ASSESSMENT OF NUTRITIONAL STATUS OF ELITE ATHLETES WITH SPECIAL REFERENCE TO NUTRITION KNOWLEDGE OF THE ATHLETES AND THE COACHES

Thesis

Submitted to the Punjab Agricultural University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE
in
FOOD AND NUTRITION
(Minor Subject: Food Science and Technology)

By

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(L-2015-H.Sc.-310-M)

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CERTIFICATE I

This is to certify that the thesis entitled, **"Assessment of nutritional status of elite athletes with special reference to nutrition knowledge of the athletes and the coaches"** submitted for the degree of **Master of Science**, in the subject of **Food and Nutrition** (Minor subject: **Food Science and Technology**) of the Punjab Agricultural University, Ludhiana, is a bonafide research work carried out by **Aditi Sewak (L-2015-H.Sc-310-M)** under my supervision and that no part of thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE II

This is to certify that the thesis entitled, **"Assessment of nutritional status of elite athletes with special reference to nutrition knowledge of the athletes and the coaches"** submitted by **Aditi Sewak (L-2015-H.Sc-310-M)** to the Punjab Agricultural University, Ludhiana, in partial fulfillment of the requirements for the degree of **Master of Science**, in the subject of **Food and Nutrition** (Minor subject: **Food Science and Technology**) has been approved by the Student's Advisory Committee along with External Examiner after an oral examination on the same.

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ABSTRACT

Research study for the assessment of nutritional status and knowledge of 120 (16-25 years) elite athletes and nutrition knowledge of their coaches, selected from 5 universities and participating in 4 sports *viz.* hockey, athletics, badminton and lawn tennis was carried out. The nutritional status of athletes was assessed by anthropometric measurements and haemoglobin analysis followed by their nutrient intake using 24 hour recall method. Their physical activity level was recorded followed by assessment of knowledge, attitude and practice (KAP) score along with the KAP score of coaches. Anthropometric analysis revealed that the males had an average value of height (1.76m); weight (72.1kg), Body Mass Index (BMI) (23.1 kg/m^2), waist circumference (31.6 inches), hip circumference (37.8 inches) and waist hip ratio (0.8) while the corresponding values among females were1.6m, 54.3kg, 20.5kg/m^2, 26.7inches, 36 inches and 0.74 respectively. The overall triceps skinfold thickness of males (8.5mm) was found to be significantly ($p \leq 0.05$) lesser as compared to females (11.7mm). A total of 57% selected athletes had a normal BMI. The haemoglobin level of the athletes was found to be 13.8g/dL among males which was significantly ($p \leq 0.05$) higher than the average haemoglobin level of 10.8g/dL in females. Majority of all the selected males i.e. 95.4% were non-anaemic while 41.8% of the females were found to be mildly anaemic. The overall nutrient intake findings suggested that the protein intake of males (107 g/day) was higher than females (85.2 g/day); no significant difference regarding fat intake by males (96.8 g/day) and females (84.9g/day) except in athletics observing a significantly higher ($p \leq 0.05$) fat intake by males (107.8 g/day) compared to females (78.9 g/day); significantly higher ($p \leq 0.05$) iron intake by males (22.1mg/day) than females (18.6mg/day); while consumption of calcium (88.5%), vitamin A (95.3%) and vitamin C (171.2%) was adequately high among overall athletes. Majority of athletes (51.7%) had vigorously active lifestyle; 44.2% had active lifestyle. The KAP score of athletes exhibited a significant ($p \leq 0.05$) difference between male and female athletes among the athletes of hockey and lawn tennis. However, the difference between overall male and female athletes was observed to be statistically non-significant. Majority of coaches (96.7%) had no formal training in sports nutrition and 90% of them had no access to registered dietician. KAP score data of the coaches revealed that 10% had excellent KAP score; 53% had a very good score; 30% had good KAP and 6.7% had average to poor score. The haemoglobin level of the athletes revealed a positive significant ($p \leq 0.05$) correlation with the time spent in sports. A positive significant ($p \leq 0.05$) correlation between KAP score of coaches and their years of experience was observed. KAP score of athletes had a significantly ($p \leq 0.05$) positive correlation with the KAP score of coaches.

Keywords: Anthropometric analysis, Biochemical assessment, Body Mass Index (BMI), Elite athletes, Knowledge Attitude and Practice (KAP) score, Nutrient intake.

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Signature of Major Advisor **Signature of the Student**

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ਪੰਜ ਯੂਨੀਵਰਸਿਟੀਆਂ ਤੋਂ ਚਾਰ ਖੇਡਾਂ ਭਾਵ ਹਾਕੀ, ਐਥਲੇਟਿਕਸ, ਬੈਡਮਿੰਟਨ ਅਤੇ ਲਾੱਅਨ ਟੈਨਿਸ ਖੇਡਣ ਵਾਲੇ 120 (16-25 ਸਾਲ) ਸ੍ਰੇਸ਼ਟ ਅਥਲੀਟਾਂ ਦੇ ਪੋਸ਼ਣ ਪੱਧਰ ਅਤੇ ਜਾਣਕਾਰੀ ਅਤੇ ਪੋਸ਼ਣ ਸਬੰਧੀ ਉਹਨਾਂ ਦੇ ਕੋਚਾਂ ਦੀ ਜਾਣਕਾਰੀ ਦਾ ਮੁਲਾਂਕਣ ਕਰਨ ਲਈ ਮੌਜੂਦਾ ਅਧਿਐਨ ਕੀਤਾ ਗਿਆ। ਐਂਥ੍ਰੋਪੋਮੈਟ੍ਰਿਕ ਮਾਪ ਅਤੇ ਹੀਮੋਗਲੋਬਿਨ ਵਿਸ਼ਲੇਸ਼ਣ ਰਾਹੀਂ ਐਥਲੀਟਾਂ ਦੇ ਪੋਸ਼ਣ ਪੱਧਰ ਦਾ ਮੁਲਾਂਕਣ ਕੀਤਾ ਗਿਆ ਅਤੇ ਇਸ ਉਪਰੰਤ 24 ਘੰਟੇ ਰੀਕਾਲ ਵਿਧੀ ਦੀ ਵਰਤੋਂ ਕਰਕੇ ਐਥਲੀਟਾਂ ਦੁਆਰਾ ਗ੍ਰਹਿਣ ਕੀਤੇ ਗਏ ਪੋਸ਼ਕ ਤੱਤਾਂ ਦਾ ਮੁਲਾਂਕਣ ਕੀਤਾ ਗਿਆ। ਉਹਨਾਂ ਦੀ ਸਰੀਰਕ ਗਤੀਵਿਧੀ ਦਾ ਪੱਧਰ ਦਰਜ ਕੀਤਾ ਗਿਆ ਅਤੇ ਇਸ ਉਪਰੰਤ ਕੋਚਾਂ ਦੀ ਜਾਣਕਾਰੀ, ਰਵੱਈਏ ਅਤੇ ਅਭਿਆਸ (ਕੇ.ਏ.ਪੀ.) ਅੰਕ ਦਾ ਮੁਲਾਂਕਣ ਕੀਤਾ ਗਿਆ। ਐਂਥ੍ਰੋਪੋਮੈਟ੍ਰਿਕ ਮੁਲਾਂਕਣ ਤੋਂ ਪਤਾ ਚੱਲਿਆ ਕਿ ਪੁਰਸ਼ਾਂ ਦੀ ਔਸਤ ਲੰਬਾਈ 1.76 ਮੀਟਰ; ਭਾਰ 72.1 ਕਿ.ਗ੍ਰਾ., ਬੀ.ਐਮ.ਆਈ. 23.1 ਕਿ.ਗ੍ਰਾ./ਮੀ.^{2}, ਕਮਰ 31.6 ਇੰਚ, ਹਿੱਪ ਦਾ ਘੇਰਾ 37.8 ਇੰਚ ਅਤੇ ਕਮਰ:ਹਿੱਪ ਅਨੁਪਾਤ 0.8 ਸੀ ਜਦੋਂਕਿ ਮਹਿਲਾਵਾਂ ਲਈ ਇਹ ਮਿਕਦਾਰਾਂ ਕ੍ਰਮਵਾਰ 1.6 ਮੀਟਰ, 54.3 ਕਿ.ਗ੍ਰਾ., 20.5 ਕਿ.ਗ੍ਰਾ/ਮੀ.^{2}, 26.7 ਇੰਚ ਅਤੇ 0.74 ਸੀ। ਪੁਰਸ਼ਾਂ ਦੀ ਕੁੱਲ ਟ੍ਰਾਈਸਿਪ ਤਵਚ ਮੋਟਾਈ (8.5 ਮਿ.ਮੀ.) ਮਹਿਲਾਵਾਂ ਦੀ ਟ੍ਰਾਈਸਿਪ ਤਵਚ ਮੋਟਾਈ (11.7 ਮਿ.ਮੀ.) ਤੋਂ ਅਰਥਪੂਰਨ ਤੌਰ ਤੇ ਘੱਟ ਸੀ। 57% ਐਥਲੀਟਾਂ ਦਾ ਬੀ.ਐਮ.ਆਈ. ਠੀਕ ਸੀ। ਪੁਰਸ਼ਾਂ ਦੀ ਹੀਮੋਗਲੋਬਿਨ ਪੱਧਰ 13.8 g/dL ਸੀ ਜੋਕਿ ਮਹਿਲਾਵਾਂ ਦੇ ਔਸਤਨ ਹੀਮੋਗਲੋਬਿਨ ਪੱਧਰ (10.8 g/dL) ਤੋਂ ਅਰਥਪੂਰਨ ($p\leq0.05$) ਤੌਰ ਤੇ ਵਧੇਰੇ ਸੀ। ਜ਼ਿਆਦਾਤਰ ਪੁਰਸ਼ਾਂ (95.4%) ਵਿੱਚ ਖੂਨ ਦੀ ਕਮੀ ਨਹੀਂ ਸੀ ਜਦੋਂਕਿ 41.8% ਮਹਿਲਾਵਾਂ ਵਿੱਚ ਖੂਨ ਪੱਧਰ ਲੋੜ ਤੋਂ ਥੋੜ੍ਹ ਘੱਟ ਦਰਜ ਕੀਤਾ ਗਿਆ। ਪੁਰਸ਼ਾਂ ਦੁਆਰਾ ਪ੍ਰੋਟੀਨ (107 ਗ੍ਰਾਮ/ਦਿਨ) ਦੀ ਖਪਤ ਮਹਿਲਾਵਾਂ (85.2 ਗ੍ਰਾਮ/ਦਿਨ) ਤੋਂ ਵਧੇਰੇ ਸੀ; ਫੈਟ ਦੀ ਖਪਤ ਦੇ ਲਿਹਾਜ਼ ਨਾਲ ਪੁਰਸ਼ਾਂ (96.8 ਗ੍ਰਾਮ/ਦਿਨ) ਅਤੇ ਮਹਿਲਾਵਾਂ (84.9 ਗ੍ਰਾਮ/ਦਿਨ) ਵਿੱਚ ਕੋਈ ਅਰਥਪੂਰਨ ਵਿਭਿੰਨਤਾ ਦਰਜ ਨਹੀਂ ਕੀਤੀ ਗਈ; ਪਰ ਅਥਲੈਟਿਕਸ ਵਾਲੇ ਪੁਰਸ਼ਾਂ (107.8 ਗ੍ਰਾਮ/ਦਿਨ) ਦੀ ਫੈਟ ਗ੍ਰਹਿਣ ਦੀ ਮਿਕਦਾਰ ਮਹਿਲਾਵਾਂ (78.9 ਗ੍ਰਾਮ/ਦਿਨ) ਤੋਂ ਅਰਥਪੂਰਨ ($p\leq0.05$) ਤੌਰ ਤੇ ਵਧੇਰੇ ਸੀ; ਪੁਰਸ਼ਾਂ (22.1 ਮਿ.ਗ੍ਰਾ./ਦਿਨ) ਮਹਿਲਾਵਾਂ (18.6 ਮਿ.ਗ੍ਰਾ./ਦਿਨ) ਦੇ ਮੁਕਾਬਲੇ ਆਇਰਨ ਦੀ ਖਪਤ ਅਰਥਪੂਰਨ ($p\leq0.05$) ਤੌਰ ਤੇ ਵਧੇਰੇ ਸੀ; ਜਦੋਂ ਕਿ ਕੈਲਸ਼ੀਅਮ (88.5%), ਵਿਟਾਮਿਨ ਏ (95.3%) ਅਤੇ ਵਿਟਾਮਿਨ ਸੀ (171.2%) ਦੀ ਖਪਤ ਸਾਰੇ ਹੀ ਐਥਲੀਟਾਂ ਵਿੱਚ ਵਧੇਰੇ ਸੀ। ਜ਼ਿਆਦਾਤਰ ਐਥਲੀਟਾਂ (51.7%) ਦੀ ਜੀਵਨਸ਼ੈਲੀ ਬਹੁਤ ਵਧੇਰੇ ਕਿਰਿਆਸ਼ੀਲ ਸੀ ਅਤੇ 44.2% ਅਥੈਲੀਟਾਂ ਦੀ ਜੀਵਨਸ਼ੈਲੀ ਕਿਰਿਆਸ਼ੀਲ ਸੀ। ਐਥਲੀਟਾਂ ਦੇ ਕੇ.ਏ.ਪੀ. ਅੰਕ ਤੋਂ ਪੁਰਸ਼ ਅਤੇ ਮਹਿਲਾ ਐਥਲੀਟਾਂ ਵਿੱਚ ਅਰਥਪੂਰਨ ($p\leq0.05$) ਵਿਭਿੰਨਤਾ ਦਰਜ ਦਾ ਪਤਾ ਚੱਲਿਆ। ਜ਼ਿਆਦਾਤਰ ਕੋਚ (96.7%) ਨੇ ਖੇਡ ਪੌਸ਼ਣ ਵਿੱਚ ਕੋਈ ਔਪਚਾਰਿਕ ਸਿਖਲਾਈ ਨਹੀਂ ਲਈ ਹੋਈ ਸੀ ਅਤੇ ਉਹਨਾਂ ਵਿੱਚੋਂ 90% ਰਜਿਸਟ੍ਰਡ ਆਹਾਰ ਮਾਹਿਰ ਦੇ ਸੰਪਰਕ ਵਿੱਚ ਨਹੀਂ ਸਨ। ਕੋਚਾਂ ਦੇ ਕੇ.ਏ.ਪੀ. ਅੰਕ ਆਂਕੜਿਆਂ ਤੋਂ ਪਤਾ ਚੱਲਿਆ ਕਿ 10% ਕੋਚਾਂ ਦਾ ਕੇ.ਏ.ਪੀ. ਅੰਕ ਬਹੁਤ ਹੀ ਜ਼ਿਆਦਾ ਵਧੀਆ; 53% ਦਾ ਬਹੁਤ ਵਧੀਆ; 30% ਦਾ ਵਧੀਆ ਅਤੇ 6.7% ਦਾ ਔਸਤ ਦਰਜੇ ਦਾ ਸੀ। ਐਥਲੀਟਾਂ ਦੇ ਹੀਮੋਗਲੋਬਿਨ ਦੇ ਪੱਧਰ ਦਾ ਖੇਡਣ ਦੇ ਸਮੇਂ ਨਾਲ ਅਰਥਪੂਰਨ ($p\leq0.05$) ਸਬੰਧ ਵੇਖਣ ਨੂੰ ਮਿਲਿਆ। ਕੋਚਾਂ ਦੇ ਕੇ.ਏ.ਪੀ. ਅੰਕ ਦਾ ਉਹਨਾਂ ਦੇ ਤਜ਼ਰਬੇ ਨਾਲ ਅਰਥਪੂਰਨ ($p\leq0.05$) ਅਤੇ ਸਕਾਰਾਤਮਕ ਸਬੰਧ ਵੇਖਣ ਨੂੰ ਮਿਲਿਆ। ਐਥਲੀਟਾਂ ਦੇ ਕੇ.ਏ.ਪੀ. ਅੰਕ ਦਾ ਕੋਚਾਂ ਦੇ ਕੇ.ਏ.ਪੀ. ਅੰਕ ਨਾਲ ਅਰਥਪੂਰਨ ($p\leq0.05$) ਅਤੇ ਸਕਾਰਾਤਮਕ ਸਬੰਧ ਵੇਖਿਆ ਗਿਆ।

ਮੁੱਖ ਸ਼ਬਦ: ਐਂਥ੍ਰੋਪੋਮੈਟ੍ਰਿਕ ਮੁਲਾਂਕਣ, ਜੀਵ-ਰਸਾਇਣਕ ਮੁਲਾਂਕਣ, ਬੀ.ਐਮ.ਆਈ., ਵਧੀਆ ਐਥਲੀਟ, ਜਾਣਕਾਰੀ, ਰਵੱਈਆ ਅਤੇ ਅਭਿਆਸ (ਕੇ.ਏ.ਪੀ.) ਅੰਕ, ਪੌਸ਼ਕ ਪੱਧਰ

ਪ੍ਰਮੁੱਖ ਸਲਾਹਕਾਰ ਦੇ ਹਸਤਾਖਰ **ਵਿਦਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ**

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CHAPTER I

INTRODUCTION

An elite athlete is defined as one who has previously or currently competed as a state player, varsity player (individual or team), a professional player or a national or international level player. Nutrition plays a very important role in attaining high level of achievements in sports. A permutation of proper training and a sensible approach to nutrition is the key to successful athletic performance. From decades, nutrition has been recognized as a contributing factor for success in training and competition (Alexopoulas and Frazier 2012). A requisite for optimal growth and development, nutrition is correspondingly an essential part for sport performance in young athletes. Hence, physical fitness and training are very much dependent on nutritional status of sports personnel. Adequate calorie intake, ample hydration and consideration to timing of meals are needed for ultimate athletic performance (Purcell 2013). Thus, nutritional status has a direct bearing on the level of physical performance. In order to obtain adequate nutrition to elevate health and fitness or sports performance, an athlete's dietary goals should include seeking active supplementation information from nutritionists or dieticians. Such a practice not only aid to improve athletic performance but also to stimulate healthy dietary practices in long term.

Nutritional requirement is directly proportional to sports performance and vice-versa. Taking care of nutrition for sports performance has gained prime importance as it is considered that sports persons need more energy to carry out their sporting activity. Strong emphasis on diet has been posed by track as well as field athletes. It is essential for an athlete expending energy at such high levels to consume adequate calories, yet a number of studies specify that female athletes are unable to meet recommended demands of nutrients, especially that of energy while training and competing (Hoogenboom *et al* 2009; Anderson and Dawn 2010). According to the Joint Position Statement by American College of Sports Medicine; American Dietetic Association and Dieticians of Canada (2000), adequate calorie intake is desirable in order to maintain lean tissue mass, immune as well as reproductive function and an optimal athletic performance. Inadequate calorie intake leads to a condition in which the body uses fat and lean tissue mass as fuel, which may result in loss of muscle mass, thus compromising strength and endurance.

Presently, a considerable amount of research studies are available regarding nutrient intake of athletes but somehow, studies regarding sports-specific nutritional needs are yet to be performed (Valliant *et al* 2012). The critical component to meet adequate energy needs is to achieve energy balance which is attained when energy intake equals energy expenditure, as stated by Rodriguez *et al* (2009). A number of factors are there

which influence energy expenditure such as type, duration and intensity of exercise along with body size, fat free mass (FFM) and nutritional status prior to exercise. Consumption of macronutrients in adequate amounts is essential to sufficiently replenish glycogen stores and carbohydrate consumption is an important factor impacting muscle glycogen storage (Bruke *et al* 2004). However, it was revealed in a research study by Valliant *et al* (2012) that delivering nutrition education resulted in a significant increase in sports nutrition knowledge accompanied by increased intake of energy, carbohydrates and protein. The study also suggested that sustaining optimal athletic performance with a low energy intake is challenging for an athlete, therefore, advising athletes against skipping meals and encouraging them to keep healthy snacks available is one way to maintain athlete's health even while travelling to tournaments.

Since the time people began to participate in sports competition, nutrition has been perceived as an integral component of physical performance. As we have progressed in understanding human metabolism and exercise physiology, it has been made clear in last few decades that manipulation of nutrient intake had the potential to positively influence on the sports performance (Molinero and Marquez 2009). Nowadays, there has been a high prevalence and a variety of nutritional supplements being accepted and practiced by the athletes. The outraging market has led number of elite athletes to use nutrition supplements in hopes of improving performance. Often these supplements can be harmful enough as they are based on very little or no scientific evidence. Such products which may be advertised by the name of sports supplements, ergogenic aids/supplements claim to provide required nutrients in appropriate quantities to optimise sports performance. Therefore, it is of primary importance for the sports nutrition professional to have a thorough working knowledge of foods and supplements in order to provide a sound advice to the sportspersons.

A variety of personnel including coaches, athletic trainers, sports nutritionists and medical practitioners may deliver nutrition education. Athlete nutrition-awareness programmes aim to mend dietary inadequacies and promote ideal health and athletic performance by fostering sound knowledge in general and sport-nutrition-specific areas (Burns *et al* 2004). Such nutrition programmes for athletes, may be chiefly coach driven and should be continued even at the elite level, with regularised intervention by experts as influenced by financial constraints (Zinn *et al* 2006). Adequate nutrition education positively affects an athlete's dietary intake. A wholesome guidance attained by sports nutritionist would enable an athlete to make better food choices, thereby maintaining his/her goal weight. According to Supriya and Ramaswami (2013), there has been a direct correlation between healthy food choices and an athlete's nutrition knowledge. In this context, it was found by

Dunn *et al* (2007) that out of a few number of studies conducted on nutrition knowledge among collegiate athletes, the majority among this population had a dearth of basic nutrition knowledge. The dramatic increase in the number of athletes participating in exercise and sports has contributed in a big deal to attain better physical fitness, along with significant health benefits and therefore, an enhanced overall well-being (Barker *et al* 2007). It is believed that nutritional intake is influenced by an individual's nutrition knowledge, which in turn influences performance of elite athletes (Devlin and Belski 2015). Performance is further influenced by various other factors which include cultural food preferences and food choices, skill in purchasing food, reading label on food package and food preparation (Obayashi *et al* 2003). Increased sports participation also invites pressures to perform at high level competitions which have given birth to a condition known as female athlete triad which has received a forefront position in sports medicine (Hoongenboom *et al* 2009). Female athlete triad has been defined as a trio of low energy availability, menstrual dysfunction and low bone mass which is acquired as a result of poor nutrition. One key element to impact this condition is nutrition. The study also suggested that many researchers agree that female athletes consumed an inadequate diet which was a result of lack of nutrition knowledge and nutritional misconceptions among them. According to Ousley *et al* (2001), parents, coaches and peers are the major sources from where an athlete receives most of their nutrition knowledge, yet many athletes have incorrect or baseless sources of information which may become the cause of development of such conditions among female athletes.

