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Obesity, Sedentary Lifestyle and Oxidative Stress among Young Adolescent

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In order to determine the clinical conditions and effect of obesity and sedentary life style among adolescents on the systemic oxidative stress, 58 obese young adolescents of both sexes, aged 11-14 years were collected for the study. Another group of 24 healthy normal non obese children of the same matched age and sexes were collected as control group. All cases and controls were exposed to full clinical history and examination, including weight, height and calculation of body mass index. Levels of free and esterified F_2-isoprostanes in plasma, concentrations of vitamin C and vitamin E, were measured and levels of erythrocyte superoxide dismutase activity (SOD) as well as erythrocyte catalase activity were estimated. Total cholesterol and triglycerides levels were determined enzymatically as well as HDL and LDL cholesterol levels. Sedentary lifestyle, frequent soft drinks ingestion as well as fast food ingestion represented a common habit, with smoking among this age group as compared with control group. with significant increase in weight and BMI as compared with controls. A significant high levels of free and esterified F_2- isoprostanes, total cholesterol levels, HDL cholesterol and LDL cholesterol were detected among obese adolescents as compared with control group. While significant low levels of vitamin C, vitamin E, SOD and catalase enzymes were detected among obese adolescents as compared with control group. We concluded that obesity with sedentary lifestyle are highly associated with systemic oxidative stress, which is reflected on their health and school performance.

Key words: Child health, obesity, oxidative stress, sedentary lifestyle, biochemistry

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INTRODUCTION

Sedentary lifestyle is a type of lifestyle most commonly found in modern cultures. It is characterized by sitting or inactivity for most of the day. It is believed to be a factor in obesity and other disorders, primarily heart disease. Overweight and obesity (as defined by a body mass index (BMI) of >25) has been estimated to be present in 60% of the adult United States population (Flegal *et al*., 1998; Mokdad *et al*. (2001, 2003). Obesity, diabetes and metabolic syndrome are now common in children (Troiano and Flagel, 1998).

The marked increase in the incidence of overweight and obese persons is recognized as one of the most serious public health issues (Eckel *et al*., 2002). Although obesity itself appears to augment the incidence of cardiovascular events, it is also associated with major risk factors for atherosclerosis including hyperlipidemia, diabetes mellitus, hypertension and the metabolic syndrome (Grundy, 2002).

Because modification of eating and physical activity habits have been relatively unsuccessful in decreasing the prevalence of obesity from a public health standpoint, additional strategies must be considered for the prevention of obesity (Heinecke, 2001). The idea that obesity is a state of chronic oxidative stress and inflammation, even in the absence of other cardiovascular diseases risk factors, increases the importance of developing effective prevention and treatment strategies for obesity (Ziccardi *et al*., 2002). So, if obesity is a condition of increased oxidative stress, obese individuals may benefit from antioxidant supplementation. (Heinecke, 2001).

Oxidative Stress (OS) is a general term used to describe the steady state level of oxidative damage in a cell, tissue, or organ, caused by the Reactive Oxygen Species (ROS). It is characterized by an imbalance between increased exposure to free radicals, principally derived from oxygen and antioxidant defenses, comprised of both small molecular weight antioxidants, such as glutathione and antioxidant enzymes, such as superoxide dismutase. Free radicals can be generated endogenously from various sources or derived from exogenous sources such as environmental toxins and cigarette smoke. Free radicals cause direct damage to critical biomolecules including DNA, lipids and proteins. Oxidative stress is now recognized to be a prominent feature of many acute and chronic diseases. However, definitive evidence for this association has often been lacking due to recognized shortcomings with methods available to assess oxidant stress status *in vivo* in humans (Halliwell and Grootveld, 1987).

Several *in vitro* markers of oxidative stress are available, but most are of limited value in vivo because they lack sensitivity and/or specificity or require invasive methods (Roberts and Morrow, 2000). Isoprostanes are prostaglandin (PG) -like substances that are produced in vivo independently of cyclooxygenase (COX) enzymes, primarily by free radical-induced peroxidation of arachidonic acid (Morrow *et al*., 1990). The formation of PG-like compounds during auto-oxidation of polyunsaturated fatty acids was first reported in the mid-1970s, but isoprostanes were not discovered to be formed *in vivo* in humans until 1990 (Morrow *et al*., 1990). The F_2-IsoPs represent, in 2005, the most established index of oxidative stress status *in vivo* in humans. They can be measured in human body fluids such as plasma and urine using highly precise methods (Morrow, 2005). Evaluation of the role of Obesity and Sedentary lifestyle in systemic oxidative stress was the aim of present study.

MATERIALS AND METHODS

Subjects: This study was carried out on 58 young adolescents of both sexes, aged 11-14 years suffering from overweight and obesity from those attending the outpatient clinic of pediatrics in Abou EL-Riesh Student Hospital and referred to Nutrition Department NRC; over a period of two years (January 2003 to February 2005). A group of 24 children with the same ages and sexes was included as control group. All cases and control subjects were exposed to full clinical history and examination, including weight, height and calculation of body mass index.

