NUTRITONAL STATUS ASSESSMENT OF ELITE CRICKETERS FROM URBAN VADODARA AND IMPACT EVALUATION OF A COCOA FLAVANOL RICH DRINK ON THE MUSCLE RECOVERY

Synopsis of PhD Thesis

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BY

Submitted by
Ms PRACHI DEOTA

Guide
Dr. SUNEETA CHANDORKAR

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DEPARTMENT OF FOODS AND NUTRITION
FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
VADODARA- 390002

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CHAPTER 1: INTRODUCTION

Many factors contribute to success in sports, including talent, training, motivation as well as Nutrition. Diet affects performance and the foods which are part of the training and competition phase affect how the athlete trains and competes. Good diet supports intensive training while reducing the risk of illness and injury (International Olympics Committee, 2012). Sports nutrition is critically essential as long before deficiency symptoms start appearing, physical performance declines. (ILSI, NIN, SAI, 2007).

Sports demand increased nutrient requirement owing to the raised physical activity. The physical demands of each sport varies and so differs the nutrient requirements. Cricket is a major international sport with millions of dollars being spent and earned on domestic and international matches (Mandrekar, 2017). Cricket is a dominantly endurance sport with intermittent power demands. Like in any other sport, physical fitness has a big role in the performance of a cricketer.

Iron Status In Sports Persons

Adequate Iron is very crucial for athletes and a balanced diet can easily help meet this iron requirement. As in the non-athletic population even in athletes, females are more prone to being iron deficient. Iron is a functional component of oxygen transport and energy production in humans and therefore has big role in sport and exercise performance (Alaunyte, Stojceska and Plunkett, 2015). Therefore it is critical to regularly monitor iron status of athletes and correct it if needed.

Fitness In Sports Persons

Fitness assessment is a very important aspect of an athlete's program. The fitness levels of an athlete have impact on the competitive performance and therefore fitness training is given lot of attention. In cricket, fitness components like endurance, speed, power, agility and flexibility are very important (Mandrekar, 2017).

Cricket And Nutritional Supplements

Dietary supplements are used by athletes worldwide (Williams, 2004). Athletes across various sports rely on nutritional supplements for many benefits including promoting adaptation to training, accelerating recovery, enhancing competitive performance and providing convenient source of nutrients. (Knapik et al, 2016) With the supplement market being what it is today, supplements are readily available to athletes and are accepted more within the athletic culture (McDowall, 2007). Various forms in which sports foods are available in the market include sports drinks, sports gels, liquid meals and sports bars (International Olympics Committee, 2012).

In cricket, Protein supplements and Sports drinks are widely consumed. Protein supplements are used to meet increased protein requirements during intense training. Sports drinks are consumed during ongoing training or matches to replenish lost water and electrolytes and get optimum amount of carbohydrates. However, as a word of caution, the American College of Sports Medicine has suggested that athletes should be counseled regarding the appropriate use of supplements and should consider taking them after careful evaluation (Potgieter, 2013). Thus the short cut approach through supplementation should be discouraged and emphasis should be laid on good eating habits as a foundation to optimal nutrition (International Olympics Committee Sports Medicine Manual, 2000).

Cocoa Flavanols And Muscle Recovery

In cricket as in any other sport, exercise induced muscle damage (EIMD) is very common in response to training or workout or intense physical activity. EIMD further results in delayed onset muscle soreness (DOMS) (Pritchett et al, 2011). Speedier muscle recovery from DOMS is crucial for the next athletic performance. Cocoa flavanols are hypothesized to show positive impact on muscle recovery but there are limited studies on the same. Creatine Kinase is a biomarker to assess muscle recovery (Brancaccio et al, 2007). A research carried out with administration of 350 mg of cocoa flavanol containing drink twice post exercise for a single day proved to be ineffective in reducing the Creatine Kinase level. Therefore it was suggested to assess the long-term impact of cocoa flavanol supplementation on muscle recovery. (Peschek et al, 2013) .

Knowledge, Attitude And Practices In Athletes Regarding Basic Sports Nutrition

Basic knowledge regarding nutrition specific to the sport in which an athlete is training can result in better nutrition-based choices. Therefore, it is important to discover the existing knowledge, practices and attitude of athletes towards Sports Nutrition. This will give an insight into whether any intervention is required in the same and if so then which aspects to focus on. The availability of nutrition information for athletes varies. Younger/recreational athletes are more likely to receive generalised nutrition information from mainly their coaches and trainers. Whereas, elite athletes are more likely to have access to specialised sports nutrition input from qualified professionals (Beck et al, 2015).

Rationale

The study was formulated with the following rationale

- There is paucity of data on the nutritional status, body composition, energy expenditure, fitness level, morbidity-injury profile and nutrition awareness in Elite Indian cricketers. The present study was therefore formulated to bridge this gap and assess the above-mentioned aspects. Post exercise recovery is very crucial for the next performance. Therefore, a cocoa flavanol rich drink was developed and standardized in the laboratory and its impact on the post event muscle recovery was evaluated.

Broad Objective

- To assess the nutritional status, fitness level and nutrition awareness among elite cricketers of Urban Vadodara and study the impact of supplementation on the post event muscle recovery.