There is an urgent requirement of standardizing good nutritional habits with respect to sportspersons. Once, a practical standardization of such food habits is attained, depending upon this country's food availability, a scientific approach towards importance of nutrition for sportspersons could be achieved. A combination of appropriate food selection, adequate nutrition knowledge and preparation skill is required for a better dietary intake while the underlying assumption is that behavioural change will assist education in these areas. For adopting healthier food habits, even a small amount of nutrition knowledge is pivotal (Worsley 2002).

It has been revealed by Wardle *et al* (2000) the individuals having more knowledge are almost twenty-five times more likely to meet present recommendations for foods such as fruits, vegetables, fat as compared to those having lesser nutrition knowledge. There is not only lack of research studies on nutrition knowledge of athletes but also a number of methodological limitations with the instruments for measuring nutrition knowledge is there, which may contribute to the weak link between nutrition knowledge and dietary intake (Obayashi *et al* 2003). Certain beliefs about food and nutrition also influence nutrition knowledge of an individual based on a non- scientific approach rather culture biased. It has

been identified that nutrition knowledge is also influenced by demographics such as sex, age, level of education as well as the socioeconomic status of an athlete (Turrell and Kavanagh 2006). It has been found in various studies that as compared to younger athletes, middle aged athletes have a better history of performance in sports (Hendrie *et al* 2008). In another study by Dunn *et al* (2007) it was revealed that female athletes score better than male athletes in sports indicating that the sex of an athlete also influences nutrition knowledge and thus performance.

The educational resources for athletes belonging to low income communities are comparatively less, which may have become the reason for possessing insufficient knowledge about nutrition and sports supplements which negatively affects health conscious decision making by them (Peerkhan and Srinivasan 2010). In sports specific studies, collective factors such as athletic calibre, physique, sports type are said to be capable of increasing focus on dietary intake, which may influence nutrition knowledge. It has been evident that participation in various competitions and tournaments increases nutrition knowledge scores of athletes as they gain experience in their sport. Nevertheless, there is a need for an athlete to achieve the goals of sound nutrition which require a practical approach for nutrition education in order to address key food and fluid choices along with eating strategies. The nutrition knowledge of collegiate athletes varies according to their college subject majors. It had been stated in a research study by Azizi *et al* (2010) that the nutrition knowledge of those athletes pursuing physical education course at their institutions is better than those pursuing some other major subject and has also suggested that provision of nutrition courses in non –physical education subjects may positively influence dietary behaviours of those athletes. Also, a majority of athletes have been reported to highlight the importance of breakfast.

Individual assessment along with counselling from a sports nutrition expert has been recommended for athletes with extreme nutrient requirements, or with nutritional problems (Smart *et al* 2014). Such a research cannot be completed without assessing knowledge of coaches regarding nutrition, as coaches are the first persons dealing with sportspersons as their word is taken as the word of God by the athletes. Proliferation of studies concerning numerous aspects of sports nutrition has been rising since years. Sound nutrition practices year-around influence finer points of athletic training.

It has been concluded by Reade *et al* (2008) that coaches often receive nutrition knowledge from other coaches, their experiences and self-involvements in sports and competitions. Little evidence has been found so far which signifies role of sports scientists to be the main source of nutrition knowledge for coaches, thus indicating an insignificant interaction among sports scientists and coaches. This study also suggested that collaboration

of coaches with sports scientists and inculcation of creative ideas in sports programmes could contribute to coaching significantly. However, some coaches receive such innovative ideas to implement sports programmes by other coaches as well or from various sports seminars they attend. Lack of time to search and implement innovative sports programmes had also been found as a drawback in creating elite athletes.

In recent years, coaches concern regarding nutrition of their athletes has been increased, although very less studies show such evidence. It is generally associated with the fact that rare investigations have been reported regarding problem of knowledge about sports nutrition. In order to achieve appropriate nutritional practices and awareness regarding health hazards, receiving knowledge of sports nutrition and dietary supplementation is crucial. It has been found in a study carried out by Sajber *et al* (2013) the most important source of information regarding coaches' sports nutrition knowledge is self-education while athletes reported their main source of sports nutrition knowledge were their coaches.

The effective primary resources of nutrition education are thus coaches, athletic trainers, registered dieticians and sports scientists. The key areas of nutrition which are to be considered while planning diets for athletes includes accurate analysis of energy needs and body composition along with a combination of macronutrients, vitamins and minerals, hydration, training diet and cautious use of supplements and ergogenic aids. Dissemination of incorrect information regarding nutrition is a major concern for professionals whose sports nutrition knowledge is deficient, often based on unsupported evidence (McGehee *et al* 2012). It has been stated in a study conducted by Walsh *et al* (2011) that nutrition knowledge and dietary practices of young athletes may be benefitted from appropriate nutritional education. A number of barriers to healthy eating had been described by athletes as well their coaches in a research study carried out by Heaney *et al* (2008). The most significant barrier stressed upon by most of the groups was lack of time for preparation of desired food item. Financial limitations, inadequate cooking skills were also being strained as factors responsible for inadequate intake of healthy diet. Excess body weight and fat levels have been reported as major concerns by the coaches who stimulate a feeling in athletes to maintain required body shape which may become a cause of lesser intake of diet.

Athletes are not born but are made, thus the training and preparation process of promising young athletes must, therefore take account of measures not only to train and provide coaching to them in the sophisticated techniques of playing their game or sport, but also to equip them with scientific and authentic information relating to the role of good nutrition in maintaining required physique and improved physical performance. Therefore, it has become a necessity to pay attention towards obtaining information and authentic data on

dietary knowledge, attitude and practices of athletes as well as their coaches with respect to their food habits, beliefs and fads they possess. Hence, in the present study, an attempt was made to obtain data regarding the objectives mentioned below:

1. To study the nutritional status of athletes performing at state and national levels.
2. To assess the nutrition knowledge level of the selected athletes and coaches.
3. To develop nutrition guidelines for improvement in sports performance.

CHAPTER II

REVIEW OF LITERATURE

The review regarding nutritional status of elite athletes and nutrition knowledge of the athletes and coaches has been collected and discussed below subsequent headings:

2.1 Nutritional status of athletes

2.1.1 Impact of nutritional status on performance of athletes

2.1.2 Impact of supplements on nutritional status and performance of athletes

2.2 Nutrition knowledge of athletes

2.2.1 Impact of nutritional knowledge on nutritional status and performance of Athletes

2.2.2 Impact of nutrition education on nutrition knowledge and nutritional status of athletes

2.3 Nutrition knowledge of coaches

2.1 NUTRITIONAL STATUS OF ATHLETES

2.1.1 Impact of nutritional status on performance of athletes

The level of physical performance has a direct bearing on nutritional status, for this reason sports nutrition had been considered an integral part in the field of medicine. Koley and Sharma (2013) evaluated nutritional status of Indian female athletes from six Indian universities and compared with equal number of controls from the same place. Athletes' height, weight, BMI, waist circumference, hip circumference, waist to hip ratio and mid-upper arm circumference were the six anthropometric characteristics which were measured. The results indicated significant higher mean values in height, waist circumference, waste to hip ratio and lesser mean values in weight, BMI, hip circumference and mid-upper arm circumference among Indian female athletes than their control counterparts while no significant difference between the BMI of both the groups were observed and majority individuals had BMI within normal range. As far as mean nutrient intake was concerned, significant higher mean consumption values of all the nutrients except energy, iron and sodium by the athletes as compared to control group had been observed. It was, therefore, concluded that Indian female athletes possessed a better nutritional status as compared to their complementary control group.

Nande and Sabiha (2011) studied how physical fitness of young female players engaged in three Indian traditional games like Kabaddi, Kho-kho and rope mallakhamb was affected by sports training and nutritional adequacy. A significantly higher mean intake of energy and energy yielding nutrients intake as compared to Recommended Dietary

Allowances (RDAs) was reported. The average carbohydrate, protein and fat intakes along with micronutrients such as riboflavin, iron, thiamine and vitamin C were found to be adequate. An increase had been shown in the lean body mass and body density while decrease in percent body fat at 12 months. The fact that regular participation in sports lead to decrease in percent body fat, correspondingly increasing lean body mass had been confirmed by the results which clearly depicts an association between regular sports training and participation and inclination towards healthier life.

Croll *et al* (2006) examined eating habits and energy and nutrient intake among adolescents who participated in weight-related and power team sports and compared same parameters with non-sport involved adolescents. It was found that the frequency of eating breakfast was more in youth who were involved in sports as compared to their peers who did not play any sport. Also, the mean intake of nutrients such as protein, calcium, iron and zinc was found to be higher in athletes pursuing weight-related and power team-sport than those who did not pursue any sport. Regardless of sports involvement, it had been reported that adolescent female had low intake of calcium. Consequently, it was established that better eating habits and nutrient intake had been shown by adolescents involved in sports as compared to their peers who were not involved in sporting events. However, nutrition interventions particularly regarding calcium intake were still required.

Bandyopadhyay (2007) compared and evaluated anthropometry and body composition between athletes (volleyball and soccer players) and sedentary men, both groups participated from West Bengal, India. Significantly higher girth measurements, skinfolds, body fat percentage and endomorphy among sedentary men were reported while lean body mass and mesomorphy were found to be significantly higher in sports persons. In comparison to their overseas counterpart, volleyball and soccer players had higher fat percentage with lower body height and body mass. A significant correlation was exhibited between percent fat and body mass index (BMI) on the basis of which prediction equations had been formulated in each group. Therefore, this data was concluded to serve as a reference standard for anthropometry and body composition of Indian volleyball and soccer players and recommended to be a great help to provide first-hand impression of body composition of the studied population could be delivered by prediction norms of fat percentage.

Koley and Kaur (2011) estimated the dominant handgrip strength and its correlations with some hand and arm anthropometric variables of randomly selected Indian inter-university female volleyball players from six Indian universities and revealed that the mean values in eleven variables were higher among female volleyball players while lesser mean value in two variables had been shown by their control counterpart, thus, significant

differences in height, weight, left hand width, left and right hand length, right upper arm length, right forearm length, dominant and non-dominant handgrip strength had been observed. A significant positive correlation had been observed between dominant handgrip strength with all the studied variables among Indian inter-university female volleyball players had been concluded. Another two-fold study on anthropometric profile along with correlation between body mass index, percent body fat and hand-grip strength of Indian inter-university volleyball players had been conducted by Koley *et al* (2010). The results suggested taller and heavier characteristics of male volleyball players while female volleyball players were slightly taller and lighter than their respective counterparts.

Nutritional status, iron deficiency-related biochemical indices, and immunologic patterns of female Judo athletes and control subjects were evaluated in a comparative study conducted by Kim *et al* (2002). The study evaluated the food records of the subjects which showed energy expended was 41.0Kcal/kg, with major contributions to total energy intake made by protein, fat and carbohydrate as 12.5%, 29.2% and 58.3% respectively. Vitamins consumption level exceeded the recommended dietary allowance; however, iron and calcium intake levels were found to be 100% less than the recommended dietary allowance. Nutrients whose consumption was found higher in athletes as compared to control group included energy, protein, phosphate, Vitamin B1 and B2. Nutrient Adequacy Ratio and the Index of Nutritional Quality analysis reported more desirable patterns of athletes as compared to control groups. Haemo-dilution during strenuous exercise might cause anaemia. Slight immunosuppression had been observed in the immunologic pattern of the subjects. A positive correlation was also found between iron, vitamin B1, niacin intakes and immunoglobulin (Ig) G levels among athletes. Further investigation regarding relationship between nutrient intakes and immune system of endurance-trained athletes was suggested.

A study to assess micronutrient status of female and male players engaged in different sport disciplines who had participated in university/state levels was undertaken by Nande *et al* (2009). It was revealed that mean intake of micronutrients such as thiamine, riboflavin, folic acid; calcium and phosphorus were found to be less than their respective recommended dietary allowances (RDAs), irrespective of their gender and event of sports. In contrast, the mean dietary intake of carotene and vitamin C exceeded recommended dietary allowances (RDAs) by the players. However, only 50% of recommended iron intake was being met by the players. Skipping meals due to training and hectic college schedule of the players was reported to be the probable reason for poor nutrient intake by them. The haemoglobin % by World Health Organisation (WHO) of majority of players had been perceived to be exceeding the normal cut off levels. The average systolic and diastolic values of players were recorded

to be closer to the normal. The mean normal pulse rate of majority of group of players was insignificantly at higher side.

Prevalence of Vitamin D insufficiency in various populations worldwide had been known but this nutrient has been considered important for athletes as it affects bone-mass, immunity and physical performance. Constantini *et al* (2010) evaluated the prevalence of Vitamin D insufficiency and deficiency among young athletes and dancers in a cross-sectional study in sport medicine clinic. Seventy-three percent of participants were found to be Vitamin D deficient. Higher deficiency of this nutrient had been found among dancers as compared to young athletes. Furthermore, the concentration of serum 25(OH) D levels was adjusted according to age and sex correlated with serum ferritin and season among athletes from indoor versus outdoor sporting events. It was this concluded that the young athletes and dancers from a sunny country pursuing various events were identified to be vitamin D deficient. Those who practiced indoors were found to have higher rate of Vitamin D deficiency, especially during winter months and during the incidence of iron depletion. Since Vitamin D is important for athletes for various reasons, it was suggested that regular screening of athletes and dancers for serum Vitamin D status is essential followed by necessary treatment.

A typical aspect for maximal performance in athletes is their dietary practices. Various research studies had shown that there is prevalence of insufficient dietary information during competitions among Indian athletes. Sharma (2015) investigated dietary practice of university athletes pursuing different sporting events. It was reported that 43.33% athletes adapted change in their dietary pattern during competitions. It had been further observed that 31.67% athletes skipped meals before competition while 23.33% of them were aware of carbohydrate loading prior to competitions. However, 34.17% athletes were found to consume sports drink everyday prior to their training regime, whereas 60% athletes consumed energy bars for the same. Consumption of energy gel during training or competition was not a common practice among athletes. The reason behind lack of good dietary practice was the dearth of nutrition knowledge among athletes as well as their coaches pursuing different games and sports. Furthermore, sports specific differentiation of dietary practices had been indicated as a strong impact of sports coaches, trainers, teammates, family and last but not the least, our Indian culture.

Ramana *et al* (2004) conducted a study on athletes to assess body composition using appropriate tools of measurement such as body height, weight, circumferences and skinfold thickness at four sites, followed by use of indirect calorimetry during three phases of training i.e. transition, pre-competition and competition phase. Significant increase in lean body mass

and maximal work performance had been observed from transition to competition phase. Thus, it was concluded that in order to assess training induced adaptations, body composition had been recognized as an important component and might enhance work performance. Veena and Subapriya (2010) conducted a comparative study on nutritional status and sports performance of adolescent female athletes and non-athletes. Inadequacy in the dietary intake of important nutrients among both the groups with a higher percentage of deficiency among athletes had been observed as a result. The reason that athletes were found to have deficient dietary intake could be hidden in the fact that athletes require more nutrients especially energy than normal individuals and participants of this study were unable to meet the requirements as suggested for athletes' diet.

2.1.2 Impact of supplements on nutritional status and performance of athletes

Athletes are at a constant search for methods to improve aerobic capacity through various nutritional and ergogenic aids. Shenoy *et al* (2012) conducted a study to find out the effect of 'Ashwagandha' on the cardiorespiratory endurance capacity i.e. aerobic capacity of elite Indian cyclists chosen randomly with a minimum participation at state level. The supplementation of capsules (500mg) of aqueous roots of Ashwagandha twice per day for eight weeks was given to athletes while placebo group received starch capsules. The aerobic capacity of cyclists in terms of maximal aerobic capacity, metabolic equivalent, respiratory exchange ratio and total time for athlete to reach exhaustion stage was measured through the baseline treadmill test which was performed again after a span of eight weeks of supplementation. As a result, significant improvement in all the parameters in the experimental group was observed whereas, the baseline parameters of the placebo group did not show any change. In the nutshell, Ashwagandha was observed to improve the cardiorespiratory endurance of the elite athletes.

Edward (2007) conducted a study on fluid and fuel intake during exercise. It was reported that players who consumed fluids containing sodium during any event, the stamina lasted longer than two hours. It was concluded that athletes shall be benefitted the most by tailoring their individual needs of water, carbohydrates and salt required for specific challenges in their event of sport, giving special reference to impact of environment on sweating and heart stress. However, effect of vitamin and mineral status on physical performance had been studied by Lukaski (2004) which revealed impaired muscle function and limited work capacity is related to iron deficiency with or without anaemia. As the body becomes deprived of magnesium during completion of sub-maximal exercise, an increase in oxygen demand had been observed which may further affect endurance performance. Role of vitamin and mineral supplements become insignificant in improving measures of performance

in people consuming adequate diets as revealed by Geor (2006) in a study to evaluate role of nutritional supplements and feeding strategies in equine athletic performance. It was concluded that although nutritional supplements were commonly assumed to boost performance or health in horses for most but there is still efficient evidence awaited to prove the above statement.

An integral component of fatty acid transfer into the mitochondria is an amino acid called carnitine. It had been suggested in various research studies that athletes could benefit from carnitine supplementation as they might be at risk of low carnitine status which had negative effects on their performance. The habitual dietary carnitine intake of endurance trained adult males had been reported in a research study conducted by Broad *et al* (2006) and determined risk of carnitine deficiency by measuring plasma and urinary carnitine concentrations. The results revealed that mean dietary intake of carnitine was 64mg/day which fell between normal range (21-110mg/day). Mean resting plasma and free carnitine ratio was also found to fall between normal range so as the urinary excretion concentration. Dietary carnitine intake and plasma or urinary excretion had no significant correlation. Therefore, it was concluded that endurance trained males, consuming a mixed diet were not at all at risk of carnitine insufficiency.

Importance of micronutrients to enhance physical performance had been reported by various research studies. A multi-micronutrient-fortified beverage was supplemented to clinically healthy school age children (who were assessed for physical performance which measured a double blind for test and placebo groups), placebo controlled randomized trial on children between 7 to 10.5 years of age in a research study by Vaz *et al* (2011). The children were supplemented one out of three i.e. fortified choco-malt beverage powder, matched energy equivalent unfortified placebo and untreated control randomly. Endurance and aerobic capacity were included in the primary efficacy outcomes by the use of various physical tests. The status of micronutrients such as thiamine, riboflavin, folate, niacin, iron, pyridoxal phosphate, vitamin B 12 and C were assessed and were measured at the baseline after intervention. An increase in aerobic capacity and whole body endurance within subject accompanied by a significant improvement in status of above mentioned micronutrients had been observed in the group supplemented with choco-malt beverage as compared to other two groups. Therefore, it was concluded by the study that multiple micronutrient supplementation in such populations proved to be beneficial in improving micronutrient status, athletes' endurance and work capacity.

Adequate consumption of energy is a crucial issue in case of athletes which primarily depends upon type, intensity and duration of physical activity related to discipline of sports

practiced and to the duration of training cycle. The energy requirement of athletes is generally 50% higher than that of adults who do not practice any sport. Zapolska *et al* (2014) conducted a study to characterize the mode of nutrition, including dietary supplements and to assess somatic indices in female volleyball players. It was indicated in the data analysis that anthropometric characteristics and body composition of the players meet the recommendations associated with the somatic features in volleyball. The daily diet of the volleyball players was also found to be deficient in energy when compared with recommendations given for physically active people. The average diet of majority players was found to have excessive proportion of saturated fatty acids and dietary cholesterol with a too low content of monounsaturated and polyunsaturated fatty acids, followed by a very low supply of carbohydrates and dietary fiber. An alarmingly low level of vitamins and minerals, especially iron and calcium had been observed in athletes' diet with insufficient use of dietary supplements. The body composition of majority of athletes had no significant abnormality though they were recommended to slightly lower fat mass and increase the muscle mass. Further research on nutrition of sportspersons along with imparting nutrition education to them had been suggested.

Metabolism is deleteriously affected by strenuous endurance training which is recognized to raise oxidative stress in the body which may further affect sports performance due to changes in haem status. This oxidative stress can be countered by antioxidant ingestion as shown in a study conducted by Kelkar *et al* (2008) to assess effect of antioxidant supplementation on haematological parameters, oxidative stress and performance of Indian athletes. Composition of antioxidant supplementation included beta-carotene, Vitamin A, Vitamin E, Vitamin C, Zinc and selenium in tested quantities. Several parameters of body composition and serum levels which indicated oxidative stress were also evaluated. A significant improvement in Haemoglobin level, Packed Cell volume (PCV) and Red Blood Corpuscles (RBC) were seen as a result followed by improved serum oxidative stress levels, thus concluding that antioxidant supplementation overcomes oxidative stress which calls for enhanced sports performance. It had been stated by Chamorro *et al* (2009) that body mass index (BMI) alone cannot be referred to determine body composition of athletes in their study to determine correlation between body mass index and body composition. After reviewing athletes' training regime, it was reported that optimal muscle content had been displayed by well-trained athletes and concluded that fat content is left as the only indicator to assess body mass index.

2.2 NUTRITION KNOWLEDGE OF ATHLETES

2.2.1 Impact of nutrition knowledge on nutritional status and performance of athletes

Nutrition education aims to enhance nutrition knowledge and improve dietary intake in athletes which in turn influences performance. Heaney *et al* (2011) systematically reviewed the level of nutrition knowledge in athletes and non-athlete comparison groups along with determining the impact of nutrition knowledge on dietary intake. Athletes' knowledge was found to be equal to or better than that of non-athletes but lower than the comparison groups including nutrition students. It was also stated that nutrition knowledge of females had an edge over that of males. There had been a vague information regarding association of nutrition knowledge of athletes and their dietary intake. It was concluded that a superior quality and contemporary research by means of high quality, authenticated tools to measure nutrition knowledge and its impact on dietary intake had been looked for in the coming era. A similar study was conducted by Devlin and Belski (2015) to gain an insight into the current level of sports nutrition knowledge among forty-six elite male Australian football players. The mean nutrition knowledge score was found out to be 60.5%. Also, sports dietician was selected as the first source of nutrition information by 98% athletes while team mates were the second choice as a source of nutrition information by majority of them. It was, therefore concluded that dietary interventions by athletes require a better understanding of nutrition knowledge by them.

It has been suggested by various studies that optimal nutrition enhances sports performance but there is prevalence of deficit nutrition knowledge and dietary inadequacies among collegiate athletes. Rash *et al* (2008) identified prevalence of adequate knowledge and favourable intake of carbohydrates while intake and knowledge about Vitamin E was observed to be poor, followed by adequate intake but inadequate knowledge about Vitamin C and proteins among college track athletes. Furthermore, high mean dietary intake scores were found for Vitamin A, cholesterol, saturated fat, calcium and magnesium while low dietary intake scores were observed for Vitamin E, fiber, sodium and potassium. Another study conducted by Meti and Saraswathi (2007) on impact of nutrition intervention programme on performance of high school kabaddi players revealed that there was a significant increase (35%) in overall nutrition knowledge of athletes while improvement in practice was only 15%. Seventy percent improvement in carbohydrate intake was observed after nutrition education. The players found intervention programme as useful in sports performance as a result of self-evaluation.

