Effects of Nutritional and Dietary Supplements on Renal Function Among University Bodybuilders in Ghana

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ABSTRACT

Despite the widespread use of bodybuilding supplement among University bodybuilders, the potential negative health impact that these supplements (creatine, whey, amino acids) can pose on organs, mainly kidney, remains unclear among this population in Ghana. Hence, the study assessed the plasma levels of creatinine, urea and uric acid among male bodybuilders in KNUST, Ghana, as a measure of renal function. 78 undergraduate students forming three test groups (26 Bodybuilders on supplements for the past 12 months, 25 Bodybuilders not on supplements and 27 non-bodybuilders) were randomly selected for the study. Questionnaires were administered to obtain background information on Bodybuilding and on dietary intake. Also, venous blood samples were analysed for 3 endogenous markers - creatinine, urea and uric acid and compared to normal ranges. Elevated levels of uric acid were found among all Bodybuilders (supplement users (470.9 ± 71.89μmol/L) and non-supplement users (436.1 ± 69.78μmol/L)) (p<0.001). Though creatinine levels of bodybuilders were within normal range, higher levels were recorded for bodybuilders on supplement (91.93 ± 10.40μmol/L). Frequency of consumption of protein-rich foods were significantly higher among Bodybuilders (p=0.04) and mean urea levels (4.61±0.8μmol/L) were within normal range with no significant difference among all participants (n=78) (p=0.009). The study suggests that creatine and other nutritional supplements may have caused elevated levels of uric acid among bodybuilders on supplements. Possible association between endogenous markers of renal function and unique patterns of dietary intake among this population has also been identified.

Keywords: Bodybuilders; nutritional supplements; creatinine; renal function; GFR; endogenous markers; University students

1. INTRODUCTION

Over the past decade bodybuilding has become an integral part of the physical development process especially among university students. While most people take nutritional supplements simply as part of a healthy lifestyle, important motivations for others include ensuring nutritional adequacy, gain self-confidence, have a change in physique, look
more attractive, gain attention and enhance physical performance. The growth of the sport has led to the increment in the use of creatine as supplement since it gained widespread popularity in the early 1990’s\(^1\). Out of the very few studies conducted on prevalence rates among university students, almost all have recorded higher prevalence of consumption among university athletes especially in male populations. A study conducted among student athletes in Isfahan University of Medical Sciences revealed a prevalence rate of 49%\(^2\). Several studies have also indicated some adverse effects of nutritional supplements usage, including cardiovascular, haematological, metabolic, and neurological problems\(^3,4,5\), whereas there is little scientific data that confirms the advantageous effects of nutritional supplements in athletes\(^6\), much less evidence is also available describing and linking these effects to nutritional supplements. Among athletes, bodybuilders are predisposed to the use of supplements compared to other sportsmen\(^7\). Latterly, this idea has been raised in Ghanaian youth and adolescent bodybuilders especially among university students. Body image has necessitated many to rely on different types and brands of products including hormonal injections, amino acids, β-hydroxy-methylbutyrate, creatine-monohydrate, botanical products and their concentrates and extracts among others, characterized by a change in dietary pattern. Creatinine is a waste product produced by the spontaneous, irreversible dehydration of body creatine phosphate from muscle metabolism\(^8\) and its serum concentration is widely interpreted as a measure of glomerular filtration rate (GFR); serving as an index of renal functioning in clinical practice. It is suggested that prolonged use of creatine and other nutritional supplements is nephrotoxic and thus, detrimental\(^1\). According to the World Health Organization\(^9\), 21,000 children less than four years were killed by Kidney and Urinary Tract Diseases. 13,000 children within five to 13 years lost their lives through kidney failure and 45,000 people with age group between 15 and 29 suffered from chronic kidney diseases (CKDs). In this report, modifiable factors were considered to include lifestyle and dietary intake. The potential negative health impact bodybuilding supplements can pose on organs, mainly kidney is unclear\(^10\) especially among university students in Ghana. Increasingly, more university bodybuilders are taking creatine and other nutritional supplements for longer periods\(^2\). As the usage of supplements has become widespread, Information remains scanty and warning them about the effects must be taken seriously. Based on the biochemical and physiological action of nutritional supplements, this study aims to assess the levels of three endogenous markers of renal function among university bodybuilders in Ghana. Specifically, to determine plasma levels of creatinine, uric acid and urea among bodybuilders consuming creatine and other nutritional supplement in Ghana.

