumption (n=162).

Item	Yes		Sometimes		Rarely	
	No%	%	No	%	No	%
Meals						
French fries	120	74.2	39	24	3	1.8
Pizza	91	55.9	57	35.38	14	8.72
Chicken burgers and French fries	88	54.2	36	22.4	38	23.4
Pasta	84	51.7	50	30.8	29	17.8
Kabsa	58	35.6	40	24.4	65	40
Potatoes, cooked	56	34.4	44	27.3	62	38.3
Pasta Bechamel	47	29.1	69	42.8	46	28.2
Grape leaves	46	28.5	45	28	70	43.5
Vegetables and meat, cooked	46	28.4	37	22.7	79	48.8
Sambousek	35	21.8	52	32	75	46.2
Koushari	33	20.5	58	36.1	70	43.4
Stir-fried vegetables	18	11.2	30	18.4	114	70.4
Grilled vegetables	11	6.6	20	12.2	132	81.2
Sandwiches						
Falafel with full-fat cheddar cheese	76	47.2	40	24.5	46	28.3
Toast with full-fat cheddar cheese	74	45.64	35	21.64	53	32.72
Tuna	63	38.6	46	28.4	53	33
Fried Eggs	31	19.3	36	22.2	95	58.5
Eggs with tomatoes	31	19.1	41	25.2	90	55.7
Bean	15	9.1	28	17.2	119	73.7
Bean and eggs	8	5	22	13.4	132	81.6
Sweets						
Sweet galaxy	57	35.3	49	30.2	56	34.5
Sweet Twix	43	26.4	54	33.4	65	40.2
Basbousa	35	21.3	43	26.7	84	52
Sweet 0rio	31	19.4	43	26.5	88	54.1
Jatoh	29	17.6	42	25.9	92	56.5
Drinks						
Soft drinks	82	50.4	23	14	58	35.6
Nescafe	68	41.8	52	32.1	42	26.1
Coffee	64	39.4	34	21.2	64	39.4
Tea	44	27	33	20.4	85	52.6
Tea with milk	43	26.7	46	28.1	73	45.2
Any hot drink	40	24.7	14	8.7	108	66.6
Fruit canned juices	33	20.58	29	18.2	99	61.21
Snacks						
Biscuits	109	67.28	47	29.01	6	3.7
Chocolat	130	80.25	29	17.9	3	1.85
Chips	97	59.88	61	37.65	4	2.47

Yes: Daily; Sometimes: 2-4 time/week; rarely: 1 time/week or less.

Besides, biochemical parameters analysis (Table 7) indicated that levels of Alb, TP, FBG, TG, HDL and Hb decreased significantly. However, LDL and TChol levels increased significantly. UA level didn't change.

Table 3. Daily food habits and physical activity (n=162 students).

Questions	Answers	
	N	%
Q1. Do you eat your meals regularly?		
Always regular	93	57. 4
Irregular	69	42.59
Q2. Do you take breakfast?		
Daily	35	21.6
3-5 times/week	95	58.64
≤ 2 times/week	32	19.75
Q3. How often do you take green salad?		
Daily	26	10.04
3-5 times/week	46	28.39
≤ 2 times/week	90	55.55
Q4. How often do you take cooked vegetables?		
Daily	18	11.11
3-5 times/week	58	35.8
≤ 2 times/week	86	53.08
Q5. How often do you take fruits?		
Daily	16	9.87
3-5 times/week	57	35.18
≤ 2 times/week	89	54.93
Q6. Do you practice any physical activity regularly?		
Once or 2/week	60	37.04
Rarely	102	62.96

Table 4. Variation of the BMI of girls' Academic Campus in Jazan University, Kingdom of Saudi Arabia during their freshman year (n = 162).

BMI classification	The first week of the semester		14 weeks after	
	N	%	N	%
Underweight (<18.5)	38	23.46	35	21.6
Normal (18.5-24.99)	73	45.06	72	44.44
Overweight(≥25)	-	-	-	-
Pre-obesity (25-29.99)	27	16.67	28	17.28
Med obesity (30-34.99)	15	9.26	17	10.49
Obesity (≥35)	9	5.56	10	6.17
Mean BMI(kg/m^2)	23.170±6.2834		23.475±6.2844*	

Results present both number of students in each classification (N) and the corresponding percentage (%). BMI level is presented as mean ± SD. *significant difference is compared to the result at the beginning of the semester ($p < 0.05$).

Statistical Pearson correlation test results are presented in Table 8. These results proved that there are no correlations between weights gain and other concerned parameters. Also, no correlations were recorded between Hb level and the rest of biochemical parameters. However, results showed a strong positive correlation

Table 5. Variation of metabolic biomarkers during the first semester of freshman year of girls' Academic Campus in Jazan University, Kingdom of Saudi Arabia during their freshman year (n = 162).

