High Dietary Calcium and Weight Regulation in Mature and Premature Rats

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Abstract

The present study was undertaken to find out a suitable dietary regime to maintain a lower prevalence of overweight or obesity by adjusting the diet components. Therefore, male albino rats were selected according to their ages and divided into two main groups, i.e., premature and mature groups. Each rat group was divided into 4 subgroups and each subgroup was fed on a diet of varied composition. Serum levels of lipids, calcium, phosphorous and testosterone were determined in addition to body weight measurement. The results indicate non-significant decrease of percentage of body weight gain in premature rats fed on high-calcium diets while significant decrease of percentage of body weight gain in mature rats fed on the same diet composition. The levels of serum HDL-C, LDL-C, triglycerides and testosterone were significantly decreased in premature rats fed high-calcium diets. In premature rats, only rat subgroup fed on high calcium from milk, showed a significant decrease in serum cholesterol levels. Calcium and phosphorus levels exhibited non-significant change between premature rats. In mature rats, HDL-C and LDL-C data demonstrate non-significant changes while cholesterol and triglyceride levels were significantly decreased in rats fed high-calcium diet compared to control. Serum testosterone levels were significantly decreased in mature rats fed low-fat diets or low fat diets supplemented with high-calcium level. In general, one would suggest to consume low fat diet (4%) supplemented with high calcium from dry skimmed milk fortified with hydroxyapatite as suitable dietary program to avoid overweight.

Key Words: Premature and mature rats – Lipid profile – Calcium – Phosphorus – Testosterone.

Introduction

OBESITY is a consequence of an energy imbalance, i.e., when energy intake exceeds energy expenditure over an extended period of time [1]. Obesity is an excess of body fat which creates an increase risk of morbidity and/or premature mortality [2]. Statistical information indicated that in the year 2000 the number of obese adults increased to 300 millions [3]. Over 22 million children under the age of 5 years were severely overweight. In addition, 155 million children of school age are obese [4]. Obesity has reached epidemic proportions in developed countries and rapidly increasing in many middle income and less developed countries [5]. Overweight prevalence among youth is increasing and become a problem among Egyptian youth [6]. In Egypt, studies reported that the prevalence of overweight is 16% in the general population [7], 13% in a sample of adolescent girls and 8.6% in children <6 years of age [8].

Obesity is a complex state with genetic, metabolic, behavioral and environmental factors all contributing to its development. However, the dramatic increase in the prevalence of obesity in the past few decades can only be due to significant changes in lifestyle influencing children and adults [9]. Overweight and obesity are strongly associated with certain types of diets, such as processed foodstuffs that contain large amounts of fat [5].

Overweight and obesity lead to adverse metabolic effects on blood pressure, cholesterol, triglycerides and insulin resistance. In addition to range of non-fatal health problems associated with obesity, which include respiratory difficulties, chronic musculoskeletal problems, skin problems and infertility [10].

The cardiovascular risk factors are well known to be associated with obesity in adults. Also, obesity in children and adolescents is associated with hypertension, dyslipidaemia, abnormalities in left ventricular mass and/or function, abnormalities in endothelial function, and hyperinsulinaemia/insulin resistance [11].
People who suffer from overweight or obesity usually follow a dietary system restricting or preventing fats intake. This point is crucial for obese or overweight adolescents who follow a fat restricting dietary system because fats are the main precursor of steroid hormones so low fat intake may affects sex steroid levels and affects puberty [12].

Epidemiologic studies demonstrate an association between dietary calcium intake and obesity. Schrager [13] suggested that people with high calcium intake have a lower prevalence of overweight. Low calcium intake has been identified as a potential contributing factor to obesity [14]. Low levels of dietary calcium and dairy products increased the risk of hypertension and insulin resistance syndrome [15,16].

Studies in transgenic mice demonstrate that calcium influences adipocyte metabolism [17]. High-calcium intake depresses levels of parathyroid hormone and 1, 25-hydroxy vitamin D. The decreased in parathyroid hormone level lead to decreases in intracellular calcium, thereby inhibiting lipogenesis and stimulating lipolysis [17,18]. High dietary calcium intake increases excretion of fecal fat [19]. Calcium from dairy products is suggested to affect weight loss more than calcium derived from dietary supplements [20].