Besides motivation, skill, techniques, commitment, physical fitness and training, to attain high level of achievement in sports, nutrition plays a very important part. It had been

suggested in various studies that lack of knowledge about nutrition, healthy food choices, and components of a well-balanced diet and implication of nutrition on sports performance pertained among athletes. However, role of nutrition knowledge by improving the science based knowledge of individuals engaged in athletic performance from Coimbatore district had been studied by Sangeetha *et al* (2012). Anthropometry, dietary intake, biochemical parameters and nutrition education of athletes were measured to assess their nutritional status. It had been revealed by the results that majority of the athletes (55%) were underweight while 60% of them were found to be anaemic. Inadequacy among dietary intake of essential nutrients had been reported while the sportspersons lacked nutrition knowledge, though it was revealed that nutrition education improved their nutrition awareness score to a great extent. Furthermore, poor nutritional status among athletes of Coimbatore was reported as conclusion with dietary inadequacy of both macro and micro-nutrients. It was also reported that nutrition education had the capacity to improve nutrition knowledge of selected sportspersons.

A term used to assist individuals for appropriate selection of food for their needs when dining away from home is known as point of choice (POC) labels. The use and opinions of labels by the athletes in large dining hall environment had been explained in very few research studies. However, Burkhart and Pelly (2013) conducted a study to evaluate athletes' opinion and utilisation of POC nutrition labels which were provided in main dining hall of athletes' village at a major competition event during 2010 Commonwealth Games, New Delhi. It was reported by majority of respondents that POC information for menu items was very important and POC labels were rated as useful by 59% while only 14% athletes reported using POC labels every time. More frequent use of labels was reported by athletes from specific regions (India/Sri Lanka, Africa), sports (Team and weight category) and those with less education. Improvement of POC labels was suggested by athletes by way of accumulation of more information, improved aesthetic properties and better positioning in more convenient locations. The ultimate development of a standardised label and to identify the most effective POC label to be used in this environment calls for further research by way of assisting a broader range of athletes in forthcoming competitions.

In order to maintain proper health and enhance sports performance, nutrition plays a very significant part and it has been recommended by Spronk *et al* (2015) that there is a need to intervene in the present dietary practice to improve nutrition knowledge and healthy eating, most importantly among young male athletes. Furthermore, female athletes had been reported to score higher than male athletes with respect to nutrition knowledge while other factors such as age, level of education, type of sport did not have any significant influence on nutrition knowledge of athletes. Spronkal *et al* (2014) examined the relationship between nutrition knowledge and dietary intake in adults and reported a considerably positive but weak

correlation between advanced nutrition knowledge and dietary intake. Low health literacy is associated with poor health outcomes hence; nutrition knowledge had become an integral component of health literacy. In view of this, it was concluded that there is a need to provide more sophisticated data regarding nutrition knowledge to community nutrition educationists and public health policy makers to assist them in constructing improved guidelines for sports persons.

Nutrition is an important component of any physical fitness programme. Obtaining adequate nutrition to boost health and fitness and to intensify strength and endurance is the main dietary goal for active individuals. There is a direct affiliation among sports and nutrition. When it comes to sports nutrition, careful planning and implementation becomes obligatory as stated by Supriya and Ramaswami (2013). The KAP (Knowledge, Attitude and Practices) score revealed fair knowledge, attitude and practice score among athletes and recommended regarding implementation of nutrition education for athletes to ensure better performance outcome. Another study conducted by Peerkhan and Srinivasan (2010) reported that intake of cereals, other vegetables and milk was found to be on lower side among athletes when compared to RDA's, despite this fact, runners had a high mean nutrient intake score as compared to volleyball players and weight lifters. A good percentage of volleyball players possessed average nutrition knowledge (60-69%) as compared to weight lifters, having a satisfactory nutrition knowledge score (50-59%) while only a few runners had good nutrition knowledge score i.e. 70-79%. A considerable difference of knowledge, attitude and practice had been perceived between athletes of different disciplines and events in this study with an overall good nutrition knowledge score among them.

Inadequate intake of balanced diet by female athletes have been observed as a common issue which could be the result of lack of nutritional knowledge or misconceptions about food as stated by Hoogenboom *et al* (2009) in their study on nutrition knowledge and eating behaviours among collegiate female swimmers. Poor nutrition had been accused for development of Female Athlete Triad in this study which evaluated the nutrition knowledge of collegiate female swimmers and application of this knowledge in their regular eating habits. Seventy-two per cent athletes scored well in nutrition knowledge test while the diet of majority of athletes (95.9%) did not meet the Recommended Dietary Allowance (RDA) of all three macronutrients. Prevalence of lack of nutrition knowledge, healthy food choices, and components of well-balanced diet and consequences of nutrition on performance had been concluded. It was reported in another study by Valliant *et al* (2012) that nutrition education has found to be beneficial in improving dietary intake and nutrition knowledge of female volleyball players. Also, total energy and macronutrient intake improved among female

athletes of volleyball team post dietary intervention regarding the individual dietary needs of each athlete as well as pre and post sports nutrition knowledge survey.

Spendlove *et al* (2012) piloted a comparative study to investigate the level of general nutrition knowledge among elite athletes (whose athletic calibre and sport type data were collected), similar aged community and dieticians & nutrition scientists. It was observed that dieticians and sports nutritionists scored higher as compared to other two groups while the athletes possessed less nutrition knowledge as compared to similar aged community. Age, sex and athletic calibre had an influence on overall score whereas level of education, living situation or ethnicity had no impact on overall scores. It was concluded that the elite athletes had lower overall general nutrition knowledge which had a significant influence of age and sex. A significant positive correlation between nutrition knowledge and attitude among male and female elite athletes of Iran had been recognized in a study by Azizi *et al* (2010) in which the mean nutrition knowledge and attitude score was found out to be approximately 53% among both the groups and the results suggested possession of moderate level of nutrition knowledge followed by recommendation to improve among Iranian elite athletes.

Jose and Chandrasekhar (2010) studied nutrition knowledge, attitude and practices among sportsmen and women and reported that both male and female athletes did not score satisfactory when assessed for nutrition knowledge when compared to attitude and practice scores. Since male athletes scored slightly higher than female athletes, it was therefore concluded that male athletes receive more exposure than female athletes. A majority of athletes (85%) lack proper nutrition knowledge specifically, female handball players and male volleyball players while a significant athlete population scored fairly well for attitude, a trend which is desired. Therefore, a combination of desirable attitude and appropriate nutrition education was found to be effective in improving dietary practice, hence refining stamina and performance of athletes. Concerning about importance of nutrition education programmes, a statistical analysis of a research study conducted by Joseph and Prema (2013), indicated a significant higher nutrition knowledge score of athletes after attending nutrition education programme as compared to before attending the same.

Trakman *et al* (2016) revealed that current status of nutrition knowledge among athletes and coaches was difficult to ascertain. Nutrition knowledge gap was also found to be unclear with a view that energy density, need for supplementation and role of protein were often misunderstood. It was concluded that assessment of nutrition knowledge required validated, up-to-date tools to measure general and sports nutrition knowledge. Nutrition knowledge of female collegiate hockey players was determined in another study by Davar (2012) to evaluate how efficiently players apply their knowledge in their everyday eating

habits. The mean nutrition knowledge score came out to be 38.8% while majority possessed low nutrition knowledge with an increased interest to gain nutrition information among them. A massive impact of family food habits had been observed in this study, thus suggesting implication of nutrition education programmes to promote positive attitude of athletes towards healthy diet.

High intensity activity is desired character in elite athletes and for fuelling those muscles which provide such intensity is athletes requires carbohydrates. Taking this in view a study was conducted by Sharma *et al* (2016) to assess knowledge of adolescent female football players regarding carbohydrate consumption. It was found that there is a significant awareness about carbohydrate sources while knowledge about type of carbohydrate to be consumed during, before and after competition was not significant. It was suggested that in order to enable the players to choose appropriate diet containing sufficient carbohydrates to enhance their performance, it had become pertinent to develop nutrition education tools and imparting nutrition education programmes. In another study by Kelkar *et al* (2006), significant variation in the nutrient intake among athletes with respect to body weight and type of sport of the athlete had been stated. Except for nutrients such as protein and iron, the other nutrient intake of athletes was well comparable with the recommended daily allowances. Poor sports nutrition information had been reflected in athletes' attitude and it was also found that athletes tend to imitate their peers and coaches. Considering general sports nutrition knowledge of elite athletes, sophistication with regard to nutrition and its effect on performance had been observed among them. Vague conceptions about weight loss concepts had been reported by athletes pursuing weight category sports (boxing, weightlifting and wrestling). Positive attitude towards consumption of food supplements had been observed, thus revealing paucity of nutrition education intervention among Indian sportsmen.

In a cross-sectional study by McGehee *et al* (2012) on sports, overall nutrition knowledge score was defined as adequate (75%) among all the domains. However, athletic trainers and strength and conditioning specialists were reported to have adequate nutrition knowledge though most coaches and athletes were reported to possess inadequate knowledge about sports nutrition. It had been revealed in this study that athletes had frequent contact with athletic trainers and strength and conditioning specialists, therefore the members of the above mentioned staff's nutrition education was critical. Proper nutrition programmes had been suggested to be organised for all the groups, especially athletic trainers and strength and conditioning specialists. Such an integrative approach may provide benefit for continuity of care as professionals from both the categories might be developing and integrating preventive or rehabilitant programmes for athletes.

Spronkal *et al* (2014) reported significantly positive, but weak ($r < 0.5$) associations between higher nutrition knowledge and dietary intake, most often a higher intake of fruits and vegetables. It was reported that nutrition knowledge is an integral component of health literacy and as low health literacy is associated with poor health outcomes; contemporary high-quality research is needed to inform community about nutrition education and public health policy. Weeden *et al* (2014) described expression of concern regarding what and how to eat healthy by collegiate athletes in their study to identify nutrition knowledge based on collegiate sport. The mean nutrition knowledge among athletes was found to be 56.4% with 13.4% standard deviation which was considered to be good and were reported to be associated with completion of a nutrition course at collegiate level, participation in individual sports and citation of health care professionals considered as a primary source of nutrition information. It was concluded that completion of collegiate nutrition course was found to be beneficial, especially for those who lacked registered dietician. Healthy cooking classes for athletes by registered dietician had been recommended.

In order to determine the pattern of food intake of a particular individual, nutrition knowledge plays a vital role. Therefore, dietary habits and nutrition knowledge of athletes and non-athletes of National University of Malaysia had been determined by Sedek and Yih (2014). The relationship between nutrition knowledge and dietary habits with body mass index (BMI) to assess nutritional status had also been determined in this study which revealed a significantly lower mean score of dietary habits among athletes as compared to non-athletes ($p<0.05$). The overall mean nutrition knowledge score corresponded to good level of nutrition knowledge while similar nutrition knowledge score had been attained by both the groups. The major sources of nutrition information of athletes were found to be the internet, followed by magazines or newspapers, friends or family or neighbours were not so significant sources of nutrition information following television and coaches which were the minority choice for providing nutrition information. The results were similar among non-athletes group but they were not provided 'coach' as one of the choices. No significant relationship between nutrition knowledge and dietary habits with body mass index was reported among both the groups while a weak relationship between dietary habits and nutrition knowledge was stated among athletes while non-athletes did not show any association between the two. It was concluded that non-athlete group had healthier dietary habits while nutrition knowledge among both the groups were found to be similar.

Nutrition knowledge of athletes had been indicated minimal in various research studies. Athletic performance and health status may be hindered by dietary behaviours. Dunn *et al* (2007) compared nutrition knowledge and attitudes of college athletes at a Southern university in which male and female athletes from all the sports participated. Healthy attitudes

about eating behaviour, but low knowledge scores were found among majority of athletes. It was revealed by one of the America's college youth that improper dietary habits of athletes were due to lack of availability of healthy fast foods and easily prepared foods. Since college athletes were confined to dorms, apartments and shared housing, they were left with little space and time for meal preparation. Knowledge to determine selection of food items was an additional concern stated in this study. It was also revealed that though nutrition education and training programs were a part of school curriculum yet very few athletes understood basic nutrition concepts as they reach university settings. Improvement in nutritional quality of food choices were directly proportional to increase in athletes' nutrition knowledge as stated by Kunkel *et al* (2001).

Research on sports nutrition has been increasing, most of which shows lack of nutrition knowledge being exhibited by athletes continually as stated by Jacobson *et al* (1992); Jacobson *et al* (2001); Rosenbloom *et al* (2002); McGehee *et al* (2012). Coaches are said to be the primary source of nutrition information for athletes but there is a limited research regarding adequacy of coaches' knowledge till date. Therefore, Botsis and Holden (2015) investigated the nutrition knowledge of collegiate athletes which revealed that college coaches did not possess adequate nutrition knowledge. Thus, it was concluded that coaches might not be considered as appropriate source of nutrition information followed by recommendation to conduct more research in this area to assess nutrition knowledge of collegiate athletes. Arazi and Hosseini (2012) compared nutrition knowledge and food habits among collegiate and non-collegiate athletes of Iran. The general and sports nutrition knowledge score among male collegiate athletes was found to be 52.5% and among female collegiate athletes to be 58.45%. The same results among non-collegiate male and female athletes were found to be 39.86% and 40.66% respectively. Therefore, a significant difference was revealed in mean nutrition knowledge scores of collegiate and non-collegiate athletes with substantial higher knowledge among collegiate athletes. It was concluded that non-collegiate athletes' nutrition knowledge needed improvement and introduction of nutrition lecture courses could be a solution to this.

In a study on university student athletes by Burns *et al* (2004), it was revealed that 88% of athletes used one or more nutritional supplements, however efficacy of supplements as perceived by them was found to be moderate (2.9 or less; 5-point scale), while classes (69.4%), brochures (75%) and individual counselling (47%) was available and used by 29.9%, 33.2% and 17.9% of athletes respectively. It was also reported that athletic trainers had been declared as the primary source of nutrition information by 39.8% of athletes while strength and conditioning trainers and dieticians as source of nutrition information were secondary choice by them. According to athletes' perception, athletic trainers had strong nutrition knowledge while a significant number of them (23.5%) had no idea about availability of a

trained dietician. It was concluded that there was a need for dieticians to accelerate their marketing efforts to student athletes, which required joint effort of both dietician and athletic trainers to provide sound nutrition information along with services to meet the needs of diverse population of student athletes.

2.2.2 Impact of nutrition education on nutrition knowledge and nutritional status of athletes

According to Sajber *et al* (2013), nutrition and doping are very sensitive and untouched issues in sports, especially with regard to athletes and their coaches. Swimming coaches and their athletes were examined to assess their knowledge about nutrition and doping through a pretested reliable questionnaire. It was observed that coaches scored higher than swimmers in both the questionnaires and coaches were declared as the primary source of nutrition information by the athletes. Formal and self-education were stated as equally chief sources of information regarding nutrition and doping by the coaches. A negative correlation was observed between age and nutrition and doping knowledge while positive correlation was found between formal education and knowledge among coaches. Subsequently, nutrition education programmes specifically for older coaches and younger athletes had been emphasized in this study. Sugasari and Premakumari (2010) stated that improving athlete's routine dietary pattern, improved their endurance as shown on treadmill and bicycle ergometer readings in a study, which assessed impact of diet modification on nutitional profile and sports performance among adolescent athletes. In a similar study by Kreider and Campbell (2009) on role of protein for exercise and recovery concluded that multiple exercise modes such as endurance and strength exercise are benefited by ample intake and appropriate interval of protein ingestion.

In a study by Jessri *et al* (2010), it was found that knowledge regarding nutrients was higher as compared to knowledge regarding food supplements among both the genders. Athletes studying in medical universities or obtaining nutrition information from reputable sources scored significantly higher. A majority of athletes mentioned their coach as major source of nutrition information and the study also demonstrated that nutrition knowledge of athletes was inadequate which may contribute to poor dietary behaviour and should be improved by nutrition related training and education. A study was conducted to examine body composition, nutrition knowledge, behaviour, attitudes and educational needs of senior schoolboy rugby players in Ireland. Sixty-eight percent of players had healthy PBF (percentage body fat) while some were classified as underweight while a few players were classified as overweight. The players' nutrition knowledge was lacking in the area of foods required for refuelling and proper use of sports drink. However, majority players were

reported to consume alcohol while others used supplements. Poor nutrition knowledge and dietary behaviour were observed; although seeking nutrition education might be beneficial as reported by Walsh *et al* (2011).

2.3 NUTRITION KNOWLEDGE OF COACHES

Sports coaches play a vital role in influencing athletes' dietary habits as they are taken as the most important figures by sportspersons. Sobana and Many (2014) conducted a comparative study to measure sports nutrition knowledge among school and college coaches and further evaluated their dietary recommendations to their respective athletes. It was brought into being that weight management practices were recommended to athletes by 68.5% of coaches. Sixty three percent of college coaches along with forty percent of school coaches suggested inclusion and resistance of certain special foods pre and post training. The level of coaching whether in school or college did not have any significant influence on knowledge about female athlete triad. Twenty-six percent of the college coaches had a very good knowledge about sports nutrition (> 75%) while only seventeen percent of school coaches had a good knowledge about sports nutrition. Sports nutrition knowledge was not found to be significantly associated with level of coaching. It was also identified that both the group of coaches (school and college) did not show any influence of years of coaching, type of sport, formal nutrition training they attended on their sports nutrition knowledge. A necessity of periodical workshops on nutrition information along with nutrition education programmes for coaches to provide them with required nutrition information and skill to motivate their athletes to consume a healthy diet had been indicated in this study.

Nowicka *et al* (2013) found that it was difficult for most of the coaches to identify symptoms of eating disorders, most importantly for bulimia nervosa. Athletes' denial about eating disorder, deficiency of female staff for the team followed by insufficient treatment services available for this particular disorder were being reported to serve as barriers, which were being developed for coaches in approaching their athletes. It was further revealed that insufficient capacity of coaches to identify symptoms of eating disorder resulted in delayed conduct of early intervention and treatment for the same.

It was reported by Smith *et al* (2001) that coaches/trainers who trained female athletes scored better as compared to those who trained male athletes. Coaches and strength and conditioning trainers who had a coaching experience of more than fifteen years were reported to score better than those had less experience. It had been revealed in nutrition responses/ opinions that nutritional supplements were available or recommended for all but were taken by 6% participants' athletes. Body weight was given priority than body composition for performance by the athletes. It had also been perceived by 30% of participants that at least one

case of disordered eating occurred during past year. Majority participants informed consumption of more nutritious meals by athletes on team-sponsored meals when given larger allowances. Availability of dieticians was being reported by 30% of athletes while the same percentage of them reported utilization of participants. It was concluded that coaches and trainers possessed good knowledge about appropriate nutritional recommendations, but believed that nutrition related education and counselling of athletes by registered dieticians or qualified sports nutritionist might add to nutrition knowledge of athletes.

Sports coaches had been studied to gather information regarding monitoring/ supervision of their athletes eating and weight management, knowledge of their nutrition and health issues, and availability of prevention/intervention services for athletes at their school along with their experience with athletes exhibiting symptoms of eating and body image disturbances and their attitude toward eating and maintaining weight in the sport in a research study conducted by Heffner *et al* (2003) reported that gymnastics coaches possessed more experience with athletes exhibiting eating disturbances and had better and greater resources available to prevent and treat athletes suffering from eating disorders thus, these coaches were found to be significantly different from coaches of other sports in these aspects. Attitude of gymnastic coaches towards eating and weight in the sport also differed from other coaches. Coaching attitude and behaviour of coaches was found to trigger the risk of eating disturbances among athletes as many coaches encountered such issues in their athletes.

Though various studies discussed possession of low sports nutrition knowledge among sports coaches and their incompetency to provide and disseminate the same to their athletes, yet coaches remain the most important source to obtain nutritional information by the athletes. Therefore, a study was conducted to evaluate the sports nutrition knowledge of UK coaching certificate level 2 and 3, hockey and netball qualified coaches by Cockburn *et al* (2014). Provision of nutritional advice to the athletes by their coaches, the level of sports nutrition knowledge of coaches, contributory factors which affected nutrition knowledge of coaches were the three criterion assessed in this study. It was revealed that over half of the coaches provided nutritional advice to their athletes even though they were found to be incompetent to do so. No significant difference in correctly responding the knowledge questions had been found between the coaches who provided nutritional advice to their athletes and those who did not. However, coaches who had undertaken formal nutrition training achieved higher scores as compared to those who did not take any training. Thus, it was concluded that professional development in sports to enhance coaching practice could be beneficial for sports coaches.

Mandic *et al* (2013) reported that coaches scored better as compared to athletes for knowledge about sports nutrition as well as knowledge of doping. A positive correlation was observed between variables such as age, sports experience, formal education and knowledge of

sports nutrition and knowledge of doping scores among athletes. It was revealed that the athletes who scored better about knowledge of doping were less prone to doping behaviour in future tournaments. Systematic educational programmes on doping and sports nutrition were needed as reinforced by the data of this study with a special attention towards younger athletes.

Coaches play a significant role to help preventing Female athlete triad, yet there is need to explore the current knowledge level of coaches, their perceptions and practice behaviours. Pantano (2006) conducted a study to describe the knowledge, perceptions and behaviours of college coaches about the female athlete triad. Furthermore, the study described the relationship between these variables and compared sports nutrition knowledge of coaches having high level of general knowledge about triad with those having low level of general knowledge about the same in United States. Forty-three percent of the coaches were found to correctly list the specific components of the disorder. Significant difference in the variables such as their perceptions, behaviours and more specific knowledge about the triad had been perceived between both the groups of coaches. Thus, prevention as the best intervention for the female athlete triad had been suggested in this study. Specific factors related to syndrome such as nutritional requirements, methods of assessing menstrual irregularities, and screening techniques should be treated and prevented by future education about the triad among coaches as well as athletes.

Since athletes are placed under a lot of pressure either by themselves or created by coaches as they are expected to perform in their respective events at competitions. A study was conducted by Govero and Bhushman (2003) to determine the knowledge level of eating disorders among cross country coaches and their level of confidence in this knowledge along with determination of reported sources of educational resources. The two most common sources of information were found to be literature and sponsored programmes. It was revealed that majority of the coaches possessed relatively high level of knowledge and those with higher knowledge had high level of confidence too. Significant correlation was observed between confidence level of coaches and percent coaches answered correctly while no correlation was perceived between confidence and percent coaches who answered incorrectly. Considering years of coaching, no significant difference in knowledge scores among the coaches had been established nor were there any significant difference of gender. It was concluded that although the cross country coaches were found to be quite knowledgeable, yet there was a need to increase nutrition knowledge about eating disorders. Difficulty in treating individuals with eating disorders had been identified in various narrations of psychologists. However, it is believed that as the illness progress, treatment becomes more difficult. Thus, in order to reduce prevalence of these disorders among females, prevention is said to be critical.