Biomarker	The first week of the semester	14 weeks after
Albumin(g/L)	40.3 ±4.4	36.0 ±4.4*
Total protein(g/dL)	6.97 ±0.51	6.77 ±0.55*
Uric acid(mg/dL)	3.85 ±0.74	3.85 ±0.70
Fasting blood glucose(g/L)	88.96 ±13.0	85.59 ±9.90*
Total cholesterol(g/L)	133.75±20.44	135.38 ±18.07
Low Density Lipoprotein(g/L)	41.17 ±12.57	43.24 ±11.47*
High Density Lipoprotein(g/L)	70.73 ±9.87	68.85±7.87*
Triglyceride(g/L)	116.47±17.78	115.26 ±16.98
Hemoglobin(g/L)	11.99±1.37	11.63±1.4

Levels are presented as mean ± SD.* significant difference is compared to the result at the beginning of the semester ($p < 0.05$).

Table 6. Shapiro-Wilk's test applied to the different studied parameters ($p>0.05$).

Parameter		Skewness		Kurtosis	
		Statistics	SE	Statistics	SE
Weight	The first week of the semester	0.518	0.289	0.083	0.570
	14 weeks after	0.502	0.289	0.055	0.570
TG	The first week of the semester	0.168	0.289	-1.106	0.570
	14 weeks after	0.352	0.289	-0.850	0.570
TP	The first week of the semester	0.387	0.289	-0.611	0.570
	14 weeks after	0.509	0.289	-0.481	0.570
TChol	The first week of the semester	0,218	0.289	-1.072	0.570
	14 weeks after	0,069	0.289	-0.778	0.570
LDL	The first week of the semester	0.521	0.289	0.974	0.570
	14 weeks after	0.262	0.289	-0.424	0.570
HDL	The first week of the semester	0.369	0.289	-1.076	0.570
	14 weeks after	0.531	0.289	-0.203	0.570
FBG	The first week of the semester	-0.01	0.289	-0.656	0.570
	14 weeks after	-0.049	0.289	-0.465	0.570
HB	The first week of the semester	-0.549	0.289	0.52	0.570
	14 weeks after	-0.514	0.289	-0.013	0.570
Alb	The first week of the semester	0.314	0.289	-0.174	0.570
	14 weeks after	0.173	0.289	-0.805	0.570
UA	The first week of the semester	0.541	0.289	0.538	0.570
	14 weeks after	0.277	0.289	0.154	0.570

SE: Standard Error.

between LDL and TChol levels and a moderate negative correlation between FBG and TG levels. Besides, results demonstrated moderate positive correlations between the levels of Alb and TP, Alb and FBG, Alb and TG, HDL and TG and TG and TChol.

DISCUSSION

As NCDs incidence increased in the last decades, many scientists were interested in studying their causes. Bloom et al. (2014) confirmed that nutrition is a major modulator

Table 7. Variation of metabolic biomarkers within students that gained weight (n = 97).

Biomarker	The first week of the semester	14 weeks after
Weight(Kg)	53.26±14.3	54.63±14.34*
Albumin(gL^{-1})	40.1±4.6	35.9±4.2*
Total protein(g/dL)	6.95±0.53	6.72±0.56*
Uric acid(mg/dL)	3.87±0.79	3.88±0.76
Fasting blood glucose(g/L)	89.54±12.82	85.48±9.68*
Total cholesterol(g/L)	135.48±21.24	13.91±18.31*
Low Density Lipoprotein(g/L)	42.08±12.78	43.78±11.52*
High Density Lipoprotein(g/L)	71.54±10.3	69.79±8.48*
Triglyceride(g/L)	114.48±18.89	113.48±17.67*
Hemoglobin(g/L)	12.53±6.06	12.2±6.1*

Levels are presented mean ± SD.*significant difference compared to the result of the beginning of the semester ($p < 0.05$).

of these diseases and demonstrated that NCDs occurred progressively and silently during lifespan. Some health parameters; BMI, FBG, TChol, TG and Hb are used as biomarkers and help in NCDs prediction (O'Neill et al., 2016). These biomarkers vary during age from childhood to adulthood. But, for each period, normal ranges are identified and the destabilizations of these biomarkers can predict later in NCD incidence.

End of the adolescence is a very important period of life; it marks the end of childhood and the transition to adulthood. Also, this period coincides with the freshman year for many persons. Desouky et al. (2014) evoked the presence of non-communicable diseases risk factors of among female university students. Gropper et al. (2012) demonstrated that poor eating habits and limited physical activity, in adolescence, could be the cause of serious health problems (osteoporosis, obesity, hyperlipedemia, cardiovascular disease, type 2 diabetes, arthritis, impaired mobility, and cancer), later in life.