Specific Objectives

- To assess the socio-economic status of elite cricketers from Urban Vadodara.
- To assess the body composition and fitness level of the subjects.

- To assess the nutrient intake (diet + supplement) of the subjects.
- To assess the energy expenditure of elite cricketers from various departments of the sport.
- To record the injuries and morbidities reported by the subjects.
- To assess nutrition awareness among subjects and study the impact of Nutrition Health Education.
- To survey the composition of commercially available Protein supplements and Sports drinks, examine their nutritional quality and utility.
- To standardize a cocoa flavanol rich drink and study its impact on the muscle recovery in elite cricketers.

CHAPTER 2. REVIEW OF LITERATURE

The review of literature has been done under the following heads:

Sports

- Background and Classification
- Cricket across the globe and in India

Energy metabolism during physical activity/exercise

- Utilization of Carbohydrates, Fats and Proteins in Energy Production
- Energy Systems involved during exercise
- Effect of exercise on various body systems
- Energy metabolism in Cricket

Energy expenditure in athletes

- Energy expenditure- Background
- Energy expenditure in cricketers
- Methods to track energy expenditure

Sports nutrition

- Introduction to Sports Nutrition
- Nutritional Requirements of Athletes - Before, During and After Exercise
- Role of Vitamins- Vitamin B, Vitamin C, Vitamin D, Vitamin B12
- Role of Minerals- Calcium, Sodium and Iron
- Iron status and sports performance
- Consequences of improper nutrition in sports
    - Sports anaemia
    - Dehydration

- Commonly Encountered Problems
  - Eating disorders
  - Weight management
  - Female athlete triad
- Hydration for Athletes
- Vegetarian athletes- Challenges faced

Nutritional status of athletes

- Anthropometry of athletes
- Dietary intake of athletes
- Body composition

Fitness

- Components of fitness
- Physical fitness tests
- Excess post-exercise oxygen consumption (EPOC)

Morbidity- injury in athletes

- Morbidities in athletes
- Injuries in athletes

Muscle damage and recovery

- Muscle soreness
  - Delayed onset muscle soreness (DOMS)
  - Exercise induced muscle damage (EIMD)

- Muscle recovery
    - Markers – Lactic acid, Creatine kinase and Creatine phospho kinase MM and MB

Ergogenic aids

- Ergogenic aids- Background
- Nutritional ergogenic aids
- Commercial Nutritional Supplements commonly used by Cricketers
    - Protein supplements
    - Sports drinks

Nutrition awareness

- Nutrition awareness amongst athletes
- Nutrition awareness in Support staff (Coaches, Trainers, Physiotherapists) of athletes

CHAPTER 3. MATERIALS AND METHODS

This chapter deals with the methods and tools employed to carry out the present study. The methods used in the study are follows:

PHASE-1 (Sampling, Nutritional Status Assessment, Tracking Energy Expenditure, Morbidity Injury Profile, Fitness Assessment and Hemoglobin Estimation)

Sampling technique

All the sports association located in Vadodara involved with cricket were visited. Elite cricketers from these associations were identified. The operational definition of elite male cricketers is those who train for minimum 5 hours for at least five days a week. The operational definition of elite female cricketers is those who train for minimum 4 hours for at least five days a week. The following inclusion criteria were used to enroll the subjects in the study.

Inclusion Criteria

The subjects fulfilling following criteria were included in the study.

- Elite male Cricketers 19 to 30 years of age.
- Elite female Cricketers 14 to 30 years of age.
- Willing to participate.
- Cricketers who are not differently abled or who do not suffer from any disease.
- Non-pregnant and non-lactating females.
- Those who are not on any drug treatment.
- Those who do not have abnormally high Creatine Kinase levels at the baseline.

Exclusion criteria

The following subjects were excluded from the study

- Male cricketers who are not elite (do not train for minimum 5 hours for at least five days a week).

- Female cricketers who are not elite (do not train for minimum 4 hours for at least five days a week).
- Males below 19 years and above 30 years of age and females below 14 years and above 30 years of age.
- Those not willing to participate.
- Differently able or those suffering from any disease condition
- Pregnant and lactating females
- Those under any drug treatment
- Those having abnormally high Creatine Kinase values at the baseline.

- Purposive sampling of the subjects was carried out based on the above-mentioned inclusion criteria.
- After receiving well informed, written consent, the subjects were enrolled in the study.
- In all, 96 subjects fulfilled these criteria. All of them play through the Baroda Cricket Association.