Overdorf and Silgailis (2005) evaluated the perceived versus actual knowledge about nutrition and weight management held by high school coaches of girls' team. The results reported that only 14% of the coaches had knowledge regarding percentage of simple carbohydrates which should be constituted in an athlete's diet. Ninety-one percent of coaches rated their nutrition knowledge as average and above while only forty percent had received any formal nutrition training. High protein diet is essential for athletes had been reported by 11% of coaches while 80% of them believed protein is required to gain muscle. Therefore, lack of congruence between coaches' perceived and actual knowledge had been observed regarding nutrition and weight control. Sports coaches are the individuals having most contact with athletes and are said to be the first line defence of athlete's problem. Yet, coach's training does not include proper communication about nutrition and weight management with athletes; consequently it may not be a part of coaches' knowledge base.

CHAPTER III

MATERIAL AND METHODS

The current study had been executed for "Assessment of nutritional status of elite athletes with special reference to nutrition knowledge of the athletes and the coaches". The materials and methods employed for the investigation have been discussed under following headings.

3.1 Locale of Study

3.2 Selection of subjects

3.2.1 Criteria for selection of subjects

3.3 Development of Questionnaire

3.3.1Questionnaire for athletes

3.3.2 Questionnaire for coaches

3.3.3 Awareness and Practice (KAP) Score of Athletes

3.3.4 Assessment of Knowledge, Awareness and Practice (KAP) Score of Coaches

3.4 Pilot Test

3.5 Collection of Data

3.5.1 General information of athletes and coaches

3.5.2 Nutritional status of athletes

3.5.2.1 Anthropometric measurements

3.5.2.1.1 Basic anthropometric measurements

3.5.2.1.2 Derived anthropometric measurements

3.5.2.2 Biochemical assessment

3.5.2.3 Dietary survey

3.5.3 Food and nutrient intake of athletes

3.5.3.1 Pre exercise meals

3.5.3.2 During exercise meals

3.5.3.3 Post exercise meals

3.5.3.4 Hydration schedule

3.5.3.5 Use of supplements/drugs

3.5.4 Physical Activity Pattern of athletes

3.6 Assessment of Knowledge, Awareness and Practice (KAP) score of athletes

3.7 Assessment of Knowledge, Awareness and Practice (KAP) score of coaches

3.8 Statistical analysis

3.1 LOCALE OF STUDY

The present study was conducted in five universities of Punjab namely, Punjab Agricultural University, Ludhiana, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab University, Chandigarh, Guru Nanak Dev University, Amritsar and Punjabi University, Patiala.

3.2 SELECTION OF SUBJECTS

A total of one hundred and twenty elite athletes (30 in each category) falling in the age-group of 16-25 years and their coaches (total 30 combined from all categories) were selected from five universities of Punjab who were participating in following sports:

- Hockey
- Athletics
- Badminton
- Lawn Tennis

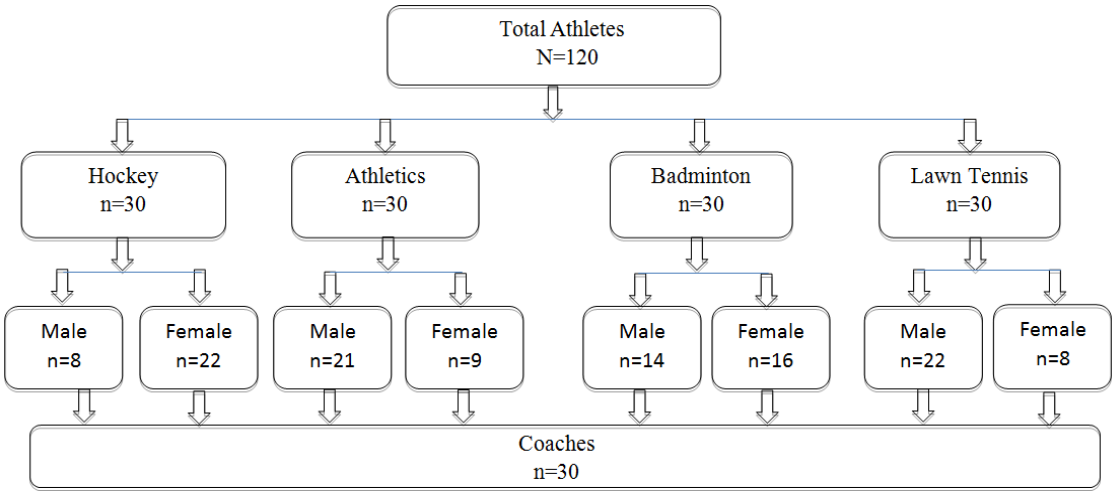

Fig: 1: Selection of subjects

3.2.1 Criteria for Selection of Subjects

The selection of subjects was independent of gender. The athletes for the above mentioned sports were selected on the basis of their participation in state or national level tournaments such as open state, open national, inter-varsity and inter-agri.

3.3 DEVELOPMENT OF QUESTIONNAIRES

Four questionnaires were developed for collection of data:

3.3.1 Questionnaire for athletes: This Questionnaire (Annexure I) was used to assess general and dietary information of athletes.

3.3.2 Questionnaire for coaches: Demographic information of coaches, their coordination with universities regarding nutrition of athletes and their access to formal nutrition trainings or nutrition professionals were established for coaches (Annexure II).

3.3.3 Assessment of Knowledge, Awareness and Practice (KAP) Score of Athletes: A multiple choice questionnaire (Annexure I) was designed to assess the knowledge, awareness and practice level of the athletes regarding basic nutrition and its significance in sports

3.3.4 Assessment of Knowledge, Awareness and Practice (KAP) Score of Coaches: A multiple choice questionnaire (Annexure II) was designed to assess the knowledge, awareness and practice level of the coaches regarding basic nutrition and its significance in sports.

3.4 PRETESTING THE QUESTIONNAIRE

The questionnaires developed were pretested on 10 athletes and 5 coaches selected randomly on non-sampled subjects. The required changes after receiving feedbacks during pre-testing were incorporated in the final questionnaire which was reconstructed to collect data for present study.

3.5 COLLECTION OF DATA

The requisite data was collected through personally interviewing the subjects.

3.5.1 General Information of athlete and coaches

The information regarding general profile of subjects, socio-economic status of family, family composition, dietary habits, food intake on daily basis, pattern of physical activity and information pertaining to health and lifestyle of the athletes while information in addition to general profile and social and family composition, access to nutrition information and nutrition expert at personal or university level to coaches were collected.

3.5.2 Nutritional status of Athletes

Nutritional status of athletes was assessed through following parameters:

3.5.2.1 Anthropometric Measurements

Height, weight, waist & hip circumference and triceps skinfold thickness were recorded using standard methods (Jelliffe 1966). Body Mass Index (BMI) and Waist/Hip ratio was further calculated based on anthropometric measurements taken.

3.5.2.1.1 Basic Anthropometric Parameters

Height

The height of the athletes was measured using stadiometer and a vertical measuring rod. The athletes were asked to stand straight upright with bare feet parallel to thighs and buttocks on the platform or touching the scale. The head was held comfortably erect, head piece was lowered, and crushing the hair, making contact with the top of the head and the height was then recorded in centimetres upto 0.5 cm accuracy (Jelliffe 1966). The readings

were being marked by means of a non-stretchable plastic measuring tape through its zero touching the base.

Weight

A glass digital balance was used to measure body weight of the respondents. The weighing of respondents was done with bare feet and with minimum clothing while they were asked to stand erect on the weighing machine platform without touching anything. The weight was then recorded in kilograms upto 0.1 kg accuracy (Jelliffe 1966).

Waist Circumference

A narrow, non-stretchable tape was used to measure the waist circumference of the athletes. The measurement was taken with minimal clothing while the athletes were asked to stand erect and approximate midpoint between lower margin of the past palpable rib and the top of the iliac crest was located for recording circumference.

Hip circumference

In order to measure hip-circumference of the respondents, narrow, non-stretchable tape was used. The athletes stood straight upright in an erect position and measurement was recorded around widest portion of the buttocks.

3.5.2.1.2 Derived Anthropometric Measurements

Body Mass Index (BMI)

The Body Mass Index (BMI) was calculated using the following formula given by Garrow (1981) from the recorded value of height and weight of the athletes:

$$\text{Body Mass Index (BMI)} = \frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$$

Table 3.1: Classification based on Body Mass Index, Cole *et al* (2000)

BMI (kg/m^2)	Interpretation of BMI category
<18.5	Underweight
18.5-22.9	Normal
23-24.9	At risk of obesity
25-29.9	Obese I
>30	Obese II

Waist/Hip ratio: Waist/Hip ratio was calculated using the formula given below:

$$\text{Waist/Hip ratio} = \frac{\text{Waist circumference (cm)}}{\text{Hip circumference (cm)}}$$

The value ‘0.8’ is used as cut off point and is denoted as a reference value for waist and hip ratio (Ghafoorunisa and Krishnamurthy, 2000).

3.5.2.2 Biochemical Assessment

The blood samples of athletes were collected and haemoglobin analysis of sportspersons was done at their respective university or associated hospital laboratories using cyanmethemoglobin method (Ranganathan and Gunasekaran 2006).

3.5.2.3 Dietary Survey

In order to obtain the information regarding food habits, dietary pattern and food consumption, a dietary survey with detailed information of food intake using 24 hour recall method for three consecutive days was carried out. Calculations of nutrient intake were done with the help of Indian Nutritive Software DietCal-A by Kaur G (2014) for dietary assessment and planning.

In general, the recommended allowances for female athletes are considered to be similar to those recommended for their male counterparts. The dietary and nutrient intake of subjects was compared with Suggested dietary intake (SDI) and Recommended Dietary Allowances (RDA) of nutrients, respectively as specified by NIN (2007).

3.5.3 Food and nutrient Intake of athletes

The food and nutrient intake record was divided into five parts to assess the kind of meals and/or liquids consumed by the athletes at the time of their training. The five food and nutrient intake divisions are discussed below:

3.5.3.1 Pre Exercise Meals

The information regarding time and type of meal consumed by the athlete before commencing training/practice of sport was collected.

3.5.3.2 During Exercise Meals

Under this column, the information such as type and duration of exercise, in addition to time and type of meal consumed during or at the break/halftime of their training was recorded.

3.5.3.3 Post Exercise Meals

The time and type of meal an athlete consumed after training or practicing his/her sport was recorded for analysis.

3.5.3.4 Hydration Schedule

The information about hydration schedule was also collected which followed a similar pattern as meal schedule and was also divided into consumption of liquids before, during and after training schedule of athletes.

3.5.3.5 Use of Supplements and Drugs

Supplement consumption is a desire expressed by a majority of athletes in order to improve health and performance as established by Sharma *et al* (2014). Therefore, the present study recorded information regarding use and type/composition of dietary supplements by athletes.

3.5.4 Physical Activity Pattern of Athletes

The daily routine and other recreational activities of the athletes were analysed to record their physical activity pattern. Information regarding the total time spent everyday on exercise, sports, personal care and household work was collected. The Physical Activity Diary Method (PADM) was used to record time spent on different activities for the days during which the dietary survey took place. Physical Activity Level (PAL) of the athletes was calculated by using Physical activity Ratio (PAR) as stated by FAO/WHO/UNO (2004).

The following formula is used to calculate mean PAL:

$$\text{PAL} = \frac{\sum[\text{Time spent on each activity (min)} \times \text{energy cost of each activity (kcal)}]}{1440}$$

The assessment of lifestyle of the athletes through physical activity level (PAL) was used as a determinant for the categorization based on categories given by FAO/WHO/UNU (2004) which are given below:

Category	PAL Value
Sedentary or light activity lifestyle	1.40-1.69
Active or moderate activity lifestyle	1.70-1.99
Vigorous or vigorously activity lifestyle	2.00-2.40

3.6 ASSESSMENT OF KNOWLEDGE, AWARENESS AND PRACTICE (KAP) SCORE OF ATHLETES

The knowledge, awareness and practice regarding role of nutrition in sports and its dietary management were assessed using the developed KAP questionnaire (AnnexureI) which was distributed among selected one hundred and twenty athletes pursuing four different sports, thirty athletes in each category of sports.

3.7 ASSESSMENT OF KNOWLEDGE, AWARENESS AND PRACTICE (KAP) SCORE OF COACHES

The knowledge, awareness, practice and dietary recommendations by coaches to their athletes, followed by role of nutrition in sports and its dietary management among athletes

were assessed using the developed KAP questionnaire (Annexure II) which was distributed among selected thirty coaches who were providing coaching in the above mentioned sports.

A total of 35 questions were included in the KAP questionnaire, out of which 14 were regarding testing of nutrition knowledge, 10 regarding attitude and 11 regarding practices. Each correct answer was given 1 mark.

3.8 STATISTICAL ANALYSIS

The data collected was statistically analysed by calculating mean, standard deviations and percentage distributions. The comparison between categories of respondents was done using t-test and correlations were found.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the present study entitled 'Assessment of nutritional status of elite athletes with special reference to nutrition knowledge of the athletes and the coaches' have been discussed below subsequent headings:

4.1 General information of the athletes:

4.1.1 General profile

4.1.2 Use of supplements

4.1.3 Morbidity record

4.1.4 Pre, during and post exercise meals and hydration schedule

4.2 Nutritional status of the athletes:

4.2.1 Anthropometric measurements

4.2.2 Classification of athletes according to BMI

4.2.3 Haemoglobin level

4.2.4 Prevalence of anaemia among the athletes

4.2.5 Food consumption pattern

4.2.6 Food intake

4.2.7 Nutrient intake

4.2.8 Pre, during and post exercise nutrient intake

4.3 Physical Activity Pattern

4.3.1 Physical activity pattern

4.3.2 Physical activity level (PAL) of the athletes

4.3.3 Classification of athletes according to physical activity level (PAL)

4.4 Knowledge, Attitude and Practice (KAP)

4.4.1 KAP score of athletes

4.4.2 Classification of KAP level of athletes

4.4.3 General profile of coaches

4.4.4 KAP Score of coaches

4.4.5 Classification of KAP level of coaches

4.4.6 Correlations

4.1 GENERAL INFORMATION OF THE ATHLETES

The general information of the athletes i.e. family size, family composition, family income, level of participation, time spent in workout, feeling of fatigue, junk food consumption, athletes' food habits and skipping of meals has been tabularised in Table 4.1.

4.1.1 General profile:

The athletes selected for the current study were practicing their respective sporting event regularly and participating at state and national levels. Table 4.1 depicts that a majority of athletes belonged to nuclear family especially female athletes with 4 to 8 members in the family as discovered from the data. It has been further revealed that 74.2% of athletes belonged to high income group with a greater mainstream of males i.e. 81.5%. A majority of athletes i.e. 75.8% were participating at national level especially all the athletes of hockey. Furthermore, a similar percentage of 34.1 and 34.2% athletes used to spend 0-2 hours and 4-6 hours respectively per day in workout while a very few (3.3%) male athletes, especially those pursuing athletics and lawn tennis spent 6-8 hours a day in workout. A considerable number of male and female athletes i.e. 50.8 and 65.5% respectively from all the sports taken up in the study experienced feeling of fatigue specifically after their morning training session. Junk food consumption was found common among almost all the selected athletes including 87.3% female athletes forming majority, but the frequency of consumption was low i.e. once or twice a week.

Majority of all the athletes i.e. 53.3% were observed to consume non-vegetarian foods comprising 71.4% of male athletes of athletics and 92.8% of male athletes of badminton whereas overall 66.2% male athletes and 38.2% female athletes consumed non-vegetarian foods. It also came into prominence that 66.7% of selected athletes did not skip meals to maintain weight, which may be considered common among female athletes. Fifty-six percent female athletes rejected the notion of skipping meals, particularly 87.5% of female athletes of lawn tennis.

4.1.2 Use of supplements

The data revealed consumption of protein supplements by 57.2% of male athletes pursuing athletics and 37.5% of female athletes pursuing badminton which might be because their coaches used to advise them to consume supplements, as observed during conversation with athletes and their coaches. Also, supplement consumption was found to be more among male athletes from all the sports as compared to female athletes. It had been stated by Pasiakos *et al* (2015) that protein supplementation may boost performance by improving the muscle mass in the body with the condition applied that ample training stimulus along with constant dietary intake recommended for physically active individuals is maintained.

Table 4.1: General Profile of the athletes (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Family Size											
Nuclear	6 (75)	18(81.9)	12(57.1)	6 (66.7)	13(92.8)	11(68.8)	18(81.8)	8 (100)	75.4	78.2	76.7
Joint	2 (25)	4 (18.2)	9 (42.9)	3 (33.3)	1 (7.14)	5 (31.3)	4(18.2)	0	24.6	21.8	23.3
Family composition											
Small (<4)	2 (25)	0	1 (4.76)	1 (11)	2(14.3)	0	1(4.5)	1(12.5)	9.2	3.6	6.7
Medium (4 to 8)	6 (75)	18(81.9)	16(76.2)	7 (77.8)	12(85.7)	11(68.8)	21(95.5)	7(87.5)	84.6	78.2	81.7
Large (>8)	0	4 (18.2)	4 (19)	1 (11)	0	0	0	0	6.2	9.1	7.5
Family income (Rs/ annum)											
Low (upto 50,000/-)	0	3(13.6)	0	0	0	0	0	0	0	5.5	2.5
Medium (50,000 to 2,50,000/-)	2 (25)	2 (9.1)	3 (14.3)	2 (22.2)	1 (7.1)	8 (50)	6(27.3)	4 (50)	16.9	29.1	23.3
High (>2,50,000/-)	6 (75)	17(77.3)	18(85.7)	7 (77.8)	13(92.8)	8 (50)	16(72.7)	4 (50)	81.5	65.5	74.2
Level of participation											
State	0	0	12(57.1)	3 (33.3)	4(28.6)	5 (31.3)	4(18.2)	1(12.5)	30.8	16.6	24.2
National	8 (100)	22(100)	9 (42.9)	6 (66.7)	10(71.4)	11(68.8)	18(81.8)	7(87.5)	69.2	83.6	75.8
Time spent in workout (in hours)											
0-2	1(12.5)	8 (36.4)	4 (19.0)	6 (66.7)	6(42.9)	7 (43.8)	7(31.8)	2(25)	27.7	41.8	34.1
2-4	3(37.5)	2 (9.1)	8 (38.1)	1 (11)	2(14.3)	3 (18.8)	9(40.9)	6(75)	33.8	21.8	28.3
4-6	4 (50)	12(54.5)	7 (33.3)	2 (22.2)	6(42.9)	6 (25)	4(18.2)	0	32.3	36.4	34.2
6-8	0	0	2 (9.5)	0	0	0	2(9.1)	0	6.15	0	3.3

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Feeling of fatigue											
Yes	4 (50)	16(72.7)	15(71.4)	6 (66.7)	3(21.4)	9 (56.3)	11(50)	5(62.5)	50.8	65.5	57.5
No	4 (50)	6 (27.3)	6 (28.6)	3 (33.3)	11(78.6)	7 (43.8)	11(50)	3(37.5)	49.2	34.5	42.5
Junk Food											
Yes	2 (25)	18(81.8)	14(66.7)	8 (88.9)	12(85.7)	14(87.5)	15(68.2)	8(100)	66.2	87.3	75.8
No	6 (75)	4 (18.9)	7 (33.3)	1 (11)	2(14.3)	2 (12.5)	7(31.8)	0	33.8	12.7	24.2
Food Habits											
Vegetarian	6 (75)	16(72.7)	5 (23.8)	5 (55.6)	1 (7.1)	8 (50)	9(40.9)	4(50)	32.3	60	45
Ovo-Lactovegetarian	0	0	1 (4.76)	0	0	1 (6.3)	0	0	1.5	1.8	1.7
Non-Vegetarian	2 (25)	6 (27.3)	15(71.4)	4 (44.4)	13(92.8)	7 (43.8)	13(59.1)	4(50)	66.2	38.2	53.3
Skipping Meals											
Yes	4 (50)	15(68.9)	7 (33.3)	3 (33.3)	5(35.7)	5 (31.3)	1(4.5)	1(12.5)	26.2	43.6	34.2
No	4 (50)	7 (31.8)	14(66.7)	6 (66.7)	9(64.3)	11(68.8)	21(95.5)	7(87.5)	73.8	56.4	66.7

*Figures in parenthesis represent percentages.

Table 4.2: Use of supplements by the athletes (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Protein Supplements	1 (12.5)	0	12 (57.2)	3 (33.3)	3 (21.4)	6 (37.5)	4 (18.2)	1 (12.5)	30.8	18.2	25

*Figures in parenthesis represent percentages.

4.1.3 Morbidity record of the athletes

Non-nutritional ailments during previous year among the selected athletes have been presented in Table 4.3. Seventy-two percent of athletes did not suffer with any disease during last one year while fever had been observed to affect majorly to those who suffered any ailments during that course of time which comprised 20% of male athletes and 16.4% of female athletes.

4.1.4 Pre, during and post exercise meals and hydration schedule of the athletes

It was found (Table 4.4) that 60.8% of the total athletes used to consume pre exercise meal an hour before their training schedule with a majority formed by female athletes including 77.3% female athletes of hockey and all the (100%) female athletes of lawn tennis followed this meal time pattern. Most of the athletes (60%) consumed primarily banana and apple before training while 28.3% percent preferred lunch, tea or coffee. Thus, most athletes preferred consumption of carbohydrate rich diet with a view that it might benefit performance which had also been reported by Ormsbee *et al* (2014) that prior consumption of such a diet within an hour, if won't benefit then it won't impair performance too. However, eggs were found to be consumed by 26.2% male athletes who consumed 2 to 4 eggs before training while only 3.6% of female athletes consumed 1 to 2 eggs.

Furthermore, Table 4.5 represents hydration schedule (before exercise) of the selected athletes which revealed that a majority of athletes i.e. 40.8% preferred hydrating themselves 10 to 15 minutes before training. In addition 42.5% of them used to consume more than 400 millilitres of water and 14.2% consumed 100-200 millilitres of juice in order to keep themselves hydrated for longer duration. The timely and a sufficient consumption of water had been observed more among athletes of hockey and lawn tennis as compared to athletes of athletics and badminton, for events comprising repeated intense efforts may get affected by hypo-hydration as compared to other power, strength and endurance events which are not much affected (Maughan and Shirreffs 2010).

As evident from Table 4.6 that 37.5% of total athletes consumed mostly banana during break or halftime of their event. A majority of athletes i.e. 58.3% were indulged in heavy exercise comprising 95.5% of female athletes of hockey while 71.4% of athletes of athletics were following heavy exercise schedule and 37.5% of total athletes were following it for more than 2 hours per day.

