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Research Article

Impact of Dietary Protein Intake, Lean Body Mass Percentage, Body Mass Index, Physical Activity on Urinary Creatine and Urinary Creatinine Excretion in A Team- Sport

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Abstract

Background: Creatine and Creatinine plays a role in muscle function. Urinary creatine and urinary creatinine concentration was measured in order to see significance in monitoring athlete and athlete's performance.

Objective: Evaluate association of dietary protein intake, Lean Body Mass (LBM) percentage, Body Mass Index (BMI) and physical activity on urinary creatine, urinary creatinine concentration in different team sports [cricket players (C), basketball players (B) and football players (F)].

Methodology: A total of 62 players from different team sports - C (n-20), B (n-17) and F (n-25) age of 18-30 years participated. Post training urine samples was analyzed. Using Jaffe's reaction, urinary creatinine was obtained and Urinary creatine is obtained by difference in the creatinine present before and after heating with acid solution. 24 hour dietary recall was taken to find athletes protein intake. LBM were taken using Body Impedence Analysis (BIA machine). Data were analysed using SPSS (Statistical Package for Social Sciences Version 16.0).

Findings: Pearson bivariate correlation (2-tailed) was used to find the relationship between BMI, LBM, total dietary protein intake per day, dietary protein, duration of practice with urine creatinine and creatine level. Positive correlation between urinary creatine and total dietary protein intake per day, dietary protein according to body weight per day was found ($p < 0.001$), ($p < 0.005$) respectively. Negative correlation between urinary creatinine and dietary protein according to body weight per day and duration of practice per day was found ($p < 0.001$), ($p < 0.005$) respectively.

Urinary creatine mean (SD) values- C group 78.63 ± 27.17, B group 102.65 ± 38 and F group 169.60 ± 41.58. Urinary creatinine mean (SD) values- C group 46.60 ± 37. 23, B group 84.88 ± 48.27 and F group 70.40 ± 44.083.

Conclusion and Significance: Significant increase was seen in urinary creatine excretion with respect to dietary protein per day, dietary protein according to body weight per day.

Urinary creatine excretion is more in football players followed by basketball players.

Significant decline was seen in urinary creatinine excretion with respect to increase dietary protein according to body weight per day and increase duration of practice.

Urinary Creatine excretion is more in basketball players followed by football players

Urinary creatine and urinary creatinine excretion depends on sports-type, duration of sports and protein consumption.

Keywords: Urinary Creatine; Urinary Creatinine; Dietary Protein; LBM; BMI; Duration of Practice

Introduction

Creatine (Cr) is a naturally found amino acid-like compound present in the diet and synthesized by the body mainly in the liver and kidney [1]. After that Cr is transported to tissues by a membrane creatine transporter (SLC6A8) [1]. In humans, more than 95% of the body Cr content is stored in skeletal muscle, where Cr or more specifically phosphocreatine (PCr). PCr plays a major role in a muscle's ability to perform and maintain short duration, high intensity exercise [2]. In athletes competing in speed and strength sports, the urge for ATP is elevated during exercise due to the nature of effort. An energy substrate required for ATP regeneration is PCr [3]. The importance of the 'phosphagen system' lies in the extremely rapid rates at which it can re-synthesize ATP [2]. Hence, PCr hydrolysis does not depend on oxygen availability, nor necessitate the completion of several metabolic reactions to buffer energy at the onset of exercise and during anaerobic intense muscle

contraction [2,4]. Clearly, the energetic capacity of this system is only dependent on the availability of PCr. In this regard, several studies have shown that Cr supplementation increases total Cr skeletal muscle content [8], and enhances performance during high intensity exercise [6] as well as resistance training [5]. Most studies investigating Cr status in athletes have focused on muscle Cr content [3]. It is obvious that measurement of Cr in muscle is highly invasive as it requires muscle biopsy and its estimation using nuclear magnetic resonance is costly [7]. Since, no study has looked at urinary Cr in athletes although urine which is easily and safely accessible. We hypothesized that the measure of urinary Cr would be of interest in athletes.