EXPERIMENTAL DESIGN/CONSORT – PHASE -1

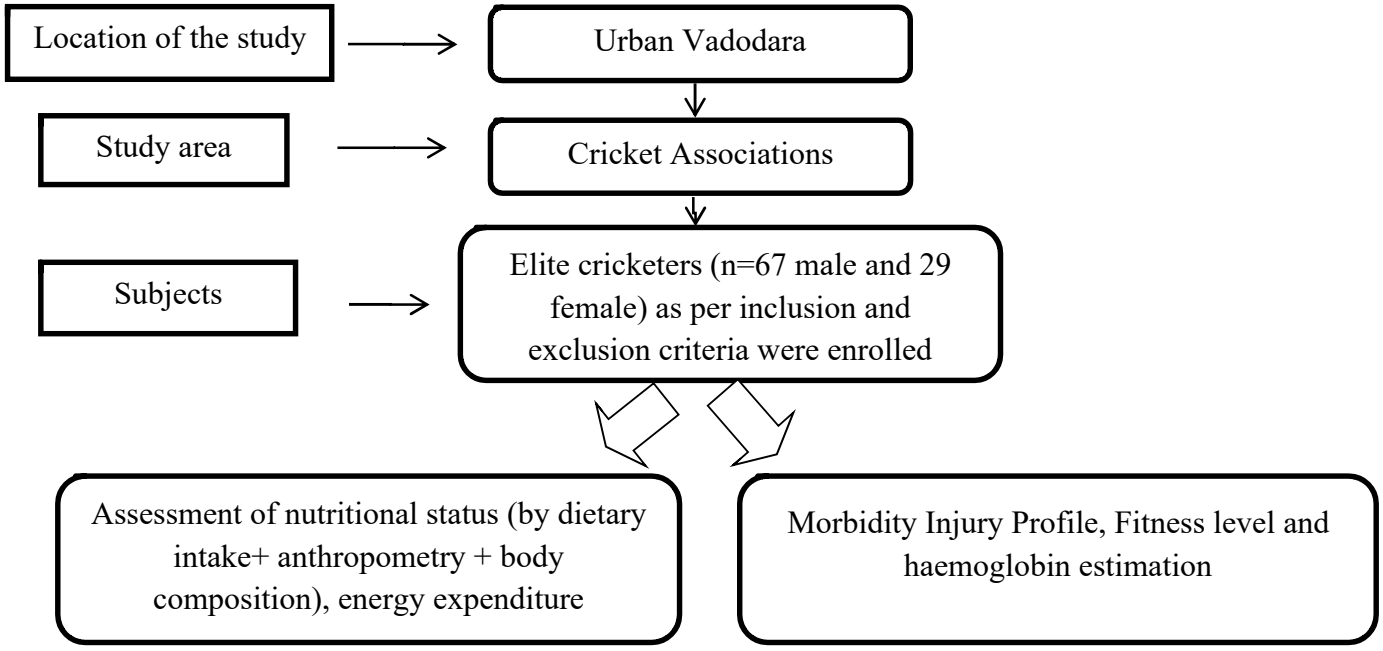


Table 1: Tools and Techniques (PHASE 1)

PARAMETER	INDICATORS	METHODS
Nutritional status	Anthropometric measures	Standard method for Height, weight, waist circumference and hip circumference
	Body composition	Body composition analyser (Bodystat Quadscan 4000 unit)
	Dietary intake	24-hr dietary recall (3 day- during training, during match and on rest day) and semi structured-food frequency questionnaire
Iron Status	Haemoglobin	Sodium lauryl sulphate method (Sysmex XN-1000)
Energy expenditure	Heart Rate	Fitness tracker (3 day- during training, during match and on rest day)
Morbidity injury profile	-	Pretested questionnaire
Fitness	Cardio Respiratory	Yoyo test, Cardio vascular endurance test -2 km
	Power	Vertical Jump test
	Speed	20 m Sprint, 40 m Sprint test
	Agility	Run a three test
	Muscular endurance	Push up test, Prone hold
	Muscular strength (lower body)	Squats
	Anaerobic fitness	Repeated sprint ability

PHASE 2

A- Survey on composition of protein supplements and sports drinks and

B- Development, supplementation and impact evaluation of a cocoa flavanol rich drink on muscle recovery

Protein supplements and sports drinks are commonly consumed by cricketers in general. Due to this reason, a market survey of commercially available protein supplements and sports drinks was conducted.

Phase 2-A: Survey on composition of commercially available protein supplements

The composition of the protein supplements was studied in terms of protein content, source and cost. For this, three sports supplement stores in the city of Vadodara, Gujarat were purposively selected. All protein supplements from the websites of these stores were listed. Further, the detailed composition of these products was accessed from official websites of the respective brands. Products that did not provide Nutrition Facts Panel were excluded from the study. In all, sixty products were surveyed.

Phase 2-A: Survey on composition of commercially available sports drinks

The composition of sports drinks was studied in terms of carbohydrate and electrolyte content, ingredients used and cost. Three sports supplement stores in the city of Vadodara, Gujarat were purposively selected. All sports drinks from the websites of these stores were listed. Further, the detailed composition of these products was accessed from official websites of the respective brands. Products that did not provide Nutrition Facts Panel were excluded from the study. In all, fifty products were surveyed.

Phase 2-B: Development, supplementation and impact evaluation of a cocoa flavanol rich drink on muscle recovery

The survey of Protein supplements and Sports drinks revealed that there was no Muscle Recovery drink available in the market. To address this gap, a muscle recovery drink was developed, standardised and supplemented to study the impact.

Development and Standardization of a cocoa flavanol rich drink

- The experimental drink had 10 g natural unprocessed cocoa powder which contributes about 350 mg cocoa flavanols. The drink was made from cocoa powder, milk and sugar and the

volume was made up to 250 ml. The drink was standardized and sensory evaluation was performed by a semi-trained panel.