Biochemical studies: All cases and control groups were subjected to estimation of levels of free F_2-isoprostanes in plasma and of F_2-isoprostanes esterified to plasma lipids were measured by stable-isotope-dilution mass-spectrometric assay by the method of Morrow and Roberts (1994). Plasma concentrations of vitamin C and vitamin E, were measured using the methods described by Jogota and Dani (1982) and Baker and Frank (1968), respectively. Estimation of erythrocyte superoxide dismutase activity (SOD) as well as estimation of erythrocyte catalase activity were done using the methods described by Winterbourn *et al*. (1975) and Sinha (1972), respectively. Total cholesterol and triglycerides levels were determined enzymatically using the method of Allain *et al*. (1974) and Megraw *et al*. (1979), respectively. HDL and LDL cholesterol estimation were done using the method of Gerald and Gerald (1981).

Statistical studies: Obese cases and control were matched in terms of age and sex. Tests of the Spearman (nonparametric) correlation were used to assess the association of F_2-isoprostane levels with other measurements. All data are expressed as means±SD. Differences were considered statistically significant if the p-value was 0.05 or lower (Hill, 1979).

RESULTS

Regarding the life style of obese adolescents in our study as shown in Table 1, we found that frequent drinking of soft drinks as well as fast food ingestion represented a common habit among this age group as compared with control group.

Regarding the anthropometric results we found that significant difference in weight and BMI was found among obese adolescents as compared with control group (Table 2).

Regarding the laboratory findings, significant high levels of free as well as esterified F_2- isoprostanes, total cholesterol levels, HDL cholesterol and LDL cholesterol were detected among obese adolescents as compared with control group. While significant low levels of vitamin C, vitamin E, SOD and catalase enzymes were detected among obese adolescents as compared with control group (Table 3).

Table 1: Common habits of obese adolescent life style as compared with control group

Variables	Smoking	Passive smoking	Physical activity	Fast food twice weekly	Regular ingestion of soft drinks	Sedentary lifestyle
Obese subjects (58 cases)	13 (22.41%)	39 (67.24%)	5 (8.62%)	49 (84.48%)	52 (89.66%)	48 (82.76%)
Control subjects (24 subjects)	2 (8.33%)	19 (79.17%)	16 (66.67%)	7 (29.17%)	11 (45.83%)	5 (20.83%)

Table 2: Anthropometric measurements of obese adolescents as compared with control group

Characteristic	Obese (58 cases)	Control (24 subjects)	p- value
Age (years)	12.3±0.58	12.86±1.26	-
Sex (M/F)	35/23	13/11	-
Height (cm)	155.46±10.47	158.85±9.65	-
Weight (kg)	70.85	57.53	0.002
BMI (kg m^{-2})	29.315	22.799	0.002

Table 3: Laboratory findings of obese adolescents as compared with control group

Characteristic	Obese (58 cases)	Control (24 subjects)	p-value
F_2-isoprostanes (P mol L^{-1}) Free	152.0±43	91.0±43	0.001
F_2-isoprostanes (P mol L^{-1}) Esterified	374.0±205	223.0±82	0.003
Total cholesterol (mg dL^{-1})	225.7±11.55	117.3±8.9	0.005
HDL cholesterol (mg dL^{-1})	83.5±10.24	71.9±9.65	0.05
LDL cholesterol (mg dL^{-1})	61.4±16.79	29.6±16.79	0.001
Triglycerides (mg dL^{-1})	192.0±13.9	86.45±11.95	0.001
Vitamin (E) (mg dL^{-1})	0.71±0.023	1.49±0.04	0.02
Vitamin C (mg dL^{-1})	0.575±0.035	1.52±0.05	0.02
Superoxide dismutase (µg g Hb)	1086.45±38.24	2687.35± 41.23	0.003
Catalase (K_f)	59.87±1.83	88.28±2.78	0.002

DISCUSSION

Oxidative Stress (OS) is a general term used to describe the steady state level of oxidative damage in a cell, tissue, or organ, caused by the Reactive Oxygen Species (ROS) (Morrow *et al*., 1995). There has been considerable interest in the role of oxidative stress in vascular disease as well. This interest has been driven by a wealth of data indicating that LDL oxidation is a prominent feature of atherosclerosis (Witztum and Steinberg, 1991). More recent studies have also suggested that oxidative stress is a feature of many risk factors for premature atherosclerosis, such as diabetes, (Gopaul *et al*., 1995) hypertension, (Griendling *et al*., 2000) and smoking (Morrow *et al*., 1995). Oxidative stress at the cellular level results from many factors, including exposure to alcohol, medications, trauma, cold, toxins or radiation. Oxidative stress profile is a sensitive assessment utilizing challenge substances to evaluate the body`s oxidative stress status, antioxidant reserve and interrelationship with liver detoxification. (Roberts *et al*., 2002).