Creatinine is derived from creatine found in muscle, blood, and urine. Urine creatinine is a waste product of the body which is formed by the spontaneous essentially irreversible dehydration of body creatine and creatine phosphate through muscle metabolism [9]. A total of 94%–98% of creatine is found within skeletal muscle [10]. A substantial increase in use of muscle will result in an increase in creatine phosphate breakdown and an increase in creatinine excretion [11].The extent of creatinine excretion depends on kidney function, age, sex, body mass, race, dietary proteins, dietary supplements, diuretics, antibiotics, salt, water, and physical activity levels [12,13]. For example, cooked meat and heat-treated milk contain a considerable amount of creatinine [12], which are excreted in urine after ingestion [13]. Furthermore, a change of 1 Kg intake of animal protein could account for a change of 9% in daily urinary creatinine output [12]. The amount of creatinine the body produces each day depends on the person's muscle mass: a young, muscular man produces more creatinine than a petite older woman. Thus, failure to consider variations in creatinine production due to differences in muscle mass may lead to misinterpretation of urine creatinine levels. Even though elevated urine creatinine commonly represents renal pathology, a low urine creatinine in certain muscle-wasting conditions such as malnutrition, and amputation does not exclude an underlying renal dysfunction. In obesity, excess mass in fat does not contribute to increased creatinine generation [14].

The reference values (0.4–0.8 g/day) of urine creatinine commonly used for sportspersons are those defined for normal sedentary people [15]. Usually, sportspersons are thought to be physically normal and healthy by definition, but the high training workload and psychophysical stress from competitions may modify their homeostasis inducing creatinine concentrations to change [16]. Therefore, definitions of the behavior of creatinine and its reference ranges in sportspersons are important to prevent misinterpretation of laboratory data in sportspersons [17]. Furthermore, sportspersons from different sports disciplines are characterized by different aerobic and anaerobic metabolism, competition season, training, and anthropometric values. Serum creatinine concentrations of sportspersons were higher than those measured in age-matched sedentary participants as total muscle mass is an important determinant of creatine pool size and of creatinine production [18]. Nonetheless, a correlation between creatinine and body mass index (BMI) has been reported in middle-aged people in a general population [19].

Creatinine is a fairly stable variable in sportspersons, but its concentration may differ from those of sedentary people and sometimes among sports and also at different stages of the competitive seasons in the same sportspersons [20]. Interpretation of creatinine concentration in sportsmen and women should take into account the specific sports of the athlete [21]. In a study by Banfi and Del Fabbro [22], some aerobic sports, –for example, cycling, the BMI values were fairly homogenous, whereas in others, for example, rugby, the values were heterogenous. In the latter sports, there were sportspersons with quite different anthropometric characteristics, often linked to their role [23]. In rugby, for example, the BMI of forwards was generally higher than that of backs; also in soccer, goalkeepers tend to have a higher BMI than other players [24]. The correlation between creatinine concentrations and BMI is not necessarily only connected with muscle mass. Lean body mass is not crucial for defining creatinine concentration as represented in general populations [25]. Today, it is widely accepted by experts that top performance in sports is achieved if an athlete possesses a set of tactics, technical, nutritional, physiological, and physical factors [26]. Therefore, sportspersons in any particular sport must possess such typical characteristics which are of advantage to their performance; for example, different sports require different BMI, body weight, and body fat. Thus, body composition significantly contributes to an individual's level of fitness for performance [27]. According to Bangsbo [28], more than 90% of the energy spent during sports is supplied by aerobic metabolism. During metabolism, creatine is formed. Creatine is a molecule of major importance for energy production in muscles and also serves as a precursor for the production of creatinine. Hence, urine creatinine levels may point to certain muscular disorders such as muscle sprains [29], and this may have implications for sports performance. According to Buford., *et al*. [30], preparation of an athlete may be harmed by the competition calendar, appearance of sprains, total body mass reduction, and dehydration; hence, the need to monitor creatinine levels in relation to sports performance is paramount.

Thus, this study is conducted to explore relevance of dietary protein intake, Lean Body Mass (LBM) percentage, Body Mass Index (BMI), physical activity on urinary creatine and urinary creatinine concentration in different team sports [cricket players (C), basketball players (B) and football players (F)].

Materials and Methods

Study design

The study was conducted as Quantitative study to compare urinary creatinine and creatine concentration in different team sports after training practice between the age of 18-30years was done in order to achieve the objectives.