- The placebo was milk (+sugar) with added colour and flavor to make it look and taste similar. Placebo was developed in a way to match nutrient composition of the experimental drink.

Sample size estimation for supplementation

- Documentary evidences suggest that a minimum of 12 participants are required for a minimum detectable difference of 350U/L for Creatine Kinase with a $\beta>0.80$. (Lipsey et al, 1990 and Saunders et al, 2004)

Inclusion Criteria for supplementation

- Those who are not intolerant or allergic to any food ingredient in the supplement.

Exclusion criteria for supplementation

- Those who are intolerant or allergic to any food ingredient in the supplement.

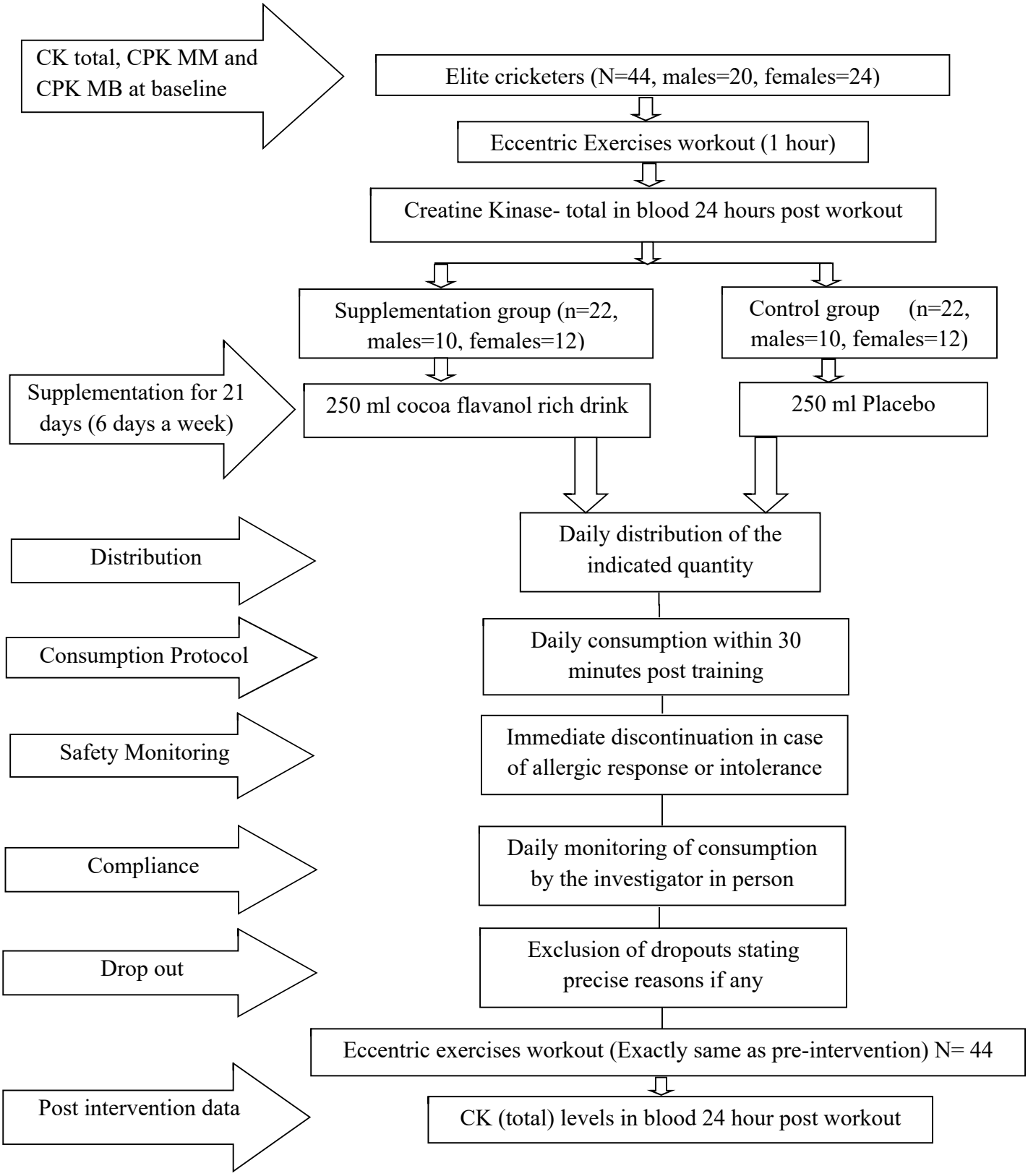
- The participants were given a list of foods having cocoa powder and asked not to consume any of those foods during the intervention period of 21 days so that it does not interfere with the results.
- Creatine Kinase was assessed in blood to determine the recovery status. It was analysed using enzymatic kit method.
- The Creatine Kinase levels were assessed on the day 1 after a resting phase of 10 days to capture the actual baseline values.

Considerations

The standardized drink was prepared by the Researcher under the supervision of the investigator.