The present study was undertaken to find out a suitable dietary system to maintain a lower prevalence of overweight or obesity by adjusting the components of diet. Hence, premature and mature rats were fed on a diet of varied composition and supplemented with calcium of different levels and sources. In order to envisage the role of diet of varied components on rat weight, some parameters were performed on rat sera such as lipid profile, phosphorus, calcium and testosterone.

**Material and Methods**

I- Nutritional experiments:

A total number of 80 male Swiss albino rats were obtained from National Organization for Drug Control And Research (NODCAR) in Giza. Animals were kept in wire cages at animal house of radio isotopes department in Dokki during April 2011, with controlled temperature (26-32°C), a 12h light-dark cycle and relative humidity (60-70%). Food and water were supplied ad-libitum for 6 weeks. The animals were divided into two main groups according to their ages, i.e., premature group consists of 40 male rats <2 months age with 85.8±5g body weight and mature group comprises of 40 male rats >4 months age with 200±10g body weight. Each rat group was randomly divided into 4 subgroups; each subgroup consists of 10 rats. The rat subgroups were: control; Fed on a balanced diet; sub group 1 (SG1): Fed on a low-fat diet (4% fat); sub group 2 (SG2): Fed on a low-fat diet (4% fat), and high-calcium (1.8%) from calcium citrate; sub group 3 (SG3): Fed on a low-fat diet (4% fat) and high calcium (1.8%) from dry skimmed milk fortified with hydroxyapatite obtained from Sigma Aldrich company (Germany). Rat basal diet was formulated according to A.O.A.C. [21]. The compositions of the vitamin and salt mixtures used were similar to that reported by A.O.A.C. [21] and Reeves et al. [22] respectively.

II- Diet:

Diet composition (%) of different rat subgroups is shown in Table (1).

III- Blood sampling:

Rat blood samples were collected twice, at the beginning and at the end of experimental period. The first blood samples were collected from inner Canthus of rat eye done by non-heparinized capillary tubes then centrifuged at 3000 r.p.m for 15 minutes and sera were frozen at –8°C. Second blood samples were collected from animal hearts after anesthesia and sacrificing at the end of the 6th week.

IV- Determination of lipid profile, phosphorus, calcium and testosterone of rat sera:

Serum calcium and phosphorous levels were determined using the methods of [23,24], respectively. Triglyceride and total cholesterol levels were determined according to [25,26], respectively. Low and High-density lipoprotein-cholesterol (LDL-C and HDL-C) were determined using the methods of [27,28], respectively. Testosterone level was determined using solid-phase radioimmunoassay procedure [29] through the use of commercial kit purchased from Siemens (USA).

Statistical analysis:

Statistical analysis was carried out on the results concerning the independent rat samples of each parameter. Analysis of variance and least significant differences (LSD) tests were used to allow comparison between the mean values of the studied parameters using SPSS 17.0 software.

**Results**

A- Serum lipids:

a- Total cholesterol level:

Rat serum cholesterol levels of premature subgroups are shown in Table (2). The results demon-
strate that there were insignificant changes except premature rat SG3 group which showed a significant decrease in serum cholesterol level. On the contrary, significant decrease in cholesterol level was found in SG1, SG2 and SG3, respectively in mature subgroups compared with control rat group.

b- Triglyceride level:

Serum triglyceride level of premature rat group showed a significant decrease in SG3, SG1 and SG2, respectively as compared with control rat group (Table 2 and Fig. 1). In mature rat group, a significant decrease was evident in SG3 as compared with control rat group and rat subgroups 1 and 2 (Table 3 and Fig. 1).

c- Serum high density lipoprotein cholesterol (HDL-C) level.

Serum HDL-C levels in premature rat groups SG2, SG3 were significantly decreased as compared with control and SG1. The levels of HDL-C of SG1 rat group was significantly decreased as compared with control rat group (Table 2). On the other hand, insignificant changes were noticed in mature rat group (Table 2).

d- Serum low density lipoprotein cholesterol (LDL-C) level.

Rat serum LDL-C levels in premature rat groups were significantly decreased in SG3 as compared with control and SG1, while SG2 showed significant decrease in LDL-C as compared with SG1 rats (Table 2). On the other hand, insignificant changes were observed in rat mature group (Table 2).