2. METHOD

This study was a cross sectional study conducted between February 2017 and April, 2017 at Kwame Nkrumah University of Science and Technology, a tertiary institution with about 30000 undergraduate students located in Kumasi, Ghana. 219 participants were selected randomly from the institution. In all a total of 78 students forming three test groups (26 Bodybuilders on supplements for the past 12 months, 25 Bodybuilders not on supplements and 27 non-Bodybuilders) met the inclusion criteria and gave their consent to participate in the study. An approved research information leaflet form was provided to prospective participants to decide if they would like to be part of the study. Participants were required to sign the written consent form, which was documented systematically using code numbers. Healthy males above eighteen years with no medical or pathological conditions who gave their consent were included in this study.

A detailed questionnaire was then used to collect background information of subjects through interviews. Questionnaire also captured information about Bodybuilding, health, lifestyle and nutritional and dietary management. All consented participants were invited to the Clinical Analysis Laboratory (CANLAB) of the Department of Biochemistry and Biotechnology, KNUST for physical examination (anthropometric measurements) and donation of blood sample. The study was approved by the Committee on Human Research Publication and Ethics (CHRPE) of the School of Medical Sciences, KNUST and Komfo Anokye Teaching Hospital.

**Anthropometric Measurement**

All measurements were conducted using the International Society for Anthropometry and Kinanthropometry (ISAK) protocol. Weight (kg) was taken on calibrated load scales (Advasco Scales Ltd., Auckland, New Zealand) without shoes or extraneous clothing. Height (m) was taken as a freestanding height measurement on a stadiometer (University of Auckland, Grafton Campus) without shoes. Two values each of both height and weight were measured.
and the average was recorded. The Body Mass Index (BMI (kg/m²)) of each participant was calculated using the equation: [weight (kg)/height squared (m²)].

### Assessment of Endogenous Markers

Venous blood (5 ml) was collected from each subject via venepuncture and the serum was separated. The separated serum was analysed for endogenous markers of renal function -Urea, Uric acid and Creatinine using methods designed by Randox Laboratory Limited, United Kingdom.

### Data Analysis

Data analysis of results from laboratory analysis was done using SPSS software version 20.0 (SPSS Inc., Chicago IL, USA). The ranges below were adopted as standards to determine if values obtained were within normal levels or not. Creatinine: 53 – 125(μmol/L), Urea: 1.7 – 8.3(μmol/L), Uric Acid: 202 – 416(μmol/L) (Randox Laboratory Limited, 2011). Where necessary, analysis was stratified by supplement use or controlled for possible confounders. One-way ANOVA was used to determine the significance of means and standard deviation of measured variables between all three test groups. Chi-square test was used to compare means and standard deviations of the mean values of endogenous markers and reference values.

### 3. RESULTS

#### Descriptive characteristics of study population

Seventy-eight participants took part in the study. 26 (33%) were bodybuilders on supplement, 25 (32%) bodybuilders not on supplement and 27 (35%) non-bodybuilders. Study participants were from 18-27 years old with mean age of 23 (±0.90) years with no significant difference among them (p = 0.170) (Table 1). All participants were non-smokers, 12 (15%) drank alcohol, 53 (68%) skipped breakfast frequently and thirty-six (46%) participants engaged in at least 20min of morning exercise daily; This was higher among bodybuilders (n=51) (61%) than non-bodybuilders (19%) (p = 0.04). Average weight and height of study participants was 76.5(±1.22) and 1.78(±0.15) respectively which did not vary significantly among all three groups (p> 0.05) though mean values obtained for bodybuilders were slightly higher than non-bodybuilders (Table 1). There was a significant difference in mean BMI values among the test groups (p = 0.048) with a mean value of 24.15 kg/m2 (±0.25) and values ranging from 20.0 kg/m2 - 26.9 kg/m2. Among bodybuilders on supplements (n = 26), 37% consumed <5g, 48% consumed 6-10g and 13% and 2% consumed 11-15g and 16-20g of supplements respectively per day. Supplement was consumed singly and in different combinations. 40% of supplement users consumed Creatine only, Herbalife® (10%), Protein and amino acids (10%), Creatine, protein and Herbalife (10%), Amino acids (2%), Creatine and Whey (8%), Protein only (10%) and Whey only (10%). Measured plasma levels of Urea, Creatinine and Uric acid ranged from 3 – 6.75(μmol/L), 60.60 – 118.90(μmol/L) and 84.0 – 606.0(μmol/L) respectively among all participants.