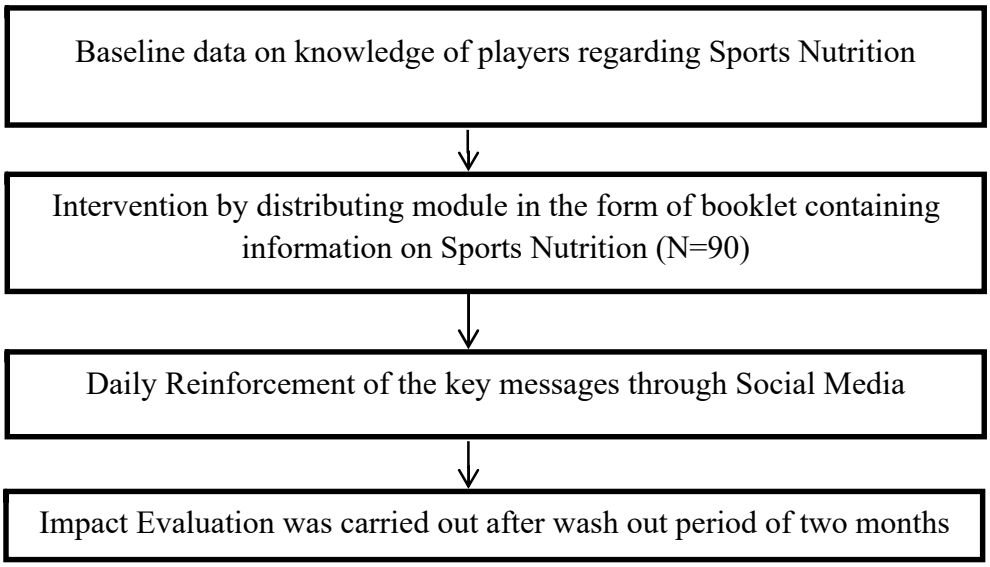
- The drink was approved by the Anti doping Agency of the Board of Cricket Control in India (BCCI)
- The participants were neither rewarded nor had to bear any cost of the supplementation.

EXPERIMENTAL DESIGN/CONSORT- PHASE 2 – B



<u>PHASE-3</u>: To assess Nutrition awareness among subjects and study the impact of Nutrition health education

Nutrition awareness was assessed on the basis of knowledge scores derived out of administration of a semi – structured pretested questionnaire. This same questionnaire was used at the baseline and for collecting post Nutrition health education intervention responses.



Data Monitoring

- Anthropometric measurements, body composition analysis, Nutrition Health Education intervention and drink supplementation was monitored by the research guide.
- Blood collection for haemoglobin and Creatine kinase was done by a technician and monitored by the investigator.

Considerations

The results of the Research were made available to the participants in writing either personally or through their coaches (as mentioned in the consent form).

Ethical Clearance- The study has received clearance from Institutional Medical Ethics Committee with approval number IECHR/2015/18.

CHAPTER 4. RESUTS AND DISCUSSION

The results of the present research are presented and discussed in this chapter phase wise as follows

PHASE 1

Nutritional status Assessment, Tracking Energy expenditure, Morbidity Injury Profile, Fitness Assessment and Haemoglobin estimation

PHASE 2

A- Survey on composition of commercially available protein supplements and sports drinks and

B- Development, supplementation and impact evaluation of a cocoa flavanol rich drink on muscle recovery

PHASE-3

Assessment of nutrition awareness among subjects and study the impact of Nutrition health education intervention

PHASE 1

NUTRITIONAL STATUS ASSESSMENT, TRACKING ENERGY EXPENDITURE, MORBIDITY INJURY PROFILE, FITNESS ASSESSMENT AND HEMOGLOBIN ESTIMATION

Composition of subjects

The subjects (N=96) belonged to four squads, 2 boys' squads and 2 women's squad. The Ranji boys squad had 29 subjects who were 23 to 29 years of age, Under-23 boys squad (n=38) who were 19 to 22 years, Senior Women's squad (n=14) who were 19 to 27 years and Under-19 Women's squad (n=15) who were 14 to 18 years of age.

Background information

In terms of education, Majority of the subjects had either completed either Secondary, higher secondary or graduation. Post graduates were from two squads; Senior women (21%) and Ranji (19%)

Nutritional status based on Body Mass index (BMI)

- The BMI data revealed that the boys' squad did not have any underweight subject whereas the Under-19 Women squad had 13% and Senior Women squad had 7% of them.
- The proportion of overweight and obese players in these squads was considerable; Under 23 boys (44.7%), Ranji (34.4%), Senior Women squad (28.6%) and Under-19 Women squad (20%)

Eating Preference

Of the 94 subjects across all the squads, 67% were non vegetarians, 18% vegetarians and 15% Ovo- vegetarians.

Nutrient intake

- Twenty-four hour diet recall was recorded for 3 consecutive days to assess the nutrient intake of the subjects.
- The mean Energy intake across various squads was, Under-23 boys squad (2583±830 kcal/day), Ranji boys squad (2551±697 kcal/day), Under-19 Women (1763±404 kcal/day) and Senior women (1669±365 kcal/day) respectively.
- The mean Protein intake across various squads was, Under-23 boys squad (90.12±31.10 g/day), Ranji boys squad (83.96±27.56 kcal/day), Under-19 Women (52.28±10.3 g/day) and Senior women (51.85±17.51 g/day) respectively.
- The mean Calcium intake across various squads was, Under-23 boys squad (1083.75±502.32 mg/day), Ranji boys squad (904.42±323.73 mg/day), Under-19 Women's (595.62±240.33 mg/day) and Senior Women (494.11±208.45 mg/day) respectively.