Hydration schedule of athletes during exercise has been presented in Table 4.7 which explains that 75.8% of total athletes consumed liquids during break or halftime of their training schedule whereby 36.7% athletes consumed only 100-200 millilitres of water and very few i.e. 7.5% consumed any other beverage during this time. The reason might be that athletes did not want to fill themselves much and only hydrate themselves a little as the schedule was yet to be completed.

Table 4.3 Morbidity record of the athletes during last one year (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Common cold	0	0	0	0		0	1 (4.54)	1 (12.5)	1.53	1.81	1.67
Fever	0	1 (4.54)	5 (23.8)	3 (33.3)	3 (21.4)	2 (12.5)	5 (16.7)	3 (37.5)	20	16.36	18.33
Typhoid	1 (12.5)	0	0	0	0	1 (6.25)	1 (4.54)	0	3.07	1.81	2.5
Chicken pox	0	0	1 (4.76)	0	0	1 (6.25)	0	0	1.53	1.81	1.67
Back pain	0	1 (4.54)	0	0	0	0	0	0	0	1.81	0.83
Breathing problem	0	1 (4.54)	0	0	0	0	0	0	0	1.81	0.83
Stomach-ache	0	1 (4.54)	0	0	0	0	0	0	0	1.81	0.83
Food poisoning	0	0	0	1 (11.1)	0	0	1 (4.5)	0	1.53	1.81	1.67
Diabetes mellitus	0	0	0	0	0	1 (6.25)	0	0	0	1.81	0.83
No disease	7 (87.5)	18 (81.8)	15 (71.4)	5 (55.6)	11 (78.6)	12 (75)	14 (63.6)	4 (50)	72.3	70.9	71.67

*Figures in parenthesis represent percentages.

Table 4.4 Pre-Exercise meals of the athletes (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Time of meal											
1hr before exercise	4 (50)	17 (77.3)	7 (33.3)	1 (11.1)	9 (64.3)	10 (62.5)	17 (77.3)	8 (100)	56.92	65.45	60.8
2hrs before exercise	0	2 (9.1)	4 (19.0)	1 (11.1)	0	4 (25)	2 (9.1)	0	9.23	12.72	10.83
>2hrs before exercise	4 (50)	2 (9.1)	10 (47.6)	7 (77.8)	5 (35.7)	2 (12.5)	3 (13.6)	0	33.84	20	27.5
Type of Meal											
Shake	0	0	3 (14.3)	1 (11.1)	5 (35.7)	3 (18.8)	8 (36.4)	1 (12.5)	24.61	9.09	17.5
Fruit-Bananas/Apple	7 (87.5)	20 (91)	8 (38.1)	3 (33.3)	6 (41.9)	9 (56.3)	12 (54.5)	7 (87.5)	50.76	70.9	60
Juice-Fresh/Mix	4 (50)	8 (36.4)	5 (23.8)	1 (11.1)	7 (50)	3 (18.8)	4 (18.2)	0	30.76	21.8	26.67
Egg 1 to 2	0	1 (4.5)	0	0	0	0	0	1 (12.5)	0	3.63	1.67
3 to 4	3 (37.5)	0	6 (28.6)	0	4 (28.6)	0	4 (18.2)	0	26.15	0	14.17
>4	0	0	0	0	0	0	0	0	0	0	0
Any other- biscuits/soup/tea/coffee/energy/nuts/toast/ drink/ lunch/bread-butter	1 (12.5)	2 (9.1)	10 (47.6)	6 (66.7)	4 (28.6)	5 (31.3)	6 (27.3)	0	32.3	23.63	28.33

*Figures in parenthesis represent percentages.

Table 4.5 Hydration schedule before exercise of the athletes (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Before Exercise											
Immediately before exerc	1 (12.5)	5 (22.7)	4 (19.0)	0	3 (21.4)	2 (12.5)	3 (13.6)	0	16.92	1.81	15
10-15mins before exerc	4 (50)	6 (27.3)	9 (42.9)	1 (11.1)	6 (42.9)	8 (50)	12 (54.5)	3 (37.5)	47.69	32.72	40.83
30mins before exerc	1 (12.5)	4 (18.2)	6 (28.6)	1 (11.1)	4 (28.6)	5 (31.3)	4 (18.2)	1 (12.5)	23.07	20	21.67
1hr before exerc	1 (12.5)	7 (31.8)	1 (4.8)	4 (44.4)	1 (7.1)	1 (6.3)	3 (13.6)	2 (25)	9.23	25.45	16.67
>1hr before exerc	0	0	1 (4.8)	0	0	0	0	2 (25)	1.53	3.63	2.5
Amount of water											
100-200mL	0	0	6 (28.6)	0	0	3 (18.8)	0	0	9.23	5.45	7.5
200-400mL	6 (75)	13 59.1)	5 (23.8)	2 (22.2)	4 (28.6)	7 (43.8)	8 (36.4)	5 (62.5)	35.38	49.09	41.67
>400mL	1 (12.5)	5 (22.7)	10 (47.6)	4 (44.4)	8 (57.1)	6 (37.5)	14 (63.6)	3 (37.5)	50.76	32.72	42.5
Amount of Juice											
100-200mL	2 (25)	4 (18.2)	6 (28.6)	0	1 (7.1)	2 (12.5)	2 (9.1)	0	16.92	10.9	14.17
200-400mL	0	0	0	0	0	0	0	0	0	0	0
>400mL	0	0	0	0	2 (14.3)	0	0	0	3.07	0	1.67
Other Beverage- Soup/Gatorade/tea/ coffee/milk											
100-200mL	1 (12.5)	2 (9.1)	1 (4.8)	0	0	0	1 (4.5)	0	4.61	3.63	4.17
200-400mL	0	0	1 (4.8)	1 (11.1)	3 (21.4)	2 (12.5)	1 (4.5)	0	7.69	5.45	6.67
>400mL	0	0	0	0	0	0	0	0	0	0	0

*Figures in parenthesis represent percentages.

Table 4.6 During Exercise meals of the athletes (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Time of meal											
5mins to Halftime	1 (12.5)	7 (31.8)	2 (9.5)	0	0	0	0	2 (25)	4.6	16.36	10
15mins after exercise (mostly banana)	0	3 (13.6)	3 (143)	0	3 (21.4)	4 (25)	3 (13.6)	1 (12.5)	13.8	14.54	14.17
30mins after exercise (mostly banana)	1 (12.5)	12 54.5)	15 71.4)	2 (22.2)	4 (28.6)	2 (12.5)	4 (18.2)	5 (62.5)	36.9	38.18	37.5
Type of exercise											
Light	5 (62.5)	0	7 (33.3)	3 (3.3)	10 71.4)	14 87.5)	14 63.6)	1 (12.5)	55.4	32.72	45
Heavy	3 (37.5)	21 (95.5)	15 (71.4)	7 (77.8)	7 (50.0)	2 (12.5)	8 (36.4)	7 (87.5)	50.8	67.27	58.33
Duration of Exercise											
1hr	0	0	10 (47.6)	3 (33.3)	9 (74.3)	6 (37.5)	10 (45.5)	6 (75)	44.6	27.27	36.67
2hrs	5 (62.5)	3 (13.6)	4 (9.04)	2 (22.2)	3 (21.4)	6 (37.5)	6 (27.3)	0	27.7	20	24.17
>2hrs	3 (37.5)	18 (81.2)	7 (33.3)	3 (33.3)	2 (14.3)	4 (25.0)	6 (27.3)	2 (25.0)	27.7	49.09	37.5

*Figures in parenthesis represent percentages.

Table 4.7 Hydration schedule during exercise of the athletes (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
During Exercise											
Break/Halftime	8 (100)	13 (59.1)	17 (81)	4 (44.4)	11 (78.6)	13 (81.3)	19 (86.4)	6 (75.0)	84.61	65.45	75.83
Amount of water											
100-200mL	5 (62.5)	7 (31.8)	8 (38.1)	0	8 (57.1)	7 (43.8)	8 (36.4)	1 (12.5)	44.61	27.27	36.67
200mL-400mL	1 (12.5)	5 (22.7)	2 (9.5)	2 (22.2)	0	2 (12.5)	5 (22.7)	1 (12.5)	12.3	18.9	15
>400mL	2 (25)	9 (40.9)	9 (42.9)	2 (22.2)	4 (28.6)	1 (6.3)	4 (18.2)	6 (75)	29.23	32.72	30.83
Amount of Juice											
100-200mL	0	4 (18.2)	1 (4.8)	0	0	0	0	0	1.53	7.27	4.17
200-400mL	0	0	1 (4.8)	0	0	0	0	0	1.53	0	0.83
>400mL	0	0	1 (4.8)	0	0	0	0	0	1.53	0	0.83
Other Beverage-energy drink/milk/ shake											
100-200mL	1 (12.5)	0	0	0	0	0	0	0	1.53	0	0.83
200-400mL	0	0	4 (19.0)	0	0	3 (18.8)	2 (9.1)	0	9.23	5.45	7.5
>400mL	0	0	0	0	0	0	0	0	0	0	0

*Figures in parenthesis represent percentages.

Table 4.8 Post Exercise meals of the athletes (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Time of meal											
15mins after exerc	5 (62.5)	5 (22.7)	4 (19.0)	6 (66.7)	4 (28.6)	8 (50)	9 (40.9)	2 (25)	33.84	38.18	35.83
30mins after exerc	2 (25)	16 (72.7)	14 (66.7)	2 (22.2)	7 (50)	8 (50)	12 (54.5)	6 (75)	53.84	58.18	55.83
>30 mins after	0	0	2 (9.5)	1 (11.1)	3 (21.4)	0	1 (4.5)	0	9.23	1.81	5.83
Type of meal											
Shake (protein)/Milk	2 (25)	1 (4.5)	10 (47.6)	4 (44.4)	4 (28.6)	8 (50)	14 (63.6)	0	46.15	23.63	35.83
Fruit-banana/apple	7 (87.5)	12 (54.5)	5 (23.8)	2 (22.2)	3 (21.4)	9 (56.3)	10 (45.5)	3 (37.5)	38.46	47.27	42.5
Juice-fresh/mix	3 (37.5)	4 (18.2)	6 (28.6)	3 (33.3)	5 (35.7)	2 (12.5)	5 (22.7)	1 (12.5)	29.23	18.18	24.17
Egg											
1-2	0	0	0	0	0	1 (6.25)	0	0	0	1.81	0.83
2-4	5 (62.5)	0	4 (19)	0	2 (14.3)	0	4 (18.2)	4 (50)	23.07	7.27	15.83
>4	0	0	0	0	0	0	1 (4.5)	0	1.53	0	0.83
Any other											
Water/tea/Dalia/oats/ dinner/meat/nuts/toast	0	11 (50)	6 (28.6)	2 (22.2)	2 (14.3)	3 (18.8)	3 (13.6)	0	16.92	29.09	22.5

*Figures in parenthesis represent percentages.

Table 4.9 Hydration schedule after exercise of the athletes (N=120)

Characteristics	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
After Exercise											
Immediately after exercise	2 (25)	11 (50)	7 (33.3)	3 (33.3)	2 (14.3)	7 (43.8)	5 (22.7)	0	24.6	38.2	30.8
10-15 mins after	3 (37.5)	11 (50)	7 (33.3)	3 (33.3)	6 (42.9)	4 (25)	15 (68.2)	8 (100)	47.7	47.3	30.8
30mins after	2 (25)	0	7 (33.3)	2 (22.2)	3 (21.4)	4 (25)	2 (9.1)	0	21.5	10.9	16.7
1hr after exercise	0	0	0	0	2 (14.3)	0	0	0	3.1	0	1.7
> 1hr after exercise	0	0	0	0	0	1 (6.3)	0	0	0	1.8	0.8
Amount of water											
100-200mL	0	1 (4.5)	3 (14.3)	0	0	1 (6.3)	1 (4.5)	0	6.2	3.6	5
200-400mL	5 (62.5)	21 (95.5)	7 (33.3)	4 (44.4)	4 (28.6)	6 (37.5)	12 (54.5)	2 (25)	43.1	60	50.8
>400mL	2 (25)	0	10 (47.6)	4 (44.4)	7 (50)	4 (25)	8 (36.4)	6 (75)	41.5	25.5	34.2
Juice Amount											
100-200mL	3 (37.5)	6 (27.3)	2 (9.5)	3 (33.3)	2 (14.3)	3 (18.8)	1 (4.5)	0	12.3	21.8	16.7
200-400mL	0	0	2 (9.5)	0	0	1 (6.3)	1 (4.5)	1 (12.5)	4.6	3.6	4.2
>400mL	0	0	2 (9.5)	0	0	0	0	0	3.1	0	1.7
Milk/Shake											
100-200mL	0	0	0	0	0	0	0	0	0	0	0
200-400mL	1 (12.5)	0	0	0	1 (7.1)	3 (18.8)	1 (4.5)	0	4.6	5.5	5
>400mL	0	0	0	0	0	0	0	0	0	0	0
Other Beverage-energy drink/soup											
100-200mL	0	0	0	0	0	0	0	0	0	0	0
200-400mL	1 (12.5)	0	1 (4.8)	0	1 (7.1)	0	1 (4.5)	0	6.2	0	3.3
>400mL	0	0	0	0	0	0	0	0	0	0	0

*Figures in parenthesis represent percentages.

Fifty six percent of athletes consumed a post exercise meal 30 minutes after completing their exercise regime as presented in Table 4.8, also 42.5% athletes particularly females consumed fruits especially bananas while 46.2% of male athletes preferred protein shake after exercise and 23.2% of them consumed 2-4 eggs which was again a larger percentage as compared to females who were only 7.23% comprising only female athletes of lawn tennis.

Hydration schedule of athletes after completing their exercise (Table 4.9) indicated that an equal percentage of athletes i.e. 30.8% had consumed liquids immediately and 10 to 15 minutes after completing exercise. The amounts of water and juice consumed by the majority were 200 to 400 millilitres and 100-200 millilitres, respectively.

4.2 NUTRITIONAL STATUS OF THE ATHLETES

4.2.1 Anthropometric measurements

One of the most persuasive aspects in defining sound athletic performance along with other physiological aspects is the anthropometric features (Adhikari *et al* 2014). Table 4.10 represents the anthropometric characteristics of the athletes which revealed a significant ($p \leq 0.05$) difference in the height, weight, BMI, waist circumference, hip circumference and waist hip ratio among overall male athletes as compared to overall female athletes while the triceps skinfold thickness of overall male athletes was found to be significantly ($p \leq 0.05$) lesser as compared female athletes. Such significant ($p \leq 0.05$) differences are attributed to gender differences which had also been reported by Cagno *et al* (2009) in their study on rhythmic gymnasts in which higher values were reported for male gymnasts in each anthropometric measure as compared to female gymnasts.

4.2.2 Classification of athletes according to Body Mass Index

Body Mass Index (BMI) has been defined as weight (kg) / height (m^2) and is used to measure nutritional status of adults. The athletes were classified on the basis of Body Mass Index (BMI) as per the criteria given by Cole *et al* (2000) and the data has been presented in Table 4.11. Among athletes of hockey, 12.5% of the males and 13.6% of the females were underweight having BMI (<18.5). Furthermore, 22.2% of female athletes of athletics, 25% each of female athletes of badminton and lawn tennis were found to be underweight while the male athletes of these sports did not fell in this category. Fifty-seven percent of total selected athletes had a normal BMI.

A higher proportion of male athletes i.e. 37.5% of athletes of hockey, 23.8% athletes of athletics, 42.9% of athletes of badminton and 22.7% of athletes of lawn tennis were observed to be at the risk of obesity by having BMI between (23-24.9) while only a few corresponding female athletes fell under this group.

Table 4.10 Anthropometric measurements of the athletes (N=120)

Para-meters	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
	Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Height (mts)	1.8±0.1	1.6±0.04	5.0*	1.8±0.08	1.7±0.08	4.0*	1.8±0.07	1.6±0.05	5.6*	1.8±0.05	1.6±0.06	5.7*	1.76±0.01	1.6±0.02	11.2*
Weight (kg)	70.1±11.8	52.5±4.1	4.1*	74±12.4	60.2±16.6	2.2*	73.9±10.4	54.2±5.6	6.3*	70.5±8.5	50.1±6.6	6.9*	72.1±2.1	54.3±4.3	7.5*
BMI (kg/m^2)	22.7±2.1	20.4±1.5	2.9*	23.2±2.7	21.6±4.2	1.0^{NS}	23.9±2.3	20.6±2.6	3.8*	22.6±2.1	19.4±2	3.9*	23.1±0.6	20.5±0.9	4.8*
Waist (inch)	31.3±4.2	24.8±1.4	4.3*	31.8±2.9	28.7±5.3	1.6^{NS}	31.7±3.04	27.2±2.9	4.1*	31.6±2.7	26.3±3.5	3.9*	31.6±0.2	26.7±1.6	5.9*
Hip (inch)	39.1±3.8	35.1±1.4	2.9*	38±2.6	37.7±3.8	0.2^{NS}	36.3±3.8	36.3±3.2	0.0^{NS}	37.6±2.5	34.6±2.6	2.9*	37.8±1.2	36±1.4	2.0*
W/H ratio	0.8±0.1	0.7±0.03	5.0*	0.8±0.04	0.75±0.07	3.2*	0.8±0.1	0.7±0.05	4.1*	0.8±0.04	0.75±0.07	3.0*	0.8±0.02	0.74±0.03	5.2*
Tricep Skinfold (mm)	7.3±1.5	11.5±2.2	5.9*	8.4±4.3	12.8±3.8	2.8*	9.5±3.4	12.6±1.8	3.0*	8.7±2.7	9.8±1.9	1.3^{NS}	8.5±0.9	11.7±1.4	3.9*

Values are Mean ± SD *Significant at 5% level NS- Non significant

Table 4.11 Classification of athletes (percent) according to Body Mass Index (BMI)

BMI Categories	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Average		Total
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
<18.5 (Underweight)	12.5	13.6	0	22.2	0	25	0	25	1.53	20	10
18.5-22.9 (Normal)	25	86.4	52.4	44.4	28.6	56.25	54.54	75	46.2	69.1	56.7
23-24.9 (At risk of obesity)	37.5	0	23.8	11.1	42.9	6.25	22.7	0	35.4	5.5	21.7
25-29.9 (Obese I)	25	0	19	22.2	21.4	12.5	18.2	0	21.5	7.3	15
>30 (Obese II)	0	0	0	0	0	0	0	0	0	0	0

Furthermore, 21.5% of overall male athletes were found to be grade I obese while only 7.3% of overall female athletes fell under this category. A similar finding had been reported by Petrie *et al* (2008) which revealed only 2% male collegiate athletes were underweight while 66% of them were classified as overweight or obese in terms of athlete's body mass (WHO 2006).

4.2.3 Haemoglobin level of the athletes

Table 4.12 depicts haemoglobin level of the athletes and reveals the average haemoglobin level of male athletes was 13.8g/dL which was significantly ($p \leq 0.05$) higher than the average haemoglobin level of the female athletes which was 10.8g/dL. Among all the selected sports the haemoglobin level of male athletes was significantly ($p \leq 0.05$) higher than their corresponding female athletes which might be because of the higher percentage of male athletes consumed non-vegetarian foods as compared to female athletes. Khanna *et al* (2006) also reported higher concentration of haemoglobin in blood among non-vegetarian sportspersons as compared to vegetarians. The oxygen carrying capacity of the body's system to various cells and tissues increases with an increased concentration of haemoglobin in blood.

4.2.4 Prevalence of anaemia among the athletes

As depicted in Table 4.13 majority of all the selected male athletes i.e. 95.4% were non-anaemic while 41.8% of female athletes were mildly anaemic. Higher percentage of female athletes was found to be anaemic which could be attributed to a higher proportion of female athletes being vegetarians. Thirty-six percent of female athletes of hockey, 37.5% of female badminton as well as female athletes of hockey were found to be moderately anaemic. Studies have shown that more than 50% of women athletes are deficient in iron. Lower iron levels result in fatigue and poor endurance as the blood is unable to carry sufficient oxygen to working muscles. Losses of iron through menstruation and also lack of dietary iron is the most likely cause of this deficiency (NIN 2007)

In addition, 45.5% and 43.8% of female athletes of hockey and badminton respectively were mildly anaemic while only 12.5% of male athletes of hockey were found to be moderately anaemic and no male athlete fell in this category. Furthermore, 7.14% of male athletes of badminton and 4.5% of male athletes of lawn tennis were mildly anaemic.

Batra and Grover (2011) also exposed a similar finding which reported a significant ($p \leq 0.05$) difference between haemoglobin levels of vegetarians in comparison to non-vegetarians.

Table 4.12 Haemoglobin level of the athletes (N=120)

Parameter	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
	Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Haemoglobin	13.6±2.1	10.5±1.2	3.9*	13.8±1.1	11.1±1.7	4.3*	14±1.6	10.7±1	6.7*	13.6±1.1	10.7±1.2	5.9*	13.8±0.2	10.8±0.3	19.2*

Values are Mean ± SD
*Significant at 5% level
NS- Non significant

Table 4.13 Prevalence of Anaemia (in %) among the athletes (N=120)

Severity of Anaemia based on Hb (g/dL)	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Average		Total
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Moderate (7-10)	12.5	36.4	0	22.22	0	37.5	0	37.5	1.53	34.5	16.7
Mild (10-11.5)	0	45.5	0	0	7.14	43.75	4.5	37.5	3.1	41.8	20.8
Non-Anaemic (More than 11.5)	87.5	13.6	100	77.77	92.9	18.8	95.5	25	95.4	23.6	62.5

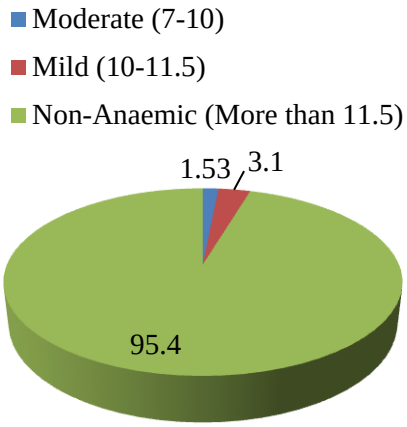

Fig. 2: Percent prevalence of anaemia among Male athletes (n=65)

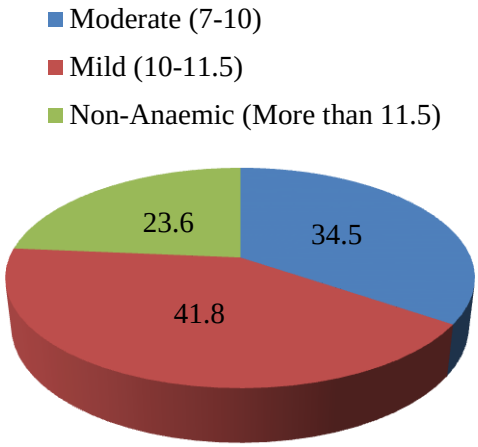

Fig. 3: Percent prevalence of anaemia among Female athletes (n=55)

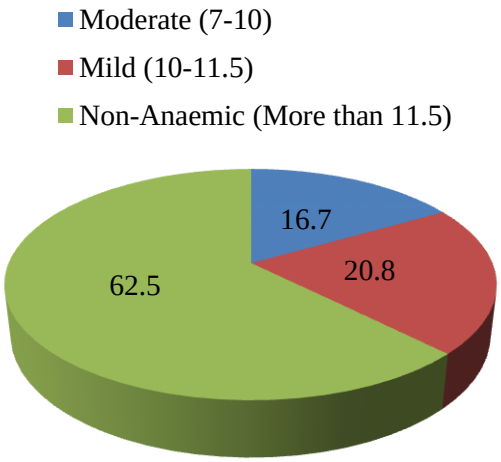

Fig. 4: Percent prevalence of anaemia among the athletes (N=120)

4.2.5 Food consumption pattern

Parantha was observed to be consumed daily by majority of male and female athletes i.e. 35.4 and 61.8% respectively as most of athletes were staying in hostels, while 49.1% of female athletes consumed poori weekly and 60% of male athletes consumed it rarely (Table 4.14). The consumption of bread followed a similar trend i.e. majority of female athletes (34.4%) consumed it weekly while 27.7% of male athletes consumed bread daily. Rice was found to be staple among majority of both male and female athletes with a daily consumption by 43.1% male and 49.1% of female athletes. Vegetarian as well as non-vegetarian dietary pattern of Indians includes consumption of cereals as staple and rice remains priority

(Omidvar and Begum 2014). However, other cereals such as suji, dalia, maida and maize were observed to be consumed rarely by 70.5, 35.4, 72.3 and 52.3% respectively by male athletes and 40, 61.8, 58.2 and 72.7% respectively by female athletes.