It was design to study urinary creatinine and creatine level in different team sports done by cross sectional study where difference between the sports that is cricket, football and basket ball was been study.

Sampling

The present study was conducted inIslamGymkhana for cricket participant, Goan Football Association for football participant, Mastan YMCA Basketball Association for basket ball participant in Mumbai. Using purposively Sampling participant were selected according to their accessibility and readiness to participate in research.After explaining the procedure of the study to the participant, verbal consent was taken for the study.

Sample size

72 participant took part in this study out of that 20 were cricketer,25 were footballer and 17 were basket baller.

Tools

Anthropometry and Lean Body Mass

Anthropometry is the measurement of the physical dimensions as well as gross compositions of the body.

According to World-health Organization, body mass index (BMI; weight (kg)/height (m^2)) is accepted as the standard index for the definition of overweight and obesity, and its ability for the screening of excess body fat in individuals.

	BMI
Underweight	Below 18.4
Normal	18.5–22.9
Overweight	23.0–24.9
Obesity	25 and Above

Table 1: BMI category according to ICMR.

Lean Body Mass includes bone, water, muscle, and tissues. Is used to know the muscle mass of an athlete as creatine is stored in muscle mass. Body composition is obtained by BIA (Bioelectrical Impedance Analysis) is a method is based on the idea that lean tissue allows electrical current to pass through it more easily than fat tissue because the lean tissue has a larger amount of water content than fat tissue does.

Questionnaire

Questionnaire was given to analyse the protein and creatine intake through food and supplement also to find the training duration per day and type of sports and physical activity participant is indulge in. Set of specific question that is close ended question was given (APPENDIX I) 24 hours dietary recalls was taken to find the protein and creatine intake through diet and supplement had before sports training (APPENDIX II).

Diagnostic tool

Tool used for diagnosis is Urine. Urine samples are obtained in a non-invasive way that makes it a useful diagnostic tool for many biochemical tests applied in physiological and pathological states Urine test is done to know the creatine and cretinine level. (Appendix III and Appendix IV).

Sample analyses

Urinary sample was collected in asterilised plastic bottle and was analysed. The procedure was used to determine urinary creatine and creatinine content is folin and Jaffe's method respectively.

Statistical analyses

Statistical data was analysed using SPSS 16.0 version. Descriptive statistic, ANOVA, Pearson bivariate correlation was used appropriately.

Results and Discussion

The present study has been aimed to assess and compare urine creatine and creatinine concentration in cricket, football and basketball during training phase in the city of mumbai.

Random participant of 62 male athletes were taken from different sports discipline that is cricket (n=20), football (n=25), basketball (n=17) from the age group of 18 to 25 years.

Cricket, football and basketball athletes playing at district level and consuming non vegetarian item for 3 to 5 days in a week. Athletes from all three groups did not consumed any supplements. Most of the athletes reported of not familiar about creatine and creatine supplement. Athletes did not do any resistance or weight training exercise. No athletes reported any health problems.

Cricketer reported of having only 2 to 3 meals in a day. Also most of them reported consuming food in snacks bar, eating biscuits and having bread butter in morning. Footballers had 3 to 4 meals in a day. Most of footballers reported consuming food from Subway, McDonalds and restaurant having ice cream, biscuits.

Basket ballers had 3 meals in a day. Basketballer did not reported of having outside food. Most of the basket baller reported having more beef.

Urine sample was taken from the athletes after their training session of 2 to 3 ½ hours to assess the creatine and creatinine level. Information on body composition was obtained through BIA before the training session of the athletes. 24 hours dietary recall was given to get information about dietary nutrient intake and practice.

Data were analysed using SPSS (Statistical Package for Social Sciences Version 16.0) Descriptive statistic was used to find mean

and standard deviation. Data was correlated within the three group. ANOVA was applied to compare means of three groups that is cricket, football, basketball. Pearson bivariate correlation was used to find the relationship between LBM, protein intake, duration of training practice, urinary creatine and creatinine level.

Results obtained are analysed, tabulated and discussed in the following order:

1. Urine creatine and creatinine concentration.
2. Correlation between creatinine, creatine, BMI, LBM, protein, duration of practice.