B- Body weight as a function of low-fat diet and high-calcium supplementation

The weight of the two main rat groups were increased in weight but the % increase was variable. For instance, the rat subgroups consumed diet of high-calcium elicits less % increase than other rat subgroups. In premature rat subgroups, the % increase of SG2 and SG3 were near or close to % increase of control rat group (Table 3). On the other hand, insignificant changes were observed in rat mature group (Table 3).

C- Serum testosterone level:

The decrease of testosterone levels for premature and mature rat groups was significant as compared with each control rat (Table 4 and Fig. 2). A greater decrease of testosterone level in SG3 than other groups (SG1, SG2 and control) was recorded (Table 4).

D- Serum calcium:

Serum calcium level showed insignificant changes in premature rat group. In contrast serum calcium revealed a significant increase in SG2 mature rat compared with control rat group (Table 4).

E- Serum phosphorus:

The results indicate non-significant difference in phosphorus level of premature rat group. On the other hand, mature rat group elicited significant decrease in phosphorus level in SG2 and SG3 compared with control rat group and SG1 (Table 4 and Fig. 3).

Generally speaking and as shown in Table (5), in premature rat groups, Ca level showed non-significant correlation with testosterone, cholesterol, triglycerides, phosphorus and HDL-C. Calcium induced a negative significant correlation with LDL-C. Also, cholesterol level possessed non-significant correlation with testosterone and all other parameters. Triglycerides level exhibited a positive significant correlation with testosterone and HDL-C contents. In mature rat group as shown in Table (6), calcium data demonstrated non-significant correlation with testosterone, cholesterol, phosphorous, HDL-C, triglyceride and LDL-C levels. Cholesterol level illustrated positive significant correlation with testosterone and significant correlation with phosphorous. Triglyceride level showed a positive significant correlation with testosterone and cholesterol. HDL-C level exhibited a non-significant correlation with testosterone content. While, LDL-C level induced a non-significant correlation with cholesterol content. All correlations were studied using SPSS 17.0 software.

Table (1): Diet composition (%) of experimental rats.

<table>
<thead>
<tr>
<th>Component</th>
<th>Control</th>
<th>Subgroup 1</th>
<th>Subgroup 2</th>
<th>Subgroup 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proteins</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>18.7</td>
</tr>
<tr>
<td>Fats</td>
<td>10</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>60</td>
<td>66</td>
<td>60.75</td>
<td>54.8</td>
</tr>
<tr>
<td>Cellulose</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Minerals</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Vitamins</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Calcium citrate</td>
<td>–</td>
<td>–</td>
<td>5.25</td>
<td></td>
</tr>
<tr>
<td>Dry skimmed milk</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>10</td>
</tr>
<tr>
<td>Hydroxyapatite</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2.5</td>
</tr>
</tbody>
</table>
Table (2): Lipid profile of premature and mature rat subgroups.

<table>
<thead>
<tr>
<th>Rat subgroup</th>
<th>Premature rats</th>
<th>Mature rats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cholesterol (mg/dl)</td>
<td>Triglycerides (mg/dl)</td>
</tr>
<tr>
<td>Control</td>
<td>79.0 ±4.3</td>
<td>140.0 ±5.7</td>
</tr>
<tr>
<td>SG1</td>
<td>75.4 ±3.3</td>
<td>120.9 ±6.3</td>
</tr>
<tr>
<td>SG2</td>
<td>77.7 ±3.2</td>
<td>118.9 ±4.5</td>
</tr>
<tr>
<td>SG3</td>
<td>69.2 ±2.4</td>
<td>109.7 ±5.5</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>9.19</td>
<td>16.5</td>
</tr>
</tbody>
</table>

SG refers to rat subgroup. The data (value ± SE) are the mean values of three measurements for the same sample. Means with each column followed by the same letter are not significantly different.

Table (3): Changes in body weight of different premature and mature rat subgroups.