It was also revealed that athletes preferred consuming whole pulses over dehusked pulses and sprouts. Whole pulses were being consumed daily by 44.6% of male athletes and 34.5% of female athletes, whereas dehusked pulses were consumed rarely by 46.2% male athletes and 58.2% female athletes. On the other hand, sprouts were also found to be consumed rarely by 67.7% of male athletes and 58.2% of female athletes. Milk consumption was reported to be the highest as a great majority of male and predominantly female athletes i.e. 87.7 and 96.4% respectively consumed milk and milk products daily. These findings were observed to be similar with those revealed by Nazni and Vimala (2010) that majority of athletes consumed recommended quantity of milk by food guide pyramid guidelines every day. Also, the green leafy vegetables was found to be consumed daily by 46.2% of male athletes and 61.9% of female athletes whereas rare consumption of roots and tubers was observed by major portion of athletes i.e. 29.2% male and 52.7% of female athletes.

Daily consumption of fruits was found among majority of both male and female athletes i.e. 60 and 67.3% respectively. The reason behind such high consumption of fruits by majority might be due to convenience of its availability, ease of consumption, provision of instant energy and being a potent anti-oxidant. Yavari *et al* (2015) also considered regular consumption of fresh fruits and vegetables as a productive and harmless way to encounter all antioxidant necessities of sports persons who undergo oxidative stress during workout. Sweets were perceived to be consumed twice a week by 36.4% female athletes and rarely by 30.1% of male athletes along with rare consumption of fried foods by 43.1 and 41.8% of male and female athletes respectively.

Frequency of consumption of various non-vegetarian foods by the athletes has been presented in Table 4.15. Daily consumption of egg whole was found to be higher among male athletes i.e. 37% as compared to female athletes i.e. 14.5%, while 17% of male athletes consumed egg yolk daily too. Egg white consumption by 26.2% male athletes daily was again observed to be higher than 12.7% of female athletes who consumed egg white daily. Chicken, white meat, fish and red meat consumption was found to be rare among both male and female athletes. Thirteen percent of female athletes forming majority, rarely consumed chicken and white meat while 24.6% of male athletes consumed fish rarely with a similar percentage i.e. 35.4% of male athletes consumed red meat rarely.

Table 4.14 Percent Frequency of consumption of various vegetarian foods by the athletes (N=120)

Food item	Daily		Thrice a week		Twice a week		Weekly		Fortnightly		Rarely	
	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)
Parantha	23 (35.4)	34 (61.8)	16 (24.6)	10 (18.2)	8 (12.3)	2 (3.6)	7 (10.8)	2 (3.6)	2 (3.1)	1 (1.8)	10 (15.4)	6 (10.9)
Poori	-	1 (1.8)	-	-	2 (3.1)	1 (1.8)	18 (27.7)	27 (49.1)	11 (16.9)	2 (3.6)	39 (60)	24 (43.6)
Bread	18 (27.7)	9 (16.4)	15 (23.1)	5 (9.1)	11 (16.9)	6 (10.9)	10 (15.4)	19 (34.5)	3 (4.6)	3 (5.5)	8 (12.3)	13 (23.6)
Rice	28 (43.1)	27 (49.1)	14 (21.5)	12 (21.8)	12 (18.5)	5 (9.1)	5 (7.7)	4 (7.3)	2 (3.1)	2 (3.6)	2 (3.1)	3 (5.5)
Suji	1 (1.5)	-	1 (1.5)	1 (1.8)	1 (12.3)	1 (1.8)	5 (7.7)	5 (9.1)	2 (3.1)	4 (7.3)	46 (70.8)	22 (40)
Dalia	13 (20)	3 (5.5)	12 (18.5)	3 (5.5)	6 (9.2)	5 (9.1)	7 (10.8)	2 (3.6)	4 (6.2)	4 (7.3)	23 (35.4)	34 (61.8)
Maida	1 (1.5)	-	1 (1.5)	-	2 (3.1)	8 (14.5)	7 (10.8)	8 (14.5)	7 (10.8)	5 (9.1)	47 (72.3)	32 (58.2)
Maize	1 (1.5)	-	2 (3.1)	-	5 (7.7)	3 (5.5)	16 (24.6)	6 (10.9)	6 (9.2)	4 (7.3)	34 (52.3)	40 (72.7)
Whole pulses	29 (44.6)	19 (34.5)	14 (21.5)	21 (38.2)	8 (12.3)	5 (9.1)	1 (1.5)	1 (1.8)	2 (3.1)	-	9 (13.8)	7 (12.7)
Dehusked pulses	6 (9.2)	8 (14.5)	9 (13.8)	5 (9.1)	9 (13.8)	7 (12.7)	8 (12.3)	-	3 (4.6)	1 (1.8)	30 (46.2)	32 (58.2)
Sprouts	2 (3.1)	2 (3.6)	5 (7.7)	3 (5.5)	2 (3.1)	1 (1.8)	9 (13.8)	13 (23.6)	2 (3.1)	2 (3.6)	44 (67.7)	32 (58.2)
Milk products	57 (87.7)	53 (96.4)	2 (3.1)	-	-	-	-	-	-	-	-	2 (3.6)
GLV	30 (46.2)	34 (61.9)	20 (30.8)	6 (10.9)	9 (13.8)	5 (9.1)	1 (1.5)	1 (1.8)	-	-	4 (6.2)	3 (5.5)
Roots and Tubers	10 (15.4)	10 (1.8)	15 (23.1)	3 (5.5)	12 (18.5)	-	3 (4.6)	2 (3.6)	4 (6.2)	11 (20)	19 (29.2)	29 (52.7)
Fruits	39 (60)	37 (67.3)	13 (20)	3 (5.5)	10 (15.4)	8 (14.5)	2 (3.1)	3 (3.6)	-	3 (5.5)	1 (1.5)	1 (1.8)
Sweets	7 (10.8)	4 (7.3)	11 (16.9)	2 (3.6)	12 (18.5)	20 (36.4)	13 (20)	7 (12.7)	2 (3.1)	5 (9.1)	19 (29.2)	17 (30.1)
Fried foods	4 (6.2)	2 (3.6)	5 (7.7)	1 (1.8)	12 (18.5)	10 (18.2)	7 (10.8)	12 (21.8)	6 (9.2)	5 (9.1)	28 (43.1)	23 (41.8)

*Figures in parenthesis represent percentages.

Table 4.15 Percent Frequency of consumption of various non-vegetarian foods by the athletes (N=120)

Food item	Daily		Thrice a week		Twice a week		Weekly		Fortnightly		Rarely	
	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)	Male (n=65)	Female (n=55)
Egg whole	24 (37)	8 (14.5)	9 (13.8)	4 (7.3)	1 (1.5)	3 (5.5)	-	-	-	-	2 (3.6)	3 (5.5)
Egg yolk	11 (17)	5 (9.1)	3 (4.6)	1 (1.8)	3 (4.6)	3 (5.5)	1 (1.5)	2 (3.6)	-	-	5 (7.7)	4 (7.3)
Egg white	17 (26.2)	7 (12.7)	4 (6.2)	3 (5.5)	2 (3.1)	2 (3.6)	-	-	-	-	1 (1.5)	4 (7.3)
Chicken/White meat	6 (9.2)	3 (5.5)	10 (15.4)	2 (3.6)	15 (23)	2 (3.6)	6 (9.2)	8 (14.5)	1 (1.5)	1 (1.8)	2 (3.1)	7 (12.7)
Fish	-	-	2 (3.1)	1 (1.8)	4 (6.2)	2 (3.6)	5 (7.7)	4 (7.3)	5 (7.7)	3 (5.5)	16 (24.6)	8 (12.3)
Red meat	1 (1.53)	-	1 (1.53)	-	4 (6.2)	2 (3.6)	4 (6.2)	2 (3.6)	3 (4.6)	0	23 (35.4)	8 (12.3)

*Figures in parenthesis represent percentages.

4.2.6 Food intake of the athletes

The data concerning various food groups intake along with their percent adequacy among the male and female athletes of all four sports has been presented in the Table 4.16 and 4.17 respectively, along with Fig. 5 and is being discussed.

Cereals, grains and products

The consumption of cereal, grains and products was found to be significantly ($p \leq 0.05$) higher among female athletes of hockey as compared to their male counterparts whereas there was no significant difference observed among male and female athletes pursuing athletics, badminton and lawn tennis. Gupta *et al* (2013) also revealed high consumption of cereals and grains among university level women players of Chattisgarh, which was similar to the findings of present study.

Pulses and Legumes

The intake of pulses and legumes was found to be significantly ($p \leq 0.05$) higher among female athletes of hockey and athletics than male athletes pursuing same event which might be due to the reason that most of the female athletes were vegetarian and pulses were the only source of protein for them while male athletes consumed non-vegetarian foods to achieve their recommended protein intake. Similarly, a significant higher consumption pattern of pulses and legumes by vegetarian males and females over their non-vegetarian counterparts was reported by Larsson and Johansson (2002). On the other hand, the status quo was different among athletes of lawn tennis where a higher consumption pattern of pulses and legumes by male athletes over female athletes was found to be statistically significant ($p \leq 0.05$).

Milk and milk products

Male athletes were observed to consume more milk and milk products as compared to female athletes in all the selected sports but the difference was statistically non-significant. Although, the percent adequacy of milk and its products was found to be inadequate as compared to Suggested Dietary Intakes which might be due to consumption preference of tea or coffee over milk and also the use of protein supplements in water by majority of male athletes.

Fats and edible oils

A significant ($p \leq 0.05$) higher consumption of fats and oils by male athletes of hockey than their female counterparts was found as depicted in Table 4.16 while male and female athletes pursuing other selected sports had no significant difference regarding fats and oil consumption. The comparison between Suggested Dietary Intakes and actual consumption showed an inadequate consumption of this food group among all the athletes.

Table 4.16 Daily average food intake (g) by the athletes (N=120)

Food Groups	SDI (g)	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
		Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Cereals grains & products	630	229±86	293±74	1.8*	275±87	287±56	0.4^{NS}	275±89	266±73	0.3^{NS}	268±76	251±77	0.5^{NS}	261.8±22	274±19.3	0.8^{NS}
Pulses & legumes	80	41.9±18	71.4±25	3.5*	50.5±21	83.3±21	4.0*	55±21.8	62.2±29	0.8^{NS}	77±24.7	49.4±25	2.7*	56.1±15	66.6±14.4	1.0^{NS}
Milk & milk products	750	580±263	575±244	0.1^{NS}	632±276	499±168	1.6^{NS}	554±278	514±200	0.4^{NS}	450±149	563±258	1.2^{NS}	554±76.7	538±36.6	0.4^{NS}
Fats & edible oils	75	33±3.7	28.7±2	3.2*	29.6±4	29.9±2	0.2^{NS}	29.5±4	31.5±3	1.5^{NS}	29.6±2.9	31.5±3	1.5^{NS}	30.5±1.8	30.4±1.4	0.1^{NS}
Fruits	200	273±170	281±79	0.1^{NS}	255±116	340±33	3.1*	269±63	310±124	1.2^{NS}	299±73.1	253±174	0.7^{NS}	273.7±18	295.7±38	1.1^{NS}
Leafy vegetables	150	73.2±38	65.3±7	1.4^{NS}	79±20	53±18.6	2.2*	51.9±13	57.2±5	1.0^{NS}	74.4±4.6	68.2±20	1.5^{NS}	69.6±4.5	61±2.3	0.8^{NS}
Other vegetables	200	56.3±80	52±43	0.1^{NS}	52±61	52.2±37	0.0^{NS}	61.4±70	57.5±60	0.2^{NS}	41.8±32.7	51.9±83	0.3^{NS}	53±8.3	53.4±2.7	0.1^{NS}
Roots and Tubers	150	63.8±24	127±48	4.7*	98±56	137±21	2.8*	103±60	99.1±42	0.2^{NS}	118.2±40	80±36.3	2.5*	95.6±23	110.7±26	0.9^{NS}
Sugars	80	53.8±25	56.9±23	0.3^{NS}	64±24	42.8±12	3.3*	59.2±27	46.6±19	1.5^{NS}	43.9±15.6	62.5±17	2.7*	55.1±8.5	52.2±9.1	0.5^{NS}
Fish, meat & poultry	100	235±205	34±81	2.7*	146±165	0	4.1*	131±171	118±185	0.2^{NS}	42.3±132	194±173	2.3*	138.5±79	86.3±87	0.9^{NS}

SDI ref: NIN (2007)
Values are Mean ± SD
*Significant at 5% level
NS- Non significant

Table 4.17 Percent adequacy of food intake (g) by the athletes (N=120)

Food Groups	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Cereals grains & products	36.3	46.5	43.7	45.6	43.7	42.2	42.5	39.8	41.6	43.5	42.7
Pulses & legumes	52.3	89.3	63.1	104.1	68.8	77.8	96.3	61.8	70.1	83.2	76.7
Milk & milk products	77.3	76.6	84.3	66.5	73.8	68.6	60	75	73.8	71.7	72.8
Fats & edible oils	44.1	38.3	39.5	39.9	39.3	42	39.5	42	40.6	40.5	40.6
Fruits	136.5	140.5	127.5	170	134.5	155	150	126.5	137.1	148	142.6
Leafy vegetables	48.8	43.5	52.7	35.3	34.6	38.1	49.6	45.5	46.4	40.7	43.6
Other vegetables	28.2	26	26.2	26.1	30.7	28.8	21	26	26.5	26.7	26.6
Roots and Tubers	42.5	84.4	65.3	91.5	68.3	66.1	78.8	53.3	63.7	73.8	68.8
Sugars	67.3	71.1	79.6	53.5	74	58.3	54.9	78.1	69	65.3	67.13
Fish, meat and poultry	235	34	146	0	131	118	42.3	194	138.4	86.3	112.5

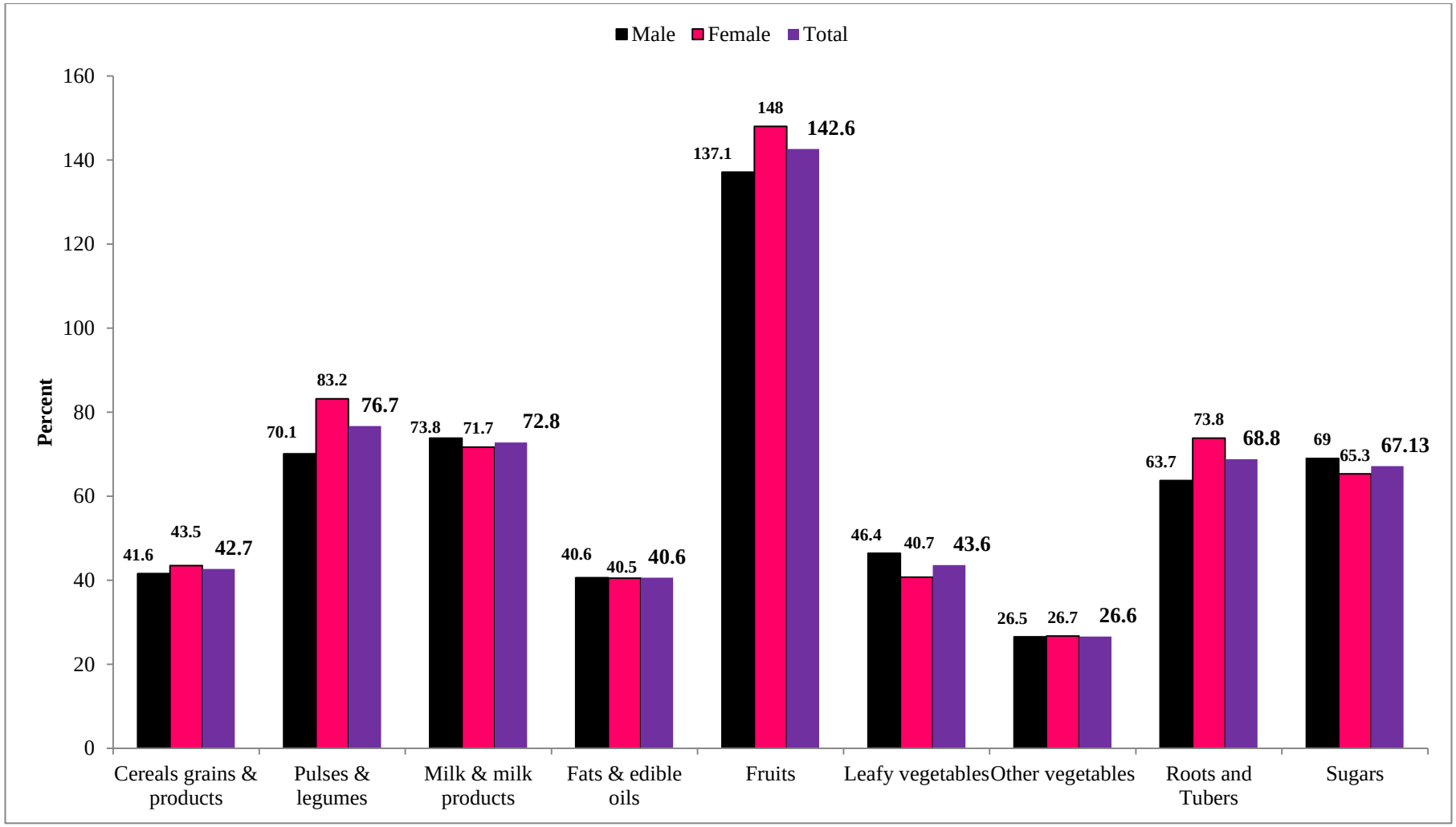

Fig. 5: Percent adequacy of food intake of the athletes (N=120)

The reason might be contributed to athletes' becoming more conscious about their looks which resisted them to consume high amounts of fats and oils. These findings were similar to the results of a study conducted by Gacek (2015) which specified a reduced intake i.e. 42% of animal fats in the light of dietary recommendations for athletes. Correspondingly, another study by Jonnalagadda *et al* (2004) expressed the attitude of both male and female skating players who preferred leaner body contours, therefore the total energy and fat intakes, particularly by female players were found to be below the recommendations.

Fruits

The consumption of fruits was found to be higher as compared to suggested dietary intakes for athletes. Such high consumption was a result of consuming one or two fruit before, during and after an exercise regime by most of the athletes; especially female athletes while male consumed eggs equally. Also, a significant ($p \leq 0.05$) higher consumption of fruits among female athletes of athletics as compared to their male counterparts was observed. Being easily accessible and convenience of consumption, fruits were found to be consumed more than dietary recommendations while male and female athletes of other selected sports were found to consume fruits equally with no significant difference in their fruits intake pattern. Fruits and grains had been preferred by female skating players (Jonnalagadda *et al* 2004).

Vegetables

The overall consumption of green leafy vegetables by male as well as female athletes was observed to be low as compared to Suggested Dietary Intakes, particularly among female athletes. A significant ($p \leq 0.05$) higher consumption of green leafy vegetables by male athletes of athletics than their fellow female athletes was observed while male and female athletes from other selected sports did not show any significant difference. A similar finding regarding deficient green leafy vegetable consumption among female athletes was reported by Vasanthamani and Anuradha (2011). Percent adequacy consumption of other vegetables was also found to be low by all male and female athletes selected in the present study followed by an inadequate consumption of roots and tubers among them whereas the consumption pattern of roots and tubers by female athletes of athletics and hockey was found to be significantly ($p \leq 0.05$) higher than their corresponding male athletes. On the other hand, male athletes of lawn tennis consumed significantly ($p \leq 0.05$) higher quantity of roots and tubers as compared to their parallel female athletes.

Sugars

A significant ($p \leq 0.05$) higher consumption of sugars was observed by male athletes of athletics than those of female athletes, on the contrary, female athletes of lawn tennis

consumed a significantly ($p \leq 0.05$) higher amount of sugars when compared to their male counterparts. The male and female athletes of other two sports did not show any significant difference in sugar consumption pattern while the overall consumption was found to be low as compared to the suggested dietary intakes. This finding could be attributed towards male and female athletes being aware about their appearance and avoiding consuming sweet foods and sugar while preferring natural sugars present in fruits over table sugar. Furthermore, a lesser percentage of athletes were found to consume juices and energy drinks which contains sugar while preferring fruits particularly banana or fresh fruit juice in their pre, during and post exercise meals.

Meat, fish and poultry

A significantly ($p \leq 0.05$) higher percentage of male athletes (athletics and hockey) consumed non-vegetarian foods especially eggs and white meat. On the contrary, female athletes of lawn tennis were found to consume significantly ($p \leq 0.05$) higher measure of eggs and chicken than their male complements while no significant difference was observed between male and female athletes of badminton.

4.2.7 Nutrient intake of the athletes

The data concerning average daily intake of various nutrients along with their percent adequacy ratio (PAR) have been presented in Table 4.18, 4.19 and 4.20 respectively along with Fig. 6 to 10 while percent energy contribution by protein carbohydrates and fats in athletes' diet has been presented in Fig 11 and compared with recommended energy distribution in Fig. 12.