- The mean Iron intake across various squads was, Ranji boys squad (15.62±5.60 mg/day), Under-23 boys squad (14.24±4.58 mg/day), Under-19 Women (10.49±2.95 mg/day) and Senior women (9.68±2.19 mg/day) respectively.

Body composition

- Body composition is routinely performed in elite athlete population due to its well reported relation to competitive success.
- The data revealed that the proportion of fat was higher than normal across all the squads, Senior Women squad (64%), Ranji squad (48%), Under-19 women squad (47%) and Under-23 boys' squad (30%).

Energy expenditure

- It was assessed using a Fitness tracker which the subjects had to wear on the wrist.
- The mean energy expenditure in Women's squad during a one day (50 over) match was tracked. Average energy expended by batsman (n=7) per hour was 83 kcal, fielder (113 kcal, n=2), Spinner (82 kcal, n=3), Pacer (107 kcal, n=3) and Wicketkeeper (61 kcal, n=1).
- Similar data could not be captured in boys' squad as due to the stringent Board of Cricket Control in India (BCCI) rules, they do not allow outsiders to present on the ground during matches.

Morbidity and injury profile

The common morbidities and injuries observed in the subjects are as discussed below.

Most common morbidities

- The subjects (N=91) were asked to report the morbidities that they experienced in the last 15 days.

- Cough and cold was the most common morbidity reported by 27.5% of the subjects. It was followed by headache (20.9%), loss of appetite (15.4%), fever (9.9%) and stomach ache (6.6%).
- Around 46% of the subjects did not experience any morbidity in the last 15 days.

Most common injuries

- Thirty seven percent of the subjects (N=91) experienced no injuries in the last 2 years.
- The top five injuries in the subjects across all the squads were ankle twist (11%), finger/thumb injury (8.8%), finger fracture (6.6%), shoulder pain (5.5%), groin injury (4.4%) and back pain (4.4%).

Fitness assessment

- Various fitness tests relevant to cricketers were conducted and the data recorded. Run a three test assesses the Agility, 20m Sprint is for Speed and Vertical jump for Power.
- Mean scores for Run a three for Ranji squad was 9.309±0.28 seconds while that for Under 23 boys' squad was 9.878±0.41 seconds. For Run a three, 27% of the Ranji squad did not achieve the BCA benchmark of <9.5 seconds while in Under 23 squad 80% did not achieve the same.
- Mean scores for 20m Sprint for Ranji squad was 2.966±.12 while it was 3.05±.14 for Under 23 squad. For 20 m Sprint, 27% of the Ranji squad did not achieve the BCA benchmark of <3 seconds while in Under 23 squad 70% did not achieve the same.
- Mean scores for Vertical jump for Ranji squad was 57.63±6.39 while it was 52.91±6.82 for Under 23 boys' squad. For Vertical jump, 27% of the Ranji squad did not achieve the BCA benchmark of ≥55cm while in Under 23 squad 70% did not achieve the same.
- Mean scores for Run a three for Senior women's squad was 11.86± 0.66 seconds while that for Under 19 women's squad was 11.74± 0.73 seconds.
- Mean scores for 20 m Sprint for Senior women's squad was 3.83± 0.29 seconds while that for Under 19 women's squad was 3.87± 0.20 seconds.

Iron status

- Iron is one of the most critical minerals with implications for sports performance. Haemoglobin levels were obtained to assess the Iron status of the subjects.
- Similar to the vast available literature, Anemia was more prevalent in Women than in men. Mild anemia was present in 23% of Senior women squad, Under-19 women squad (20%), Under 23 boys' squad (13%) and Ranji squad (5%).
- Moderate anemia was found only in Women, Senior Women (7.7%) and Under-19 women squad (13.3%).
- None of them had severe anemia.
- The players who were deficient were suggested to consume foods rich in Iron and vitamin C (to enhance absorption) and a list of such foods was provided to them.

PHASE 2

A- SURVEY ON COMPOSITION OF PROTEIN SUPPLEMENTS AND SPORTS DRINKS AND B- DEVELOPMENT, SUPPLEMENTATION AND IMPACT EVALUATION OF A COCOA FLAVANOL RICH DRINK ON MUSCLE RECOVERY

Phase 2- A: Survey on composition of commercially available protein supplements

- In all, 59 products were surveyed for their protein content, the source of protein utilized and the cost of these products. These products belonged to 15 different brands.
- The products were in the form of Powder (83.05%), Bar (13.56%) and Beverage (3.39%).
- The supplements available in powder form have to be reconstituted into beverage by adding to milk or water.
- Most of them recommend one serving to be added to 250-350ml water or milk (if the individual has additional calorie requirements).
- These products are available in various flavors and pack sizes. The bars are supposed to be consumed one at a time.

- These are recommended to be taken as snacks in between major meals. Those supplements which are in beverage form are ready to drink formulas. Like the powder forms, beverages are also available in various flavors and pack sizes.
- The serving size for Powder form ranged from 24-72g, for Bars (50-80 g) and Beverages (414-429 ml).
- Cost per gram of protein ranged from 1.71 to 11.78 INR for Powder form products, Bars (4.95-13.9) and Beverages (6.17-7.11).