<table>
<thead>
<tr>
<th>Rat subgroup</th>
<th>Premature rats</th>
<th>Mature rats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial weight (g)</td>
<td>Final weight (g)</td>
</tr>
<tr>
<td>Control</td>
<td>84.4 ±2.1</td>
<td>255.4 ±7.1</td>
</tr>
<tr>
<td>SG1</td>
<td>83.0 ±2.2</td>
<td>250.2 ±3.4</td>
</tr>
<tr>
<td>SG2</td>
<td>81.3 ±3.4</td>
<td>240.6 ±8.3</td>
</tr>
<tr>
<td>SG3</td>
<td>89.4 ±2.6</td>
<td>249.7 ±1.7</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>8.3</td>
<td>17.36</td>
</tr>
</tbody>
</table>

SG refers to rat subgroup. The data (value ± SE) are the mean values of three measurements for the same sample. Means with each column followed by the same letter are not significantly different.

Table (4): Testosterone, phosphorus and calcium levels in sera of premature and mature rat subgroups.

<table>
<thead>
<tr>
<th>Rat subgroup</th>
<th>Premature rats</th>
<th>Mature rats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Testosterone (ng/dl)</td>
<td>Phosphorus (mg/dl)</td>
</tr>
<tr>
<td>Control</td>
<td>224.1 ±47.2</td>
<td>10.8 ±0.7</td>
</tr>
<tr>
<td>SG1</td>
<td>139.0 ±10.8</td>
<td>11.0 ±0.4</td>
</tr>
<tr>
<td>SG2</td>
<td>134.9 ±10.9</td>
<td>10.6 ±0.4</td>
</tr>
<tr>
<td>SG3</td>
<td>76.0 ±3.1</td>
<td>11.6 ±0.5</td>
</tr>
<tr>
<td>LSD 5%</td>
<td>7.35</td>
<td>1.59</td>
</tr>
</tbody>
</table>

SG refers to rat subgroup. The data (value ± SE) are the mean values of three measurements for the same sample. Means with each column followed by the same letter are not significantly different.

Table (5): Correlation between calcium, phosphorous, testosterone and lipid profile parameters in premature rats.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Testosterone Pearson Correlation</td>
<td>1</td>
<td>−116</td>
<td>.044</td>
<td>.356</td>
<td>.602**</td>
<td>.679**</td>
<td>.394</td>
</tr>
<tr>
<td>Phosphorous Pearson Correlation</td>
<td>−116</td>
<td>1</td>
<td>−.207</td>
<td>.427</td>
<td>−.124</td>
<td>−.027</td>
<td>.038</td>
</tr>
<tr>
<td>Calcium Pearson Correlation</td>
<td>.044</td>
<td>−.207</td>
<td>1</td>
<td>.098</td>
<td>.135</td>
<td>−.144</td>
<td>−.476*</td>
</tr>
<tr>
<td>Cholesterol Pearson Correlation</td>
<td>.356</td>
<td>.427</td>
<td>.098</td>
<td>1</td>
<td>.293</td>
<td>.280</td>
<td>.220</td>
</tr>
<tr>
<td>Triglyceride Pearson Correlation</td>
<td>.602**</td>
<td>−.124</td>
<td>.135</td>
<td>.293</td>
<td>1</td>
<td>.573 **</td>
<td>.328</td>
</tr>
<tr>
<td>HDL-C Pearson Correlation</td>
<td>.679**</td>
<td>−.027</td>
<td>−.144</td>
<td>.280</td>
<td>.573 **</td>
<td>1</td>
<td>.463 *</td>
</tr>
<tr>
<td>LDL-C Pearson Correlation</td>
<td>.394</td>
<td>.038</td>
<td>−.476*</td>
<td>.220</td>
<td>.328</td>
<td>.463 *</td>
<td>1</td>
</tr>
</tbody>
</table>