Energy

The overall energy intake of selected male athletes was found to be significantly ($p \leq 0.05$) higher as compared to that of female athletes with a significant ($p \leq 0.05$) difference of energy intakes between athletics, badminton and lawn tennis male and female athletes whereas no significant difference was found between energy intakes of male and female athletes of hockey. The percent adequacy ratio (PAR) of energy was observed to be low in both male and female athletes when compared with recommended dietary allowance. The reason behind low energy intake can be attributed to comparatively lesser time spent in workout, which resulted in reduced requirement of energy as compared to RDA. Hinton *et al* (2004) reported a majority (62%) of female and 23% of male collegiate athletes desired to lose weight which was associated with reduced energy and macronutrient intake.

Protein

It came into prominence from Table 4.18 that the overall protein intake of male athletes was higher than female athletes which might be due to the reason that the

consumption of protein supplements among male athletes was higher than female athletes. Froiland *et al* (2004) also reported a significant higher intake supplements such as ginseng, amino acids, glutamine, weight gainers and whey protein by male athletes, particularly to enhance speed and agility, strength so as to gain muscle mass. A significant ($p \leq 0.05$) higher intake of protein by male athletes of athletics, badminton and lawn tennis as compared to their female counterparts had been observed while there was no significant difference in protein intake between male and female athletes of hockey. When the intakes were compared with RDAs, it was found to be inadequate among the entire male and female athletes of selected sport which could be attributed to the reason that majority of the selected athletes were staying in the hostels. So, they had to rely on the foods whatever was available to them.

Carbohydrates

Table 4.18 presents a significant ($p \leq 0.05$) higher intake of carbohydrates by male athletes of badminton and lawn tennis than corresponding female athletes. This finding was similar to the findings of Okumura *et al* (2017) who reported a less favourable tendency of females to consume foods rich in carbohydrates as compared to males. However, carbohydrate intake of female athletes of hockey was significantly ($p \leq 0.05$) higher than their male counterparts.

Fat

The percent adequacy ratio (PAR) of fat reported in Table 4.20 showed a low intake of fat which is the most concentrated source of energy by all the male and female athletes of all selected sports. There was not any significant difference regarding fat intake by both male and female athletes of almost all the sports except athletics in which a significantly ($p \leq 0.05$) higher fat intake by males as compared to females was observed.

Iron

The overall iron intake by male athletes was found to be significantly ($p \leq 0.05$) higher than female athletes particularly in the sports such as athletics, badminton and lawn tennis while male and female athletes of hockey consumed similar amount of iron per day. The lower intake of iron by female athletes might be due to the reason that majority of female athletes were vegetarians. The percent adequacy ratio (PAR) revealed an inadequate intake of iron as compared to RDAs by both male and female athletes. The lower iron intake could be accredited to a reduced intake of green leafy vegetables by the athletes. Gropper *et al* (2006) also reported that 25% of female athletes were unsuccessful to consume two-thirds of RDA for iron and exhibited saturation of sub-optimal serum concentrations of ferritin, iron and transferrin.

Table 4.18 Daily average nutrient intake of athletes (N=120)

Nutrients	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)		
	Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value
Energy (Kcal)	2521±540	2653±501	0.6^{NS}	3198±511	2579±385	3.6*	2927±489	2350±418	3.4*	2931±564	2585±361	2.0*
Protein (g)	95.5±45.3	86.8±22.1	0.5^{NS}	127.3±38.9	87.8±23.0	3.5*	98.5±21.7	81.3±19.6	2.3*	104.8±32.7	85.1±9.2	2.6*
Carbohydrates (g)	297±59	356±61	2.4*	395±67	353±60	1.7^{NS}	400±73	296±49	4.5*	384±75	329±60	2.1*
Fat (g)	95.7±32.3	86.7±20.6	0.7^{NS}	107.8±30.2	78.9±34.6	2.2*	88.5±20.3	82.4±17.9	0.9^{NS}	95.0±22.0	91.5±13	0.5^{NS}
Iron (mg)	17.7±3.7	19.4±3.4	1.2^{NS}	24.2±4.1	18.5±2.5	4.7*	23.7±9.8	18.1±3.7	2.1*	22.9±4.7	18.5±2.4	3.3*
Calcium (mg)	1350±392	1757±551	2.2*	2073±623	1575±520	2.3*	1819±651	1661±444	0.8^{NS}	1968±686	1947±412	0.1^{NS}
Phosphorus (µg)	1804±419	2149±418	2.0*	2443±497	1915±212	4.1*	2186±434	1768±316	3.0*	2205±486	2171±345	0.2^{NS}
Beta-carotene (µg)	540±491	2698±2172	4.4*	1169±1779	1268±1045	0.2^{NS}	1456±1048	1252±1198	0.5^{NS}	1478±1870	912±1022	1.1^{NS}
Vitamin A (µg)	782±568	395±239	1.9*	820±477	541±421	1.6^{NS}	543±333	369±229	1.6^{NS}	614±382	509±249	0.9^{NS}
Folic Acid (µg)	259±106	183±60	1.9*	274±71	213±32	3.3*	239±83	164±45	3.0*	269±118	187±46	2.7*
Vitamin C (mg)	55.9±39.1	54.4±55.0	0.1^{NS}	86.9±84.1	57.7±27.3	1.4^{NS}	62.6±22.4	96.9±64.2	2.0*	91.8±89	41.6±9.5	2.6*
Total Dietary Fibre (g)	8.3±3.0	14.4±4.8	4.1*	12.8±5.5	14.8±6.6	0.1^{NS}	14.9±4.1	14.8±3.2	0.1^{NS}	15.3±4.7	12±3.8	2.0*

Values are Mean ± SD
*Significant at 5% level
NS-Non significant

Table 4.19 Daily average nutrient intake of total athletes (N=120)

Nutrients	Total (N=120)		
	Male (n=65)	Female (n=55)	t-value
Energy (Kcal)	2894±280	2542±132	2.3*
Protein (g)	107±14	85.2±2.9	2.9*
Carbohydrates (g)	369±49	333±28	1.3^{NS}
Fat (g)	96.8±8.1	84.9±5.4	2.4*
Iron (mg)	22.1±3	18.6±0.6	2.3*
Calcium (mg)	1803±319	1735±159	0.4^{NS}
Phosphorus (µg)	2160±264	2001±193	1.0^{NS}
Beta-carotene (µg)	1161±437	1532±795	0.8^{NS}
Vitamin A (µg)	690±133	453±84	3.0*
Folic Acid (µg)	260±15.7	186±20	5.7*
Vitamin C (mg)	74.3±18	62.6±24	0.8^{NS}
Total Dietary Fibre (g)	12.9±3.2	14±1.3	0.7^{NS}

Values are Mean ± SD
*Significant at 5% level
NS- Non significant

Calcium

The average daily consumption of calcium was reported to be higher among male athletes as compared to female athletes but the difference was non-significant. However, a significant ($p \leq 0.05$) difference between male and female athletes of hockey and athletics was observed with higher intake among males. These findings were found to be similar to those reported by Ward *et al* (2004) which revealed lower calcium intake as compared to recommended levels by 84% collegiate female athletes based on their dietary records. A low dietary intake of calcium was observed when compared to RDAs which might be due to lower consumption of milk and milk products by the athletes.

β-Carotene

The average daily nutrient intake of β-Carotene was found to be higher among female athletes as compared to male athletes; the reason might be due to higher consumption of fruits by them. The intake of β-Carotene by female athletes of hockey was observed to be significantly ($p \leq 0.05$) higher than their corresponding male athletes. The percent adequacy (PAR) exhibited an inadequate intake of β-Carotene by all the selected male and female athletes which might be due to low consumption of green leafy and other vegetables by the athletes. On the contrary, Nande *et al* (2009) reported significantly ($p \leq 0.01$) higher daily nutrient intake of β-Carotene by the athletes as compared to recommended dietary intake.

Table 4.20 Percent adequacy ratio of the athletes (N=120)

Nutrients		Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total(%)		Total (%)
	RDA	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Energy (Kcal)	4500	56.0	59	71.1	57.3	65	52.2	65.1	57.5	67.7	56.5	62.1
Protein (g)	160	59.7	54.3	79.6	54.9	61.6	50.8	65.5	53.2	66.6	53.3	60
Fat (g)	120	79.8	72.3	89.8	65.8	73.8	68.7	79.2	76.3	80.6	70.7	75.7
Iron (mg)	60	30	32.3	40.3	30.8	39.5	30.2	38.2	30.8	36.9	31	34
Calcium (mg)	2000	67.5	87.8	104	78.8	91	83	98.4	97.3	90.1	86.8	88.5
Beta-carotene (µg)	4800	11.3	56.2	24.4	26.4	30.3	26.1	30.8	19	24.2	32	28.1
Vitamin A (µg)	600	130	65.9	137	90.1	90.5	61.5	102	84.8	115	75.6	95.3
Folic Acid (µg)	200	129	91.4	137	106	119	81.8	134	93.3	130.1	93.4	111.8
Vitamin C (mg)	40	140	136	217	144	157	242	230	104	185.8	156.6	171.2

NIN (2007)

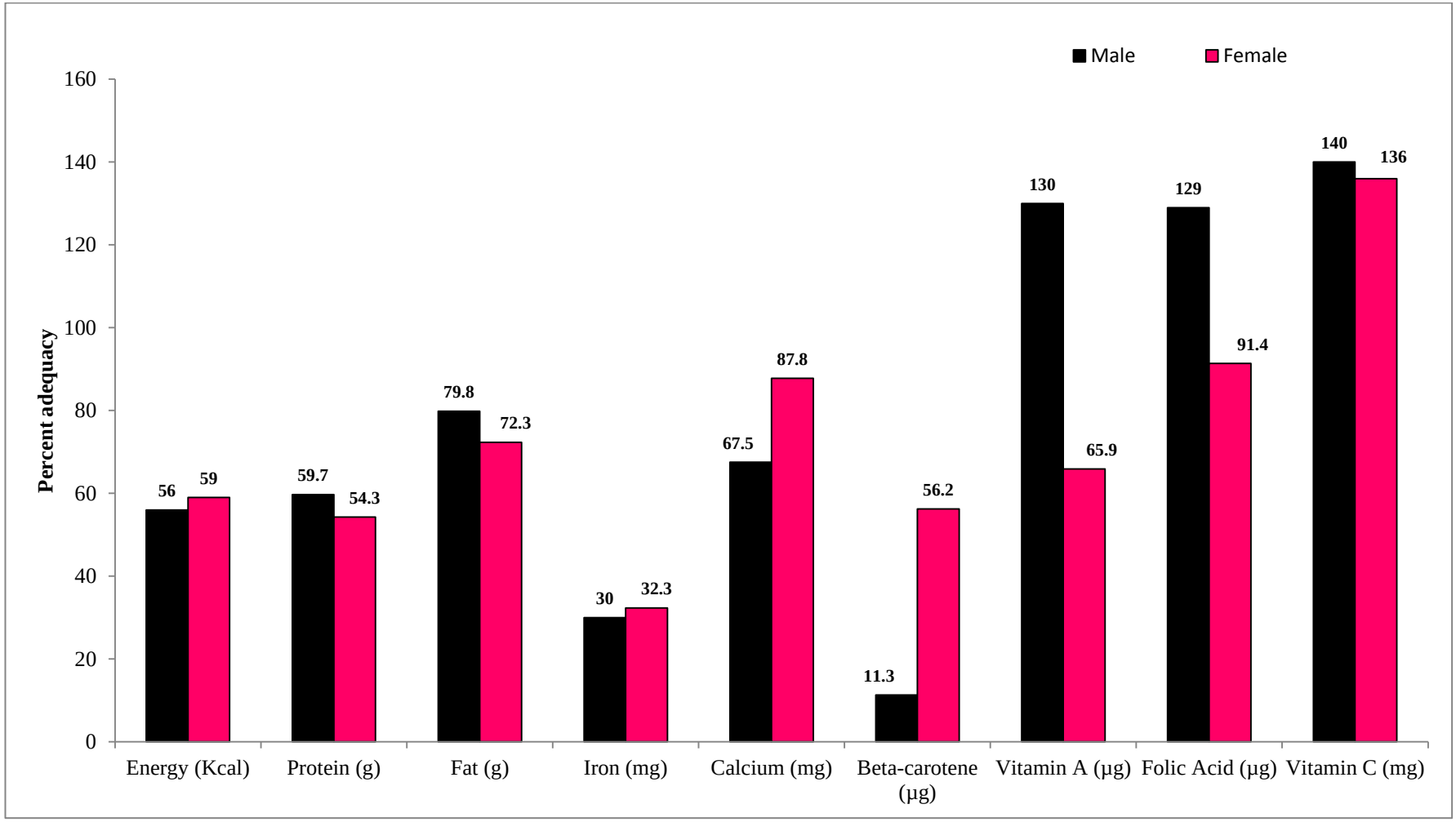

Fig. 6: Percent adequacy ratio (PAR) of athletes of Hockey (n=30)

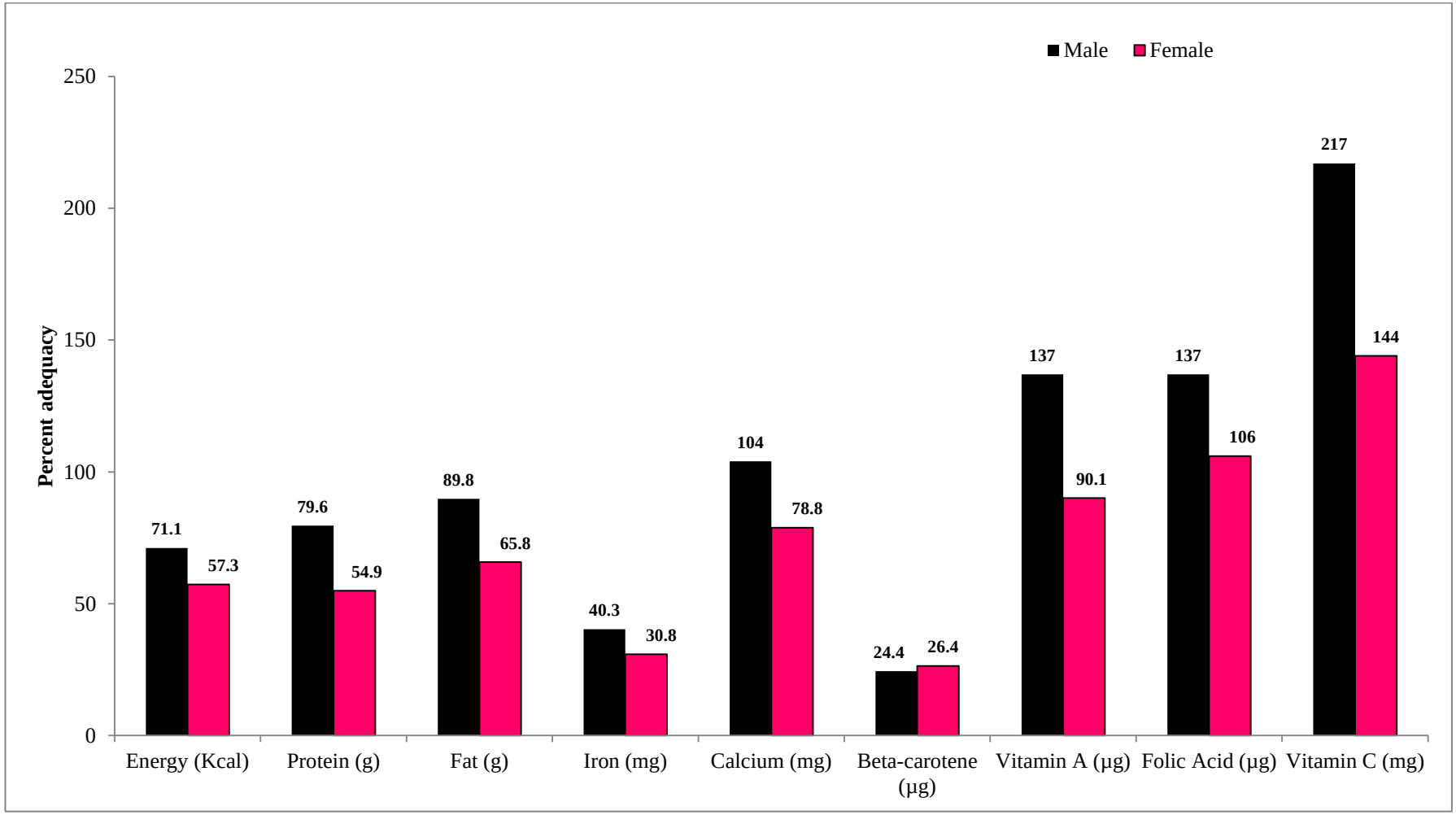

Fig. 7: Percent adequacy ratio (PAR) of athletes of Athletics (n=30)

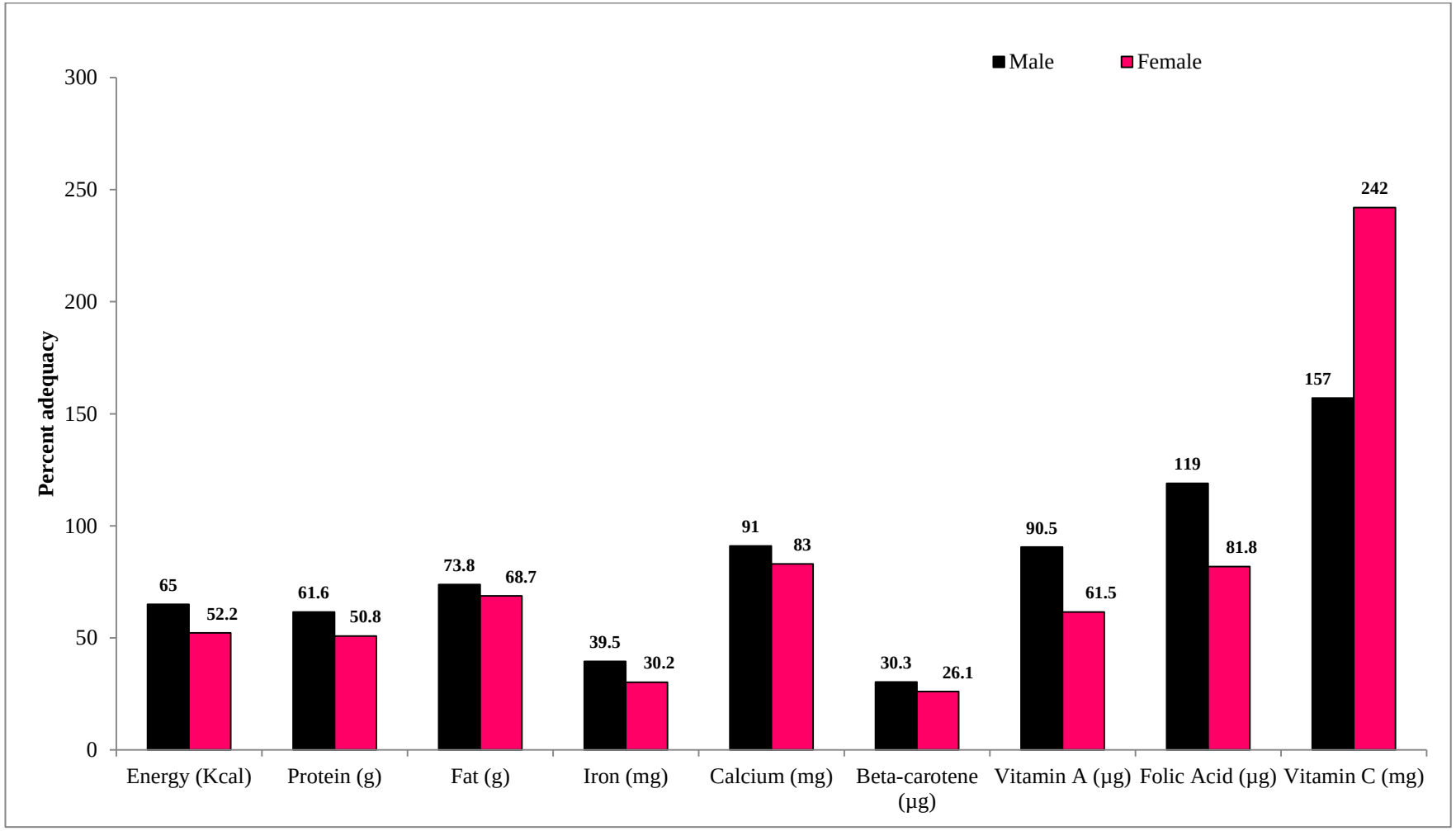

Fig.8: Percent adequacy ratio (PAR) of athletes of Badminton (n=30)

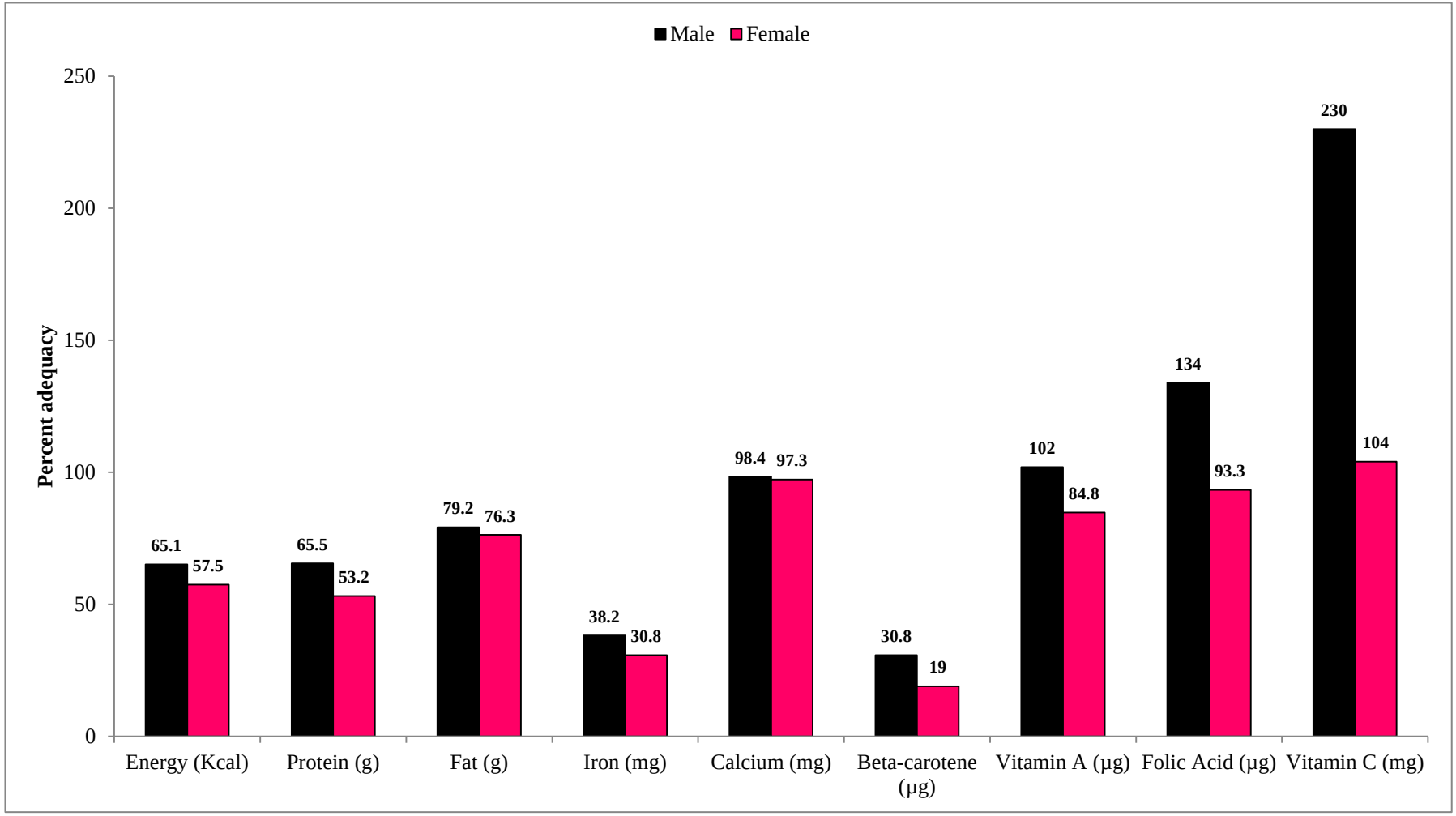

Fig.9: Percent adequacy ratio (PAR) of athletes of Lawn Tennis (n=30)