Urine creatine and urine creatinine concentration

Creatinine is a waste product derived from creatine. Creatinine is largely an endogenous in origin, so the amount excreted in the urine is influenced by the having high creatine or creatinine rich food such as meat.

J Smith *et al* reported that urine creatinine is a useful measurement to find muscle mass in human.

H. E. Refsum, S. B. Stromme reported that during and after prolonged heavy exercise there is increase in serum creatinine due to increase in production and a lesser than proportional increase or even a decrease in urinary creatinine excretion.

A. Adib *et al* reported that urine creatine excretion increases after having meat and meat products.

Nasrallah F *et al* conducted a study to find urinary creatine before and after repeated sprints in athletes where they found that after acute repeated sprints the urinary creatine further decreases than at rest as compare to control group thus concluding that the high uptake and use of creatine by muscles is more in athlete because of more muscle mass and physical activity by athletes.

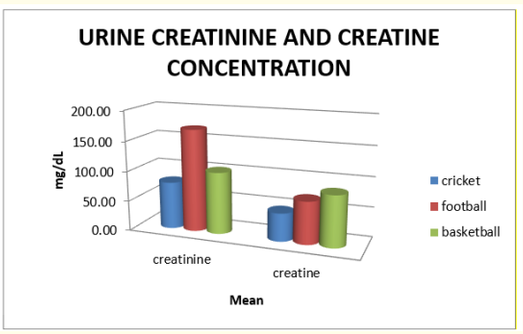

Figure 1: Mean Urine creatine and creatinine concentration among cricketer, footballers and basket ballers.

Urinary creatine mean (SD) values- C group 78.63 ± 27.17, B group 102.65 ± 38 and F group 169.60 ± 41.58. Urinary creatinine mean (SD) values- C group 46.60 ± 37.23, B group 84.88 ± 48.27 and F group 70.40 ± 44.083.

Correlation between urine creatinine, urine creatine with bmi, lbm, protein, duration of practice

Urine creatinine and urine creatine level changes due to many factor such as BMI, fat free mass, low carb high protein intake and physical activity.

G Banfi, M Del Fabbro (2006) had reported about the correlation between serum creatinine and BMI in elite athletes. Vincent James Dalbo (2007) reported positive correlation between endogenous creatine and strength training, LBM. It was reported about serum creatinine value increases with more intense exercise as compare to sedentary by G Banfi (2010).

Pearson bivariate correlation (2-tailed) was used to find the relationship between BMI, LBM, carbohydrate, protein, duration of practice with urine creatinine and creatine level Positive correlation between urinary creatine and dietary protein per day, dietary protein according to body weight per day was found ($r = 0.013$, $p < 0.001$), ($r = 0.000$, $p < 0.005$) respectively. Negative correlation between urinary creatinine and dietary protein according to body weight per day and duration of practice per day was found ($r = 0.000$, $p < 0.001$), ($r = 0.035$, $p < 0.005$) respectively.

Conclusion and Significance

Significant increase was seen in urinary creatine excretion with respect to dietary protein per day, dietary protein according to body weight per day. Significant decline was seen in urinary creatinine excretion with respect to increase dietary protein according to body weight per day and increase duration of practice. Urinary Creatine excretion is more in basketball players followed by football players.

It can be concluded that there is a significant increase was seen in urinary creatine excretion with respect to dietary protein per day, dietary protein according to body weight per day. Also significant decline was seen in urinary creatinine excretion with respect to increase dietary protein according to body weight per day and increase duration of practice. Urine creatine release ofin male athletes it had been found higher in basket-ballers after 2 and half hours of training as compare to cricketer and footballer. Urinary creatinine level it had been found higher in footballers where there protein intake and LBM percentage is seen higher as compare to cricket and basket-baller. Urinary creatine and urinary creatinine excretion depends on sports-type, duration of sports and protein consumption.