**Correlation is significant at 0.01 level.
*Correlation is significant at 0.05 level.
Table (6): Correlation between calcium, phosphorous, testosterone and lipid profile parameters in mature rats.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control SG1 SG2 SG3</td>
<td>1</td>
<td>-0.583**</td>
<td>-0.220</td>
<td>-0.207</td>
<td>0.630**</td>
<td>0.286</td>
<td>-0.150</td>
</tr>
<tr>
<td>Control SG1 SG2 SG3</td>
<td>-0.207</td>
<td>1</td>
<td>-0.424</td>
<td>-0.274</td>
<td>-0.473**</td>
<td>-0.128</td>
<td>-0.134</td>
</tr>
<tr>
<td>Control SG1 SG2 SG3</td>
<td>-0.424</td>
<td>0.630**</td>
<td>0.1</td>
<td>-0.134</td>
<td>-0.207</td>
<td>-0.099</td>
<td>-0.190</td>
</tr>
<tr>
<td>Control SG1 SG2 SG3</td>
<td>0.1</td>
<td>0.274</td>
<td>0.286</td>
<td>0.134</td>
<td>1</td>
<td>0.060</td>
<td>0.009</td>
</tr>
<tr>
<td>Control SG1 SG2 SG3</td>
<td>0.630**</td>
<td>-0.207</td>
<td>1.0</td>
<td>0.134</td>
<td>0.630**</td>
<td>0.060</td>
<td>1.0</td>
</tr>
<tr>
<td>Control SG1 SG2 SG3</td>
<td>0.286</td>
<td>-0.134</td>
<td>0.286</td>
<td>0.134</td>
<td>1.0</td>
<td>0.060</td>
<td>1.0</td>
</tr>
</tbody>
</table>

** Correlation is significant at 0.01 level.  * Correlation is significant at 0.05 level.

Discussion

The non-significant decrease in % of body weight elicits an increase of premature rat subgroups fed on a high dietary calcium and this case may be due to the maturation period which is characterized with maximum growth rates, maximum calcium utilization, maximum protein utilization and maximum bone growth [30].

Growing evidence supports a relationship between increasing calcium intake and reductions in body weight specific to fat mass [31]. The lowering effect of high-calcium diets on body weight in mature rats shown in the present study agreed with the results of Petrov and Lijnen [32] and Sun and Zemel [33]. There are two main physiological mechanisms proposed to explain how calcium intake can affect body weight or body fat. The first is that the high dietary calcium intake suppresses the levels of parathyroid hormone (PTH) and 1,25-dihydroxy vitamin D, thereby causing lower levels of intracellular calcium and inhibiting lipogenesis and stimulating lipolysis [17,18]. Therefore, calcium intake may directly affect whether adipocytes store or break down fat. The second proposed mechanism by which calcium may impact body weight is that increased dietary calcium seems to bind more fatty acids in the colon and inhibit fat absorption. Welberg et al. [34] showed that calcium supplementation increased the percentage of excretion of total fat as related to fat intake. On the contrary, Zhang and Tordoff [35] data disagreed with the present results.

Animals supplemented with high calcium in milk in the present work induced the greatest lowering effect on body weight, which is in agreement with the findings of Fried et al. [36]. Dairy sources of calcium markedly attenuate weight and fat gain and accelerate fat loss to a greater degree than do supplemental sources of calcium. This augmented effect of dairy products relative to supplemental calcium is likely due to additional bioactive compound, including the angiotensin-converting enzyme inhibitors and the rich concen-
tration of branched-chain amino acids in whey [13,37] and milk phospholipids which act as synergistic effect with calcium absorption bioavailability and utilization [38-40].

Serum calcium level showed non-significant changes in premature rat group, and this finding agreed with Kruger et al. [41] who mentioned that bioavailability of calcium is equivalent from milk fortified either with calcium carbonate or milk calcium (hydroxyapatite) in growing rats. While in mature rat group, SG2 serum calcium revealed a significant increase compared to control, SG1 and SG3 subgroups, and these data agreed with the results of Kochanowski [42] and Weaver et al. [43].

Testosterone, the main sex hormone in males, plays an important role in body like regulation of gene expression and male sex traits. So it was important to study the hypolipidemic effect of calcium and the levels of testosterone especially in premature rat subgroups. In the present study, all rat subgroups whether mature or premature showed a significant decrease in serum total testosterone. The diet containing low-fat or calcium supplemented subgroups induced the greatest decrease of total testosterone in SG3 followed by SG2 then SG1. These results are in line with the hypolipidemic effect of high-calcium supplementation or low-fat diets. This significant decrease in serum total testosterone can be interpreted as a result of lowered serum lipids due to administration of low-fat diets or high-calcium diets since lipids (cholesterol) are the precursor of steroid sex hormones. In addition, the high calcium supplementation from milk subgroups possessed the lowest serum testosterone levels and that might be alarming especially for premature males. The great decrease of testosterone in milk rat subgroups agreed with the data of Maruyama et al. [44] who reported that this decrease might stem from that milk contains large amounts of estrogens and progesterone while the decrease in testosterone found in the present study can be related to the hypolipidemic effect of high calcium supplementation.