#### Table 1. Descriptive characteristics of participants among study groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bodybuilders on supplement</th>
<th>Bodybuilders not on supplement</th>
<th>Non-Bodybuilders</th>
<th>Total value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Participants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drink alcohol</td>
<td>26 (33%)</td>
<td>25 (32%)</td>
<td>27 (35%)</td>
<td>78 (100%)</td>
<td>0.18</td>
</tr>
<tr>
<td>Skip breakfast</td>
<td>18 (69%)</td>
<td>15 (60%)</td>
<td>20 (74%)</td>
<td>53 (68%)</td>
<td>0.72</td>
</tr>
<tr>
<td>10min morning exercise/day</td>
<td>13 (50%)</td>
<td>18 (72%)</td>
<td>5 (19%)</td>
<td>36 (46%)</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Participants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td>23.4 ± 1.02</td>
<td>22.9 ± 0.99</td>
<td>22.6 ± 0.60</td>
<td>23.0 ± 0.90</td>
<td>0.170</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>77.4 ± 1.03</td>
<td>76.3 ± 1.61</td>
<td>74.8 ± 0.99</td>
<td>76.5 ± 1.22</td>
<td>0.150</td>
</tr>
<tr>
<td><strong>Height (m)</strong></td>
<td>1.74 ± 0.22</td>
<td>1.79 ± 0.14</td>
<td>1.80 ± 0.09</td>
<td>1.78 ± 0.15</td>
<td>0.230</td>
</tr>
<tr>
<td><strong>BMI (kg/m2)</strong></td>
<td>25.56 ± 0.41</td>
<td>23.81 ± 0.12</td>
<td>23.09 ± 0.21</td>
<td>24.15 ± 0.25</td>
<td>0.048</td>
</tr>
<tr>
<td><strong>Urea (μmol/L)</strong></td>
<td>4.97 ± 0.94</td>
<td>4.92 ± 0.94</td>
<td>3.89 ± 0.39</td>
<td>4.61 ± 0.81</td>
<td>0.009</td>
</tr>
<tr>
<td><strong>Creatinine (μmol/L)</strong></td>
<td>91.93 ± 10.40</td>
<td>85.93 ± 15.57</td>
<td>80.51 ± 16.93</td>
<td>86.24 ± 14.81</td>
<td>0.057</td>
</tr>
<tr>
<td><strong>Uric acid (μmol/L)</strong></td>
<td>470.9 ± 71.89</td>
<td>436.1 ± 69.78</td>
<td>294.7 ± 87.76</td>
<td>402.2 ± 77.10</td>
<td>0.012</td>
</tr>
</tbody>
</table>

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Dietary assessment of participants
The different kinds of protein-rich foods consumed by study subjects included Chicken, fish, egg, pork, beans and soya beans (figure. 1). Chicken, fish, egg and beans were mostly consumed, usually once or twice in a day. Pork and soya bean were least consumed. There was significant difference in the types and quantities of protein-rich foods consumed among all participants (p=0.013). Tukey post hoc analysis revealed the mean consumption of these foods were significantly higher among Bodybuilders (p=0.04). Overall very common foods such as Chicken and egg were consumed once daily.

Chi-square analysis of the mean levels of the endogenous markers among the test groups against reference values
Elevated levels of uric acid were found among all bodybuilders compared to the normal values (p<0.001); this was higher among those on supplement (470.9 ± 71.89) compared to those not on supplement (436.1 ± 69.78) (Table 2). Though there was no significant difference in creatinine values compared to the reference value (p=0.051), mean creatinine levels was higher among bodybuilders on supplement (91.93 ± 10.40). Urea levels remained relatively constant in the two groups (Table 2).

Table 2: Mean levels of the endogenous markers among Bodybuilders (n = 51)
4. DISCUSSION

In this study, the aim was to assess the plasma levels of creatinine, urea and uric acid among male bodybuilders in a university as a measure of their renal function. Nutritional contributions to these endogenous markers was not left out as some foods such as chicken, milk, egg, fish and other nutritional supplements such as protein, creatine, whey and amino acids have been implicated in most studies regarding kidney function especially among Bodybuilders\(^{(11)}\).

Among bodybuilders in this study, very rich protein foods such as Chicken, egg, beans and fish were most consumed and in higher proportions. The primary role of dietary proteins is for use in the various anabolic processes of the body. According to the National Kidney Foundation, eating too much protein, and thus exceeding, may 'stress' kidney and contribute to pre-existing kidney problems. Dietary protein intake can modulate renal function and its role in renal disease has spawned an on-going debate in the literature. At the centre of the controversy is the concern that habitual consumption of dietary protein in excess of recommended amounts promotes chronic renal disease through increased glomerular pressure and hyperfiltration\(^{(12)}\). The relationship between dietary protein and renal function has been studied for over half a century\(^{(11)}\). Addis and Drury\(^{(13)}\) were among the first to observe a relationship between level of dietary protein and rates of urea excretion. Soon after, it was established that increased protein intake elevated rates of creatinine and urea excretion in the dog model. The common mechanism underlying the increased excretion rates was eventually attributed to changes in GFR. Clearly, dietary protein effects the glomerular filtration rate (GFR) with both acute and chronic increases in protein consumption elevating GFR\(^{(14)}\). Although excessive protein intake remains a health concern in individuals with pre-existing renal disease, the literature lacks significant research demonstrating a link between protein intake and the initiation or progression of renal disease in healthy individuals. This study could not tell whether protein intake among this population was above the recommended daily intakes. Hence, no clear link was identified though higher consumption rates were identified among this population.