Sources of Protein in the Supplements

The top five sources of protein in the supplements were Whey protein concentrate (58.3%), Whey protein isolate (50%), Milk protein concentrate (23.3%), Milk protein isolate (21.6%), and Micellar Casein (20%).

Amongst the top nine sources of protein found in the surveyed products, only one (11.1%) was of vegetarian origin (Soy protein isolate). Seven (77.8%) protein sources were of milk origin and one (11.1%) was egg based.

Protein content in the Supplements

Maximum i.e. 30% products contained protein in the range of 70-80g. The products in the range of 80-90g protein (11.7%) were all of animal origin. The products containing protein below 10g were beverages. The supplements having protein content between 20 to 30g were bars. The highest protein content was 90g in a powder form product.

Presence of Sugar/Sweetener in Protein Supplements

The products had either sugar or sweetener or both. Sugar was present in 71.6% products, and 90% products had Sweeteners. Sweeteners are added in order to reduce the calorie content of the product. Some products had sweeteners as the main sweetening agent plus sugar in very minute quantity. Amongst those products that contained sweeteners, 87% had Sucralose, 15% had Stevia and 43% had Acesulfame Potassium.

<u>Phase 2-A:</u> Survey on composition of commercially available sports drinks

In all, fifty products from 26 brands were surveyed mainly for their composition in terms of carbohydrate content, source of carbohydrate and sodium content. The products were in the form of Powder (58%), Ready to drink formula (28%) and tablets (28%). The supplements available in powder and tablet form have to be reconstituted into beverage by adding to water.

The serving sizes of the sports drinks varied from 10g to 79g for powders (to be reconstituted by adding water up to 200ml -1 litre), 4.7-50g for tablet (to be reconstituted by adding water up to 100ml -750ml), 118-567ml for ready to drink formula.

Carbohydrate content in the Sports drinks

The recommended range of carbohydrates in Sports drinks is 4-8g/100ml. Majority of the products i.e. 67% fell in this range. Around 10% products had carbohydrate content less than 4g/100 ml. Around 22% had carbohydrate content more than 8 g/100 ml.

Sources of Carbohydrates in the Sports drinks

The top carbohydrate sources in the products were Maltodextrin (56%), Fructose (38%), Dextrose (28%) and Glucose (26%). Thirty-eight percent products had 2, 22% had 3 and 4% had 4 sources of carbohydrates. Maltodextrin plus Fructose (in 18% products) was the most common combination.

Twenty six percent of the products had presence of sweetener. Sweeteners are used to create low calorie products while still maintaining the taste that consumers like. Sucralose (54%) was the most commonly used sweetener.

Sodium content in the Supplements

The recommended range for sodium content in sports drinks is 23-69 mg/100ml and almost 74% products fell in that range. Around 7% products contained sodium below 23mg/100ml, while 19% products contained sodium above the recommended upper range.

<u>Phase 2- B:</u> Development, supplementation and impact evaluation of a cocoa flavanol rich drink on muscle recovery

In cricket as in any other sport, exercise induced muscle damage (EIMD) is very common in response to training or workout or intense physical activity. EIMD further results in delayed onset muscle soreness (DOMS). Speedier muscle recovery from DOMS is crucial for the next athletic performance. Literature shows that acute administration of 350 mg of cocoa flavanol supplementation to be ineffective and suggested a need to assess the cumulative effect. Therefore, the Cocoa flavanol rich Drink was developed to assess its cumulative effect on muscle recovery after supplementation for 21 days.

Hersheys unsweetened cocoa powder was selected due to the following reasons

- It is unalkalised which is more suitable as alkalisation reduces the flavanol content of cocoa to considerable level.
- It has 350 mg flavanol per 10 g (based on communication with Hersheys). Based on literature, this amount of flavanol is required to show improvement in muscle recovery. Other brands did not respond on the flavanol content of their cocoa powders so those could not be considered for selection.
- Hersheys cocoa powder does not contain any added colours or flavours. As the drink had to receive clearance from the Anti-doping Agency of the Board of Cricket Control in India (BCCI), it was essential that it did not contain any added substances.

Standardization of Recovery drink

- The quantity of cocoa powder was fixed i.e. 10g which is the suggested quantity based on literature to see positive impact on muscle recovery. Sensory evaluation was carried out to finalise the quantity of sugar required in the drink depending on the acceptability.

- The Experimental drink contained Cocoa powder (10g), Milk (250ml) and Sugar (20g) per serving. The Placebo drink had Sugar (15g), Milk (250ml) and Milk powder (5.6g) per serving. Natural Chocolate colour and flavour within safe limits was added to Placebo to

make it look and taste similar to the experimental drink and avoid any bias. More sugar was added to the experimental drink to balance the bitter flavour of the cocoa powder.

- As the placebo did not have any cocoa powder, the content of flavanols was nil in it whereas the experimental drink had about 350 mg cocoa flavanols.

- The Energy and Protein content of both the drinks was maintained almost similar. The Energy content in Experimental drink was 215 Kcal and Placebo was 194 Kcal while the Protein content in Experimental drink was 9.73g and in Placebo was 9.72g respectively.