As well as many countries, NCDs increased in Kingdom of Saudi Arabia (KSA). Several researchers studied this phenomenon and attributed it to life style change. Abahussain et al. (2012) reported that Saudi Arabia is a country that has experienced marked nutritional changes and rapid urbanization in recent decades. Same authors introduced local studies using a representative sample and validated instruments used to assess lifestyle factors which are particularly scarce.

In this work, health status of girls' Academic Campus in Jazan University, Kingdom of Saudi Arabia during their freshman year was investigated. As presented in the methodology, students were asked to answer questionnaires and to give blood samples for biochemical analysis at the first week of the first semester and again, 14 weeks after.

Data collected in Table 4 demonstrated that, at the beginning of the study, 23.46% of students were underweight, 45.06% of them had normal weight and 31.49% of them were overweight. 14 weeks after, prevalence of underweight decreased (21.6%) and percentage of normal weight students nearly didn't change (45.06 to 44.44%, respectively). However, the rate of overweight students increased (33.94%). Farghaly et al. (2007), Mahfouz et al. (2008) and Collison et al. (2010) confirmed this result. These authors reported obesity and increased BMI in adolescents in Saudi Arabia which indicated that unhealthy dietary choices and inactivity were generally correlated with BMI increase.

In this study, the increase in the weight was estimated to 98 ± 77 g/week. Finlayson et al. (2012) confirmed that the weight gain during freshman year occurred in the first semester. Levitsky et al. (2004) found that the weight gain during the first 12 weeks of the semester was 158.3 g/week. They announced that this amount of weight is more than that recorded by Matvienko et al. (2001) 103.85 g/week in their untreated control group. Also, Hovall et al. (1985) introduced that, analysis of variance showed that university women gained significantly more excess weight than the community women.

Same author said that, spontaneous weight gain in human populations is exaggerated in the first year of college compared to the population at large. In their study, Finlayson et al. (2012) confirmed this weight gain and introduced that, this phenomenon is assumed to result from a number of changes in lifestyle associated with being at University which includes a transition to a more sedentary lifestyle, exposure to more social eating occasions, greater access to cafeteria and fast-food meals. Furthermore, hormonal disturbance from reduced sleep was considered by this author as a factor of gain weight. In this research, most students complain reduced sleep since their habitations are distant and have to get up very early.

Arnold et al. (2015) attributed weight gain in this period to disinherited eating phenomenon in students. He explained that this phenomenon is caused by the lack

Table 8. Degree of relationships between biochemical parameters and weight gain (Pearson correlation test) (N=97 students).

Variables		Weight	Alb	TP	UA	FBG	LDL	HDL	TG	TChol	Hb
Weight	Pearson correlation coefficient	1	0.072	-0.010	-0.083	-0.089	0.058	-0.183	-0.027	-0.022	0.004
	p value	-	0.549	0.936	0.486	0.466	0.629	0.123	0.819	0.852	0.971
Alb	Pearson correlation coefficient	0.072	1	0.448**	0.112	0.259*	0.068	0.038	0.252*	0.103	-0.082
	p value	0.549	-	0.000	0.348	0.031	0.569	0.753	0.033	0.390	0.493
TP	Pearson correlation coefficient	-0.010	0.448**	1	-0.023	0.056	0.081	0.007	0.083	0.083	-0.119
	p value	0.936	0.000	-	0.851	0.648	0.500	0.954	0.490	0.490	0.319
UA	Pearson correlation coefficient	-0.083	0.112	-0.023	1	0.340**	-0.009	0.072	-0.124	-0.017	-0.135
	p value	0.486	0.348	0.851	-	0.004	0.938	0.547	0.300	0.888	0.258
FBG	Pearson correlation coefficient	-0.089	0.259*	0.056	0.340**	1	0.112	0.039	-0.257*	0.068	-0.007
	p value	0.466	0.031	0.648	0.004	-	0.361	0.753	0.033	0.580	0.956
LDL	Pearson correlation coefficient	0.058	0.068	0.081	-0.009	0.112	1	0.028	0.231	0.857**	-0.118
	p value	0.629	0.569	0.500	0.938	0.361	-	0.816	0.051	0.000	0.323
HDL	Pearson correlation coefficient	-0.183	0.038	0.007	0.072	0.039	0.028	1	0.280*	0.485**	-0.165
	p value	0.123	0.753	0.954	0.547	0.753	0.816	-	0.017	0.000	0.166
TG	Pearson correlation coefficient	-0.027	0.252*	0.083	-0.124	-0.257*	0.231	0.280*	1	0.435**	-0.060
	p value	0.819	0.033	0.490	0.300	0.033	0.051	0.017	-	0.000	0.617
TChol	Pearson correlation coefficient	-0.022	0.103	0.083	-0.017	0.068	0.857**	0.485**	0.435**	1	-0.172
	p value	0.852	0.390	0.490	0.888	0.580	0.000	0.000	0.000	-	0.149
Hb	Pearson correlation coefficient	0.004	-0.082	-0.119	-0.135	-0.007	-0.118	-0.165	-0.060	-0.172	1
	p value	0.971	0.493	0.319	0.258	0.956	0.323	0.166	0.617	0.149	-

**Correlation is negative p< 0.01. * Correlation is negative p<0.05.

of self-restraint over food consumption prompted by emotional or external factors.