In the present study estimation of the levels of free and esterified F_2-isoprostanes was taken as a marker for oxidative stress and this is agreed with Davi *et al*. (2002) they reported that the IsoPs represent a biomarker that has the potential to be of great importance in the assessment of oxidative stress. Morrow (2005) reported that the F_2-IsoPs represent the most established index of oxidative stress status *in vivo* in humans. They can be measured in human body fluids such as plasma and urine using highly precise methods.

In present study obese adolescents showed elevation of the oxidative stress profile as evident by the elevation of the levels of free and esterified F_2-isoprostanes, the low levels of vitamin C and E, SOD and Catalase enzymes, which means that systemic oxidative stress estimated in our study is related to obesity and sedentary lifestyle. These findings are agreed with Frei *et al*. (1991), they reported that systemic oxidative stress is related to smoking, diabetes and obesity in a large community-based cohort. Recently John *et al*. (2003) reported that body mass index were highly associated with systemic oxidative stress as determined by creatinine-indexed urinary 8-epi-$PGF_{2\alpha}$ levels. The effect of body mass index was minimally affected by blood glucose

and diabetes and may suggest an important role of oxidative stress in the deleterious impact of obesity on cardiovascular diseases and this is agreed with our results in this study. In contrast, adjusted analyses did not demonstrate any strong positive association with other variables, such as total cholesterol, blood pressure, or age and this is not agreed with present study as we found that there was elevation in the lipid profile regarding the total cholesterol levels as well as levels of LDL and HDL Frei *et al.* (1991). In a study by Keaney *et al.* (2003) it is reported that an association exists between increasing body mass index and increasing systemic oxidant stress (Keaney *et al.*, 2003).

In the present study 22.41% of obese adolescents were actively smokers and 67.24% were passively smokers, which means that majority of the subjects studied were exposed to cigarette smoking weather active or passive and this may explain the condition of oxidative stress among obese smokers adolescents in our study and this is agreed with Frei *et al.* (1991), they reported that there was a link between smoking and oxidative stress, cigarette smoke is replete with a number of oxidizing species capable of producing lipid peroxidation. In our study this bad habit (smoking) with obesity and sedentary lifestyle represented an effective factors of elevation of the levels of free and esterified F_2-isoprostanes and this is also agreed with study done by Morrow *et al.* (1995), they demonstrated that both plasma levels and urinary metabolites of F_2-isoprostanes (of which 8-epi-$PGF_{2\alpha}$ is a member) are increased in smokers compared with age- and sex-matched controls. In that study, plasma-free isoprostanes in smokers were ≈1.4-fold greater than in nonsmokers. Also, agreed with a study done by John *et al.* (2003), they found a 65% increase in isoprostanes as a function of smoking. So, a relation between smoking and isoprostanes as a marker of oxidative stress is well established. Regarding the prevalence of sedentary lifestyle it represented about 82.76% of obese subjects and only 20.83% of controls which is more prevalent among those less than grade 9th grade education and this is agreed with study done by Hu *et al.* (2004) they reported that the prevalence of sedentary lifestyle was inversely related to income (i.e., prevalence was highest {65.0%} for the lowest income category and lowest {48.3%} for persons in the highest income category. Prevalence also was inversely related to education and was 71.9% among persons with less than a 12th grade education, compared with 50.1% among persons with a college education.

In present study levels of vitamin C and E were low and there was an elevation in the levels of lipid profile among obese adolescents and this may be explained by Esterbauer *et al.* (1987), they stated that Vitamin E is well known to be an antioxidant factor and it was reported that lipid peroxidation of the polyunsaturated fatty acids in LDL only starts after the endogenous antioxidants such as a- and g-tocopherol, b-carotene and lycopin have been consumed, also, Chupukcharoen *et al.* (1985) reported that tissue cholesterol was increased with vitamin E deficiency. Sato *et al.* (1990), stated that vitamins E and C were reported to synergistically inhibit oxidation of LDL. Vitamins C and E are recognized to be the most readily available naturally occurring antioxidants in food, so bad food habits as well as smoking will affect their levels, this is agreed with Frei *et al.* (1989), they reported that smokers typically demonstrate reduced circulating levels of vitamin C, an important antioxidant in human plasma and this is agreed with our study as vitamin C levels was low, also, accepted with Esma *et al.* (2003) they suggested that erythrocyte antioxidants SOD and GPX and plasma non-HDL are more prone to the possible oxidant damage of acute physical exercise in chronic smokers. Obesity with sedentary lifestyle are highly associated with systemic oxidative stress, which is reflected on their health and school performance. Obese adolescents specially those with sedentary lifestyle are in need for supplementation with antioxidants specially with vitamin C and E to encounter the increased production of free radicals and to minimize the bad effects of oxidative stress produced.

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