Impact of Supplementation on Muscle Recovery

- According to the Research protocol, the subjects had to consume the drink within 30 minutes post training.
- For this period of supplementation, the training schedule was maintained same for all the subjects of a particular squad. The schedule was designed to consist of more eccentric exercises as they result into increases Creatine Kinase levels.
- In both the Women's squad (n=24), the supplementation could be successfully carried out for 21 days.
- From the Ranji boys' squad (n=20) there were three dropouts each in experimental and placebo group so the final data could be obtained on seven subjects in each group. In this squad, the supplementation could be carried out only for 10 days due to unexpected announcement of their match schedule in that duration.
- Supplementation could not be carried out in the Under-23 boys' squad due to their prolonged match season and invitation matches even during the offseason.
- The pre and post intervention Creatine Kinase values were compared to assess the impact of intervention on the muscle recovery of the subjects. It was expected that due to the intervention there will be a statistically significant reduction (based on paired t test) in the post intervention CK levels.

- In the Women's squad, the pre- intervention mean CK value was 176.7±121.1 while the mean post intervention CK value was 128.9 ± 68.6 in the experimental group. However this reduction was not statistically significant.
- Similarly, in the Ranji boys squad also, there was no positive statistically significant difference seen in the pre and post intervention Creatine Kinase levels.

PHASE-3

NUTRITION HEALTH EDUCATION INTERVENTION AND IMPACT EVALUATION ON THE KNOWLEDGE SCORES OF THE SUBJECTS REGARDING SPORTS NUTRITION

Nutrition awareness among players

The knowledge regarding sports nutrition of the subjects was assessed using a pre tested questionnaire. Following were some of the components that were assessed under the KAP survey.

a. Functions of various nutrients in the body and sources of the same.
b. Consumption pattern of foods and fluids, before, during and after competitive events/matches, foods avoided in general by the subjects and especially during the events and reasons for the same.
c. Knowledge regarding supplements and use of the same in terms of type, frequency and quantity.
d. Basic information pertaining to Carbohydrate loading, ergogenic aid

- This same questionnaire was administered post Nutrition Health Education intervention to observe the improvement in the knowledge of the subjects.
- The knowledge scores of the players reveal that majority of the players across all the squads were in the FAIR category i.e. 41-50% score.

- The players in the Excellent score category were found only in one squad i.e. Under-19 Women squad.
- Based on the gaps identified from the knowledge assessment of the subjects a Nutrition health education training module was developed to educate them.
- This module was developed in the form of a booklet to educate the subjects on the basics of Nutrition and Nutrition strategies for cricket specifically. It was developed in a simple and easy to understand way. This booklet was distributed to all the subjects included in the study and their support staff.
- Reinforcement of the key messages was done daily for 15 days through social media (What's app groups).

Components of the training Module

Some key concepts incorporated in the booklet are as follows.

- Nutrients of significance to athletes
- Nutrition before, during and after the event
- Recovery Nutrition
- Hydration
- Electrolyte requirements

The Post Nutrition Health Education (NHE) intervention data revealed that the knowledge scores of the subjects had improved.

- In the Under 23 boys' squad, the subjects in the excellent category raised from 0 to 14% post NHE intervention while the subjects in the poor category dropped from 43% to 4%.
- In the Senior women's squad, the subjects in the excellent category raised from 0 to 25% post NHE intervention while the subjects in the poor category dropped from 8% to none.
- Similarly in the Under 19 women's squad, the subjects in the excellent category raised from 7 to 73% post NHE intervention while the subjects in the poor category dropped from 13% to 7%.
- The post NHE intervention data could not be collected for Ranji boys' squad as they were unavailable due to their ongoing matches.

CHAPTER 5. SUMMARY AND CONCLUSIONS

- Data revealed that Overweight and obesity was prevalent even in elite cricketers across all the squads.
- Nearly half the subjects had compromised body composition in terms of higher than normal body fat.
- Despite the subjects being elite players, Mild Anaemia was prevalent across all the squads which is a matter of concern. The identified anaemic subjects were given guidance about Iron and Vitamin C rich foods to improve their haemoglobin levels.
- The Survey on composition of commercially available Protein supplements revealed that the most common source of protein in the products was whey protein concentrate and the protein content of majority of the products ranged from 70-80%.
- The Survey on composition of commercially available Sports drinks revealed that 67% of the products met the recommended range for carbohydrate of 4-8g per 100ml and 63% met the recommended range for sodium of 23-69mg per 100ml.
- The developed cocoa flavanol rich drink did not show positive statistically significant impact on the muscle recovery marker of the subjects.
- A booklet titled 'Nutrition Strategies for Cricketers-An Offseason, Pre-season and Match season nutrition guide' was designed for imparting education on Sports Nutrition to the subjects. This tool was used to address the gaps in the knowledge of the players regarding sport specific nutrition. More such modules in different formats like videos should be developed.
- Since the players lack optimal nutritional status, there is a need to provide some nutrition intervention like Information Education Communication (IEC) material etc.
- There is a need to provide more intensive fitness training to improve the body composition and fitness levels.
- Due to the presence of anemia in the studied subjects, it is crucial to assess the Iron status regularly and intervene wherever required.

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