Since muscular exercise requires much energy with resultant perspiration coupled with the osmotic properties of creatinine and proteins by actively inducing water intake by the cells\(^{(15)}\), bodybuilders have a higher water intake requirement to replenish what is lost during exercise. Bodybuilders \((n=51)\) consumed a considerable amount of water after workout sessions with significant differences \((p =0.048)\) among the study groups causing urinary excretion rates to increase as well (Table 1). This could possibly result from the faster glomerular filtration rate (GFR) to remove waste products of protein and other supplement metabolism.

A major cause of kidney impairment is the overconsumption of a particular dietary ingredient\(^{(11)}\) and therefore the Recommended Daily Allowance (RDA) of such ingredient must be taken into consideration. In a study conducted by Harris et al.\(^{(16)}\) to ascertain what regimen of supplementation would produce the greatest increase in total creatine in the blood, they found out that 5 g of creatine, increased plasma concentration to 795 \(\mu\text{mol/L}\), whereas a 1 g dose only “produced a modest rise”. Among bodybuilders on supplement, creatine was the most consumed and in different combinations due to its serving as a major means of energy storage\(^{(17)}\). In this study, about 63% of creatine supplement users exceeded the RDA level. Uric acid is the final oxidation product of purine metabolism and is renally excreted. Mean levels of uric acid varied significantly among the three test groups \((p = 0.012)\) (Table 1). In comparing uric acid values among bodybuilders with

<table>
<thead>
<tr>
<th>Variable</th>
<th>Min.</th>
<th>Max.</th>
<th>Bodybuilders on supplement</th>
<th>Bodybuilders not on supplement</th>
<th>Reference value ((\mu\text{mol/L}))</th>
<th>p-value (x2-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uric acid ((\mu\text{mol/L}))</td>
<td>84</td>
<td>606</td>
<td>470.9 ± 71.89</td>
<td>436.1 ± 69.78</td>
<td>202 – 416</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Urea ((\mu\text{mol/L}))</td>
<td>3.12</td>
<td>6.75</td>
<td>4.97 ± 0.94</td>
<td>4.92 ± 0.94</td>
<td>1.7 – 8.3</td>
<td>0.190</td>
</tr>
<tr>
<td>Creatinine ((\mu\text{mol/L}))</td>
<td>60.6</td>
<td>120.9</td>
<td>91.93 ± 10.40</td>
<td>85.93 ± 15.57</td>
<td>53 – 125</td>
<td>0.051</td>
</tr>
</tbody>
</table>

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reference values, there was a significant difference (p<0.001) as well. Mean values of uric acid among bodybuilders on supplement (470.9 ± 71.89) and non-supplement bodybuilders (436.1 ± 69.78) exceeded the upper limit of the reference value (202 – 416μmol/L) by far (Table 2.) and the maximum uric acid value measured was 606.00μmol/L. These elevated measures do not necessarily suggest kidney impairment, as elevated uric acid level is not a clear indicator of an impaired kidney. Catabolism of dietary purines and proteins may have also contributed to this high yield\(^{(18)}\).

Creatinine is a breakdown product of creatine phosphate in muscle\(^{(19)}\). It plasma concentrations is relatively independent of protein ingestion, water intake, rate of urine production, exercise and serve as the most useful endogenous marker in the diagnosis and treatment of kidney diseases. Since its rate of production is constant, elevation of plasma creatinine is indicative of under-excretion suggesting kidney impairment\(^{(20)}\). The results show that no study group exceeded the maximum limit of creatinine level in the blood (Table 2). Also, though there was no significant difference in creatinine levels among the three study groups (p = 0.057) mean values were significantly higher among bodybuilders on supplement (Table 2). Levels of Urea however varied significantly (p=0.009) among the study groups with a lower mean value recorded for non-bodybuilders.

5. CONCLUSION

The findings have revealed elevated levels of uric acid among a sampled population of University bodybuilders in KNUST, Ghana. Though creatinine levels did not imply Kidney malfunction, higher levels were measured among bodybuilders on supplement. This high level of creatinine is detrimental and further increment may result in accumulation of higher levels over time.

The study has also shown the possible association between endogenous markers of renal function and unique patterns of dietary intake among this population. Overall, urea levels were kept relatively constant among all study participants. Further study among other Ghanaian university bodybuilders is recommended to validate these findings. The possible effects of varying dosages of supplements consumed should also be studied to assess renal function and to intervene early. Other studies should also determine whether excess intake of dietary proteins in this population beyond the RDA contribute to increase levels of these endogenous markers.

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CONFLICTS OF INTEREST
The authors declare no competing interest

REFERENCES


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