Furthermore, our results showed that LDL levels increased modestly but significantly. However modest and significant decreases were recorded for HDL, FBG, TP and Alb levels. LDL increase and HDL decrease in freshman students are confirmed by many other studies (Desouky et al., 2014; Vergetaki et al., 2011). In his study, Keown et al. (2009) mentioned that impaired FBG increased LDL and decreased HDL, together linked with increased BMI, which are considered as an indicator to the metabolic syndrome. He added that individual with these risk factors are more subjected to have chronic disease than control persons. Same author affirmed that early screening for obesity and metabolic abnormalities can assist in prevention of cardiovascular disease risk among the apparently healthy asymptomatic college-age population. Researches that were interested in TP and Alb decreases in freshman year students are very scarce. But, generally these decreases are indications of an unbalanced diet.

In the other part of this study, big interest was given to students' alimentation habits, on one hand and the university canteen; its presentations and students consumptions, on the other hand. As presented in the results, canteen food could be divided to 5 groups; meals, sandwiches, sweets, drinks and snacks. Questionnaire answers showed that French fries, pizza, Kabsa and pastries are the most consumed. However, vegetables and fruits are rarely consumed. Also, results showed that these students consumed considerably soft drinks, tea and coffee. Besides, sweets are frequently consumed. Thus analyses of students' consumption from canteen proved that their nutritional type is high in calories but don't provide essential elements (vitamins, proteins and fibers) sufficiently. This result is in accordance with many other studies (Abahussain et al., 2012; Kelly et al., 2013).

In general, intake of fruits and vegetables is low worldwide. Several studies focused on the phenomenon which demonstrated that, the decrease in fruits and vegetables intake is positively correlated with an increase in NCDs incidence (Ruel et al., 2014; Negi et al., 2016; Gostin et al., 2017). Since, it's proved that fibers and vitamins present only in fruits and vegetables protect against vascular diseases, equilibrate blood sugar and enhance antioxidant system in the organism. Besides, questionnaire answers (Table 3) revealed that more than 40% eat irregularly their meals, only 20% of them take daily their breakfast and most of them are physically inactive. These behaviors are unhealthy and are attributed to many health problems. Thus, meals time respect inhibits hormonal disturbances and eating breakfast which has been associated with other healthy dietary behaviors such as low fat intake (Chung and Hoerr, 2005). These results are supported by Memmish et al. (2014). This author announced that most Saudis are physically inactive and consume low levels of fruits and vegetables. Furthermore, they found strong associations between obesity and diabetes, hypercholesterolemia, and hypertension. Same authors said that the adoption of a Western lifestyle, characterized by decreased physical activity and high caloric intake, is contributing to an alarming epidemiological transition marked by shift in the leading causes of death from communicable to non-communicable diseases.

Finally results of this study confirmed that these students presented metabolic syndromes, especially for students who gained weight. Statistical analysis showed either strong or moderate correlations between studied metabolic biomarkers (Table 8). These interconnections could predict some NCDs induction later in their lives. Specially, many scientific researches demonstrated paradigms where more than one metabolic biomarker could interfere to the cause of some NCDs such as diabetes and heart and vascular problems (Vincent et al., 2003; Arques, 2011; Cartier et al., 2017).

Nevertheless, this study encountered many limitations. First, to confirm the results, this study should concern more than one college. Second, the calories intakes of students could not be determined and compared to their daily needs. Finally, this study lacks the presence of control cases. Furthermore, in KSA, literature in this domain is not available enough to discuss the results, especially for the south region.

Conclusion

Results of the current conducted study demonstrate that students' alimentation is unhealthy and some of them present biomarkers for Metabolic Syndrome. In KSA, these facts are proved by many other researchers (Al-daghri et al., 2014).

Abbreviations; CDs: communicable diseases, NCDs: non-communicable diseases, BMI: body mass index, LDL: low density lipoprotein, HDL: high density lipoprotein, TP: total protein, Alb: albumin, TG: triglyceride, FBG: fasting blood glucose; Hb: hemoglobin, Tchol: total cholesterol, UA: uric acid.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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