Concerning serum total cholesterol, its level showed a significant decrease in premature SG3 rats which agreed with the findings of Malekzadeh et al. [45]. While the insignificant change of cholesterol in premature SG2 rats although feeding on high-calcium diet, might be due to the rapid growth rates of premature rats in which most of calcium is principally used in bone building at the expense of the hypocholesteremic effect of calcium. Therefore, the available calcium is not adequate to cause the hypocholesteremic effect. The calcium results that illustrate non-significant change on cholesterol level in premature rats which agreed with data of Shahkhalili et al. [19]. On the other hand, the significant decrease in mature subgroups SG1, SG2 and SG3 agreed with the findings of Malekzadeh et al. [45], Shalileh et al. [46] and Shidfar et al. [47] and disagreed with work of Zhang and Tordoff [35], Reid [48] and Jacobsen et al. [49].

The biological interpretation for a cholesterol lowering effect is that calcium is known to bind to bile acids to form insoluble soaps and thus presumably prevent cholesterol entering into the enter hepatic circulation [19,50]. A study found that a calcium supplementation induced lowering cholesterol levels in rats, rabbits, and goats but not in pigs and associated with an increase in the excretion of fecal bile acids in most but not all studied animals. In addition, this effect was more pronounced when the diet contains higher proportions of saturated fats [51]. Increased fecal loss of fat, especially saturated fatty acids (SFAs) is important because SFAs tend to increase serum cholesterol levels when absorbed.

Serum triglyceride level of premature rats showed a significant decrease in SG3, SG1 and SG2. The significant decrease of serum triglycerides in premature SG1 was expected due to feeding on a low-fat diet and also in premature rat subgroups SG2, SG3 due to the lipolytic effect of high-calcium diet [52,53]. In mature rats SG3, triglyceride level was significantly decreased. SG3 in both, premature and mature rats fed on high-calcium from milk had the greatest lowering effect on serum triglycerides which agreed with the work of Shalileh et al. [46] and disagreed with the findings of Malekzadeh et al. [45] and Shidfar et al. [47].

Serum LDL-C in premature rat subgroups fed on high-calcium from milk or calcium citrate showed a significant decrease compared to control rats and low-fat subgroups respectively. This finding agreed with the results Malekzadeh et al. [45] and Shalileh et al. [46] while in mature rat subgroups possessed non-significant change in this parameter.

In present study, premature rat subgroups; SG1, SG2 and SG3 induced a significant decrease of HDL-cholesterol level. These results agreed with Kirkland et al. [54] who reported that levels of HDL-C cholesterol in males decreased during adolescence. HDL-C showed a positive significant correlation with endogenous levels of testosterone which agreed with Freedman et al. [55]. On the
other hand, insignificant decreases were observed in HDL-C in SG2 and SG3 mature rats which agreed with Malekzadeh et al. [45].

Calcium and phosphorus homeostasis relies on a complex, tightly regulated system involving many ions and hormones. The regulation of calcium and phosphorus is controlled by the actions of these ions and hormones on the intestine, kidneys and bone [56]. In the present study, premature rat groups showed non-significant differences in serum phosphorus levels which come in harmony with the data of serum calcium levels in the premature rat groups. Also, this result can be interpreted in calcium/phosphorus homeostasis view. On the other hand, in mature rat group, the SG3 showed the greatest significant decrease of serum phosphorus levels. Also, this result can be interpreted in calcium/phosphorus homeostasis view. This might be interpreted in calcium/phosphorus homeostasis view.

Conclusion:

Consuming safe amounts of calcium about (1100-2500mg Ca/day) from 3-6 cups of yogurt or milk can be a suitable dietary regime to avoid overweight. Applying such regime on premature subjects may need further studies to be confirmed.

References


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