Appendix -I

Form no. **Date:**

Questionnaire

Impact of Dietary Protein intake, Lean Body Mass percentage, Body Mass Index, Physical activity on Urinary Creatine and Urinary Creatinine excretion in a Team- Sport

Personal Information:

Full Name: Mr/Ms: _____

Date of Birth: ___/___/___ (DD/MM/YY)

Occupation: _____

Sports Activity:_____

Permanent Address : _____

_____ State : _____

Pin: _____

Mobile: _____ e-mail: _____

Anthropometric Measurements:

Height: _____ Weight: _____ BMI:

LBM %:____ Fat %: _____

Any medical condition: _____

Food Habbits:

Veg/Non-Veg

If Non-Veg,

Type of Non-Veg: Chicken /Fish/Meat/Pork

Frequency of Non- Veg in week: _____

Amount of Non-Veg consume in a meal: _____

Water intake per day: _____

Supplementation Information

Do you consume any supplements: YES NO

If yes, mention the Name:_____

Since how long areyou consuming it- _____

Brand: _____ Timings: _____

Dosage: _____

Training Information:

Frequency of training per week_____

Daily training schedule: _____

Daily training duration:_____

Playing since: _____

Appendix -II

Meal	Time	Menu	Amount	Method of Preparation
Breakfast				
Mid-morning				
Lunch				
Snack				
Dinner				
Bedtime				

Appendix 2: 24 Hours Dietary Recall.

Appendix -III

Aim: To estimate creatinine in urine by Jaffe's method

Principle: Creatinine develops an orange red colour when treated with picric acid in the presence of strong alkali. This colour is due to the formation of creatinine picrate. The colour so produced depend on the amount of creatinine present and measured at 520 nm.

Reaction:

$$\text{creatinine} + \text{picric acid} \xrightarrow[\text{(red colour)}]{\text{strong alkali}} \text{creatinine picrate}$$

Requirements

1. Creatinine standard solution: Dissolve 0.1 gram creatine (0.1611 gram of creatinine Zinc Chloride) in 100 ml of 0.1 N HCl. Keep in a cool place in a well-stoppered bottle.1 ml of the solution contains 1mg of creatinine.
2. Saturated picric acid solution (about 1%).
3. Sodium hydroxide solution – (10%)
4. Hydrochloric acid solution – 0.1N.

Procedure

In three 50ml volumetric flask, the following contents are taken:

Make up the volume by distilled water. Mix and allow them to stand for the development of colour. Bring up the volume in each flask to the mark. Mix well and make photoelectric colorimetric reading using blue-green filter at 530 mμ.

	Blank (B)	Unknown (U)	Standard (S)
Urine	___	0.5ml	___
Distilled water	0.5ml	___	___
Standard solution of creatinine	___	___	0.5 ml
10% NaOH	1ml	1ml	1ml
Saturated Picric acid solution	10ml	10ml	10ml

Appendix 3

Appendix -IV

Aim: To estimate creatine in urine.

Principle: Creatine is obtained by difference in the creatinine present before and after heating with acid solution. Creatinine when heated with acid solution, creatine is converted into creatinine.

Requirements

1. Creatinine standard solution: Dissolve 0.1 gram creatine (0.1611 gram of creatinine Zinc Chloride) in 100 ml of 0.1 N HCl. Keep in a cool place in a well-stoppered bottle. 1 ml of the solution contains 1mg of creatinine.
2. Saturated picric acid solution (about 1%).
3. Sodium hydroxide solution – (10%)
4. Hydrochloric acid solution – 0.1N.

Procedure

- Pipette 0.3ml of urine in a test tube and add 10ml of picric acid. Mark the level of the liquid on the test tube and place in a beaker of briskly boiling water for 45 minutes. After 45 minutes boiling cool the test tube to room temperature and mark up the test tube till 4ml with distilled water then add 1ml of NaOH.
- Take 0.3 ml of distilled water and add 10 ml of picric acid solution for blank.
- For standard, add 10 ml of picric acid with 1ml of NaOH and 0.5ml of standard creatinine solution.
- Make photoelectric colorimetric reading using blue-green filter at 530 mμ.
- In a test tube the following contents are taken

	Blank (B)	Unknown (U)	Standard (S)
Urine	___	0.3	___
Saturated Picric acid solution	10ml	10ml	10ml
	___	Boil for 45 min	___
Distilled water	0.3ml	Make up to 0.4ml	___
10% NaOH	1ml	1ml	1ml
Standard solution of creatinine	___	___	0.5 ml

Appendix 4

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