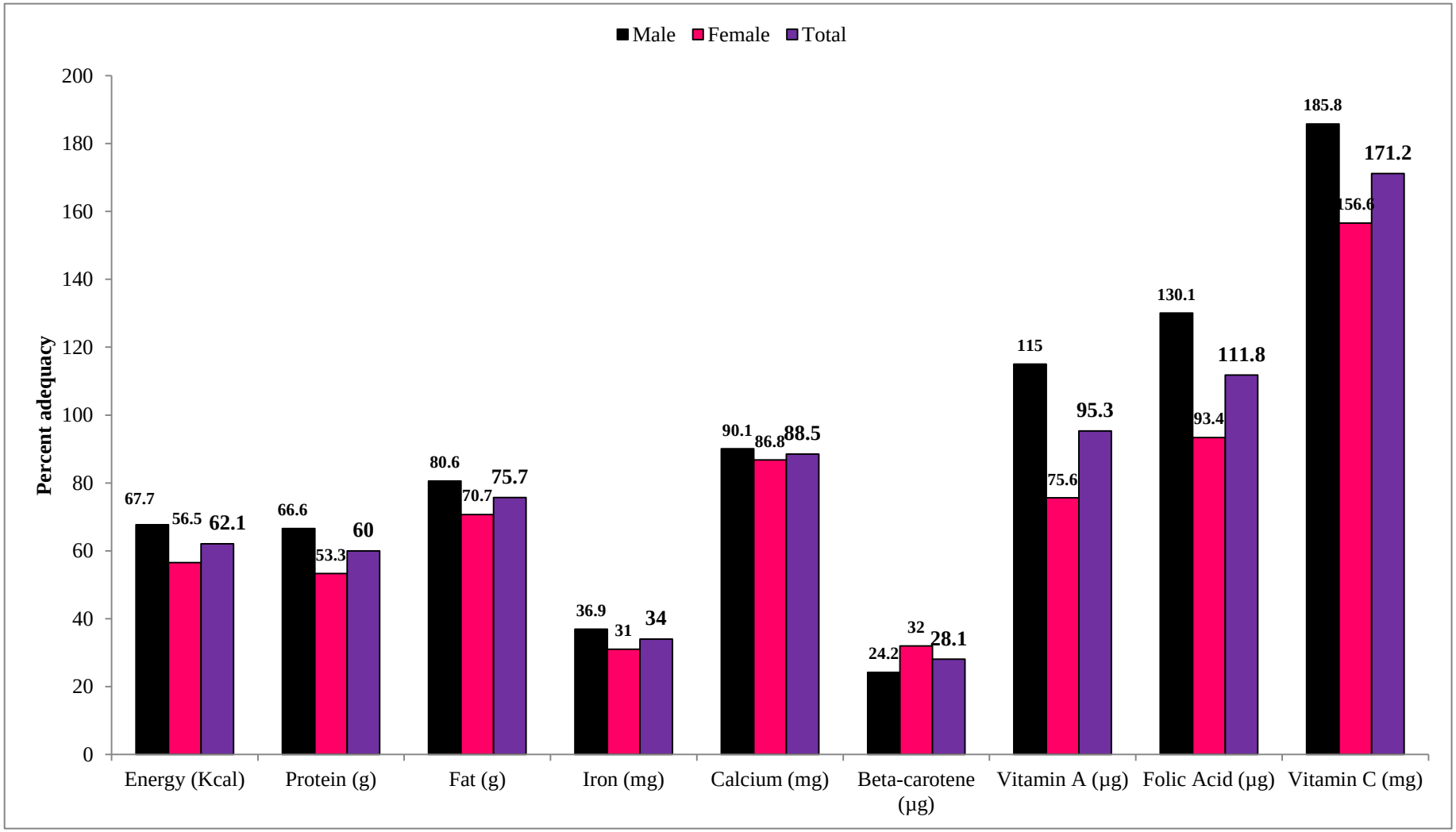

Fig.10: Percent adequacy ratio (PAR) of athletes (N=120)

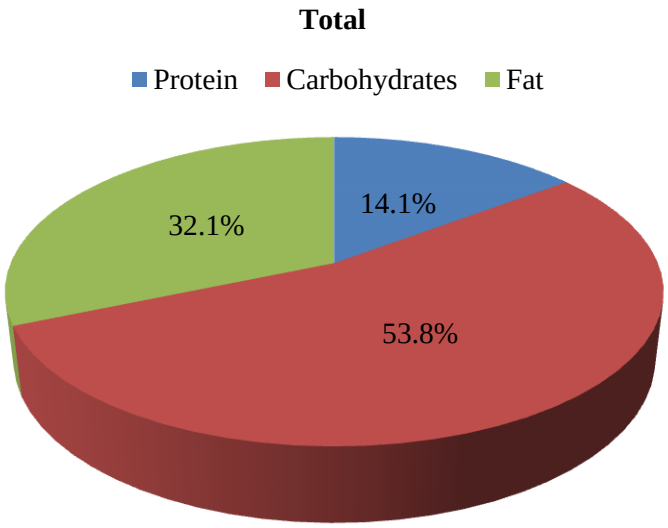

Fig. 11: Percent energy contribution in diet of the athletes (N=120)

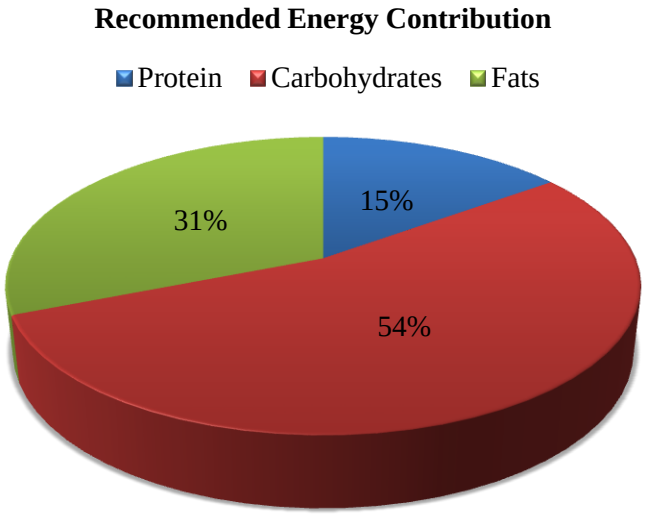

Fig. 12: Percent energy contribution according to RDA (NIN 2007)

RDA for Percent Energy Contribution (Carbohydrate:Fat:Protein) – 54:31:15

Vitamin A

A significant ($p \leq 0.05$) higher average intake of vitamin A was observed among male athletes as compared to female athletes, the reason could be attributed to the consumption of non-vegetarian foods, particularly eggs by majority of male athletes. In addition, the percent adequacy ratio (PAR) of vitamin A was found to be higher among male athletes than female athletes.

Folic acid

The average daily folic acid intake of overall male athletes was found to be 260 µg which was significantly ($p \leq 0.05$) higher than the intake of female athletes which was 186 µg. However, adequacy of folic acid intake among all the athletes (N=120) was found to be more than adequate.

Vitamin C

The percent adequacy of Vitamin C was observed to be adequate to highly adequate with no significant difference between overall male and female athletes. However, the female athletes of badminton had significant ($p \leq 0.05$) higher intake of Vitamin C than their male counterparts whereas the male athletes of lawn tennis had significant ($p \leq 0.05$) higher intake of this vitamin as compared to their female counterparts. Such high intake levels could be attributed to high consumption of seasonal fruits by the athletes.

4.2.8 Pre, during and post exercise nutrient intake of athletes

Pre-exercise nutrient intake

The pre exercise nutrient intake of all the male and female athletes of the selected four sports has been presented in Table 4.21.

The overall average daily intake of energy was found to be significantly ($p \leq 0.05$) higher among selected male athletes as compared to selected female athletes while in sports such as hockey and badminton, male and female athletes did not exhibit any significant difference in pre exercise energy intakes. A higher energy intake by male athletes might be contributed to consumption of eggs along with fruits, while majority of female athletes consumed only fruits or other light food items before exercise. Energy drink or other protein supplement beverage was preferred by higher percentage of male athletes than female athletes as recommended by their coaches. Pre exercise dietary guidelines were being recommended by 93% of sports coaches while only 46% of coaches endorsed post exercise dietary practices (Juzwiak and Lopez 2004).

Protein intake before exercise was also found to be significantly ($p \leq 0.05$) higher among overall male athletes than female athletes while protein intake of hockey male and female athletes did not show any significant difference. Prevalence of higher percentage of non-vegetarians among male athletes who consumed 2 to 4 eggs before commencing their workout regime justified a higher protein intake by male athletes as compared to female athletes. Also, male athletes were more willing to consume protein supplements as compared to female athletes. The protein intake of male athletes before exercise was reported to be adequate as compared to recommendations than that of female athletes (Baker *et al* 2013).

Table 4.21 Daily average nutrient intake of the athletes before exercise (N=120)

Nutrients	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
	Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Energy (Kcal)	329±214	211±131	1.5^{NS}	329±331	116±156	2.4*	321±206	234±185	1.2^{NS}	367±254	177±137	2.6*	336±21	185±51	5.5*
Protein (g)	11.2±13.2	2.8±4.3	1.8^{NS}	12.3±14.9	3.5±5.7	2.4*	11.4±10.4	4.9±6.4	2.0*	11.4±12.7	2.7±3.8	2.8*	11.6±0.5	5.6±3.9	3.0*
Carbohydrates (g)	48.2±24.0	44.2±19.2	0.4^{NS}	41.9±36.97	21.3±24.4	1.8*	40.5±26.0	40.3±23.2	0.0^{NS}	45.8±22.9	34.5±13.2	1.7^{NS}	44±3.5	35.1±10	1.7^{NS}
Fat (g)	10.07±13	2.3±5.3	1.6^{NS}	10.7±14.2	4.2±7.9	1.6^{NS}	11.3±11.2	5.1±7.7	1.7*	12.8±13.6	2.4±5.7	3.0*	11.2±1.2	3.5±1.4	8.5*

Values are Mean ± SD; *Significant at 5% level; NS- Non significant

Table 4.22 Daily average nutrient intake of the athletes during exercise (N=120)

Nutrients	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
	Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Energy (Kcal)	15±42	15±38	0.01^{NS}	75±143	51±154	0.4^{NS}	46±58	34±47	0.6^{NS}	25±50	66±60	1.7^{NS}	40±27	41.3±22	0.1^{NS}
Protein (g)	0±0	0.11±0.2	2.5*	3.4±9.1	3.4±10.3	0.0^{NS}	0.24±0.4	0.2±0.3	0.3^{NS}	1.5±6.5	0.2±0.22	1.0^{NS}	1.3±1.6	1±1.6	0.3^{NS}
Carbohydrates (g)	3.8±10.6	3.6±9.5	0.04^{NS}	10.9±17.8	3.7±11.2	1.3^{NS}	11.2±14.2	8.07±11.4	0.7^{NS}	4.5±8.5	16.4±15.0	2.1*	7.6±4	7.9±6	0.1^{NS}
Fat (g)	0±0	0.03±0.08	1.8*	1.5±4.6	1.9±5.7	0.2^{NS}	0.04±0.1	0.06±0.09	0.5^{NS}	0.07±0.14	0±0	2.3*	0.4±0.8	0.5±0.9	0.1^{NS}

Values are Mean ± SD; *Significant at 5% level NS- Non significant

Carbohydrate intake before exercise exhibited no significant difference between overall intakes by male and female athletes. However, a significant ($p \leq 0.05$) higher intake of carbohydrates was observed by male athletes of athletics as compared to female athletes. The carbohydrate intake by overall male athletes contributed to 52.4% of total energy while intake by female athletes contributed to 75.9% to total energy which clearly indicated a higher consumption of carbohydrate diet by female athletes before exercise than male athletes. This finding might be attributed to a higher consumption of fruits, specifically bananas by female athletes while male consumed an equal proportion of fruits and eggs. A similar conclusion had been stated by Baker *et al* (2013) that only 18% of male and 29% of female athletes consumed 30-60g of carbohydrates before and during practice or competition.

The total energy contribution by fats in pre exercise meal of male athletes was observed to be 30% while energy contribution by fat in the pre exercise diet of female was found to be only 17% which clearly determined a significant ($p \leq 0.05$) higher intake of fat by male athletes before exercise as compared to those of their female counterparts. However, no significant difference was observed regarding fat intake between male and female athletes of hockey and athletics.

During exercise nutrient intake

The nutrient intake of the selected male and female athletes of all the selected sports during exercise has been presented in Table 4.22 and is discussed below:

The energy intake of overall male and female athletes during exercise was found to be lower than the intake of energy before exercise. There was no significant difference observed in the energy intakes of male and female athletes during exercise. A non-significant difference regarding protein intake among overall male and female athletes during exercise was observed.

The energy contribution by the intake of carbohydrates during exercise by all the athletes was observed to 75% approx. which indicated consumption of carbohydrate rich during exercise meal with a major contribution made by bananas. A significant ($p \leq 0.05$) higher intake of carbohydrates by lawn tennis males was observed over lawn tennis females while no significant difference concerning intake of this nutrient was found between male and female athletes of other selected sports. Kerksick *et al* (2008) suggested ingestion of 30-60 grams of carbohydrates per hour, every 10-15 minutes during exercise while adding protein into the meal may enhance performance and encourage muscle glycogen re-synthesis during acute stamina dependent exercise.

A very low intake of fat was found in meals consumed during exercise by all the selected athletes with a significant ($p \leq 0.05$) higher consumption of fat among male athletes of lawn tennis as compared to their female counterparts and female athletes of hockey as

compared to their corresponding male athletes. Furthermore, no significant difference of fat intake between male and female athletes of athletics and badminton had been observed. Such low intake of energy, protein and fat could be attributed to consumption light meals, particularly fruits such as banana and apple. Water intake during this period was also observed to be high while no source of protein was ingested as it could make the player feel distended, which was undesirable as the workout regime was yet to be completed.

Post exercise nutrient intake

The nutrient intake of post exercise meals is being discussed below along with its tabular presentation in Table 4.23.

A high energy intake (Table 4.23) by all the selected athletes was observed, while male athletes of hockey and lawn tennis exhibited a significant ($p \leq 0.05$) higher intake of energy as compared to their corresponding female athletes. However, no significant difference between male and female athletes of badminton and athletics was observed. A high consumption of energy after exercise was observed which might be due to the reason that the athletes were aware about replenishing the depleted energy during exercise and workout.

The energy contributed by protein in a post exercise meal of overall male athletes was found to be 16.2% while it was 14.8% among overall female athletes. Since protein depletion is the most during workout, the need to replenish body protein becomes priority. With a suggested intake a single post exercise protein mixture increased the rate of power restoration in 48 hours and served as an ergogenic aid (Etheridge *et al* 2008). The protein intake by male athletes of hockey was found to be significantly ($p \leq 0.05$) higher as compared to female athletes of hockey while any significant difference was not observed between male and female athletes regarding protein intake after exercise. Majority of male athletes (46.2%) preferred consumption of protein supplement after exercise while among female athletes only 23% preferred the same.

The overall average carbohydrate intake of almost all of the male and female athletes had no significant difference except those in the athletes of lawn tennis, where male athletes were found to consume significant ($p \leq 0.05$) higher amount of carbohydrates as compared to female athletes. Burke (2010) suggested that there was a need to create strategies to promote carbohydrate availability such as ingestion of carbohydrate before, during and after exercise schedule which was critical to enhance performance.

Table 4.23 Daily average nutrient intake post exercise of the athletes (N=120)

Nutrients	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
	Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Energy (Kcal)	468±279	254±140	2.8*	332±282	261±168	0.9^{NS}	273±224	389±173	1.6^{NS}	404±232	252±111	2.4*	369±84.7	289±66.6	1.5^{NS}
Protein (g)	19.2±13.1	4.54.6	3.1*	16.1±14.2	12.9±13.1	0.6^{NS}	8.99±9.8	15.3±13.1	1.5^{NS}	15.3±12.3	10.2±7.6	1.4^{NS}	14.9±4.2	10.7±4.6	1.3^{NS}
Carbo-hydrates (g)	46.2±26.5	44.2±18.9	0.2^{NS}	37.1±32.5	31.5±19.5	0.6^{NS}	35.3±22.9	43.6±11.3	1.2^{NS}	42.8±23.8	27.4±11.5	2.4*	40.4±5	36.7±8.5	0.7^{NS}
Fat (g)	20.5±14.9	5.23±6.9	2.8*	11.2±11.8	7.5±8.6	0.9^{NS}	8.8±10.9	13.3±9.8	1.2^{NS}	15.3±11.6	10.5±8.6	1.2^{NS}	14±5.1	9.1±3.5	1.6^{NS}

Values are Mean ± SD *Significant at 5% level NS- Non significant

Fat intake was found to be significantly ($p \leq 0.05$) higher by male athletes of hockey than female athletes of hockey while male and female athletes of other selected sports exhibited no significance difference regarding fat intake. The total energy contribution by fat intake of overall male athletes was discovered to 34% while that of overall female athletes was 28% which indicated an adequate consumption of fat after exercise by the athletes.

4.3 PHYSICAL ACTIVITY PATTERN:

4.3.1 Physical Activity Pattern

The routine physical activity of the athletes was recorded along with time spent on these activities (Table 4.24) to study their physical activity pattern. The results revealed a significant ($p \leq 0.05$) difference in mean sleeping hours of both overall male and female athletes with higher sleeping hours among female athletes of hockey, athletics and badminton as compared to their corresponding male athletes. On the contrary, male athletes of lawn tennis had reported significantly ($p \leq 0.05$) higher sleeping hours than female athletes of lawn tennis. There was no significant difference observed in personal care by overall male and female athletes while female athletes of athletics spent a significant ($p \leq 0.05$) more time than male athletes of athletics whereas the male athletes of badminton were found to spend significant ($p \leq 0.05$) more time than female athletes of badminton. The time spent on having meals did not show any significant difference between male and female athletes of selected sports.

A non-significant difference regarding time expenditure on light activities by overall male and female athletes was observed, while male athletes of hockey and badminton were found to spend significant ($p \leq 0.05$) more time as compared to their female counterparts in this activity. A similar result had been displayed concerning time spent in watching TV which also did not show any significant difference between overall male and female athletes so as in driving but male athletes of lawn tennis spent significantly ($p \leq 0.05$) higher time while driving as compared to female athletes of lawn tennis.

There was no overall significant difference between overall male and female athletes in preparing meals as majority of athletes resided in hostels while few female athletes such as athletes of hockey and badminton being non-hostellers spent significant ($p \leq 0.05$) higher time in preparing meals as compared to corresponding male athletes. The time spent in other general household work was found to be significantly ($p \leq 0.05$) higher among female athletes of hockey and badminton in comparison to their fellow male athletes whereas male athletes of lawn tennis spent significantly ($p \leq 0.05$) higher time in general household work than their female counterparts.

Table 4.24 Physical Activity Pattern of the athletes (N=120)

Activities (in hours)	PAR°	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
		Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Sleeping	1.0	6.6±1.5	8.3±0.9	3.0*	7.3±0.8	8.1±0.6	3.0*	7.1±1.2	8.4±1.2	3.0*	7.4±1	6.9±0.6	1.8*	7.1±0.3	7.9±0.7	2.1*
Personal care	2.3	1.6±1.1	1.75±0.5	0.3^{NS}	1.8±0.6	2.2±0.4	1.9*	1.8±0.7	1.2±0.4	3.0*	1.3±0.6	1.5±0.3	0.1^{NS}	1.7±0.2	1.7±0.4	0.0^{NS}
Having meals	1.5	3.2±0.8	3.2±0.8	0.1^{NS}	2.8±0.6	2.4±0.7	1.3^{NS}	2.7±0.5	2.9±0.5	1.3^{NS}	2.7±0.4	2.9±0.5	0.7^{NS}	2.8±0.2	2.9±0.3	0.1^{NS}
Light activities while sitting	1.5	6.1±2.4	4.2±2	2.0*	5±1.4	5.4±2.4	0.4^{NS}	6.5±1.9	3.8±1.4	4.3*	5.9±1.7	6.5±1.7	0.9^{NS}	5.9±0.6	5±1.2	1.3^{NS}
Watching TV/ Computer work	1.4	1.5±0.9	0.8±0.5	2.0*	0.9±0.6	1.4±1.7	0.9^{NS}	0.6±0.4	1±0.5	2.6*	1±0.8	0.6±0.5	1.6^{NS}	1±0.4	0.95±0.3	0.2^{NS}
Driving	2.0	0.3±0.5	0.1±0.3	0.9^{NS}	0.7±0.6	0.6±0.3	0.6^{NS}	0.7±0.7	0.6±0.3	0.6^{NS}	0.7±0.4	0	7.9*	0.6±0.2	0.3±0.3	1.5^{NS}
Preparing meals	2.1	0	0.35±0.2	8.9*	0.03±0.2	0	1.0^{NS}	0	0.4±0.4	4.1*	0.03±0.1	0	1.0^{NS}	0.02±0	0.2±0.2	1.6^{NS}
Other general household work	2.8	0.04±0.1	0.7±0.5	6.1*	0.4±0.5	0.3±0.4	0.6^{NS}	0.2±0.3	0.6±0.5	3.5*	0.3±0.4	0.1±0.2	2.5*	0.2±0.2	0.4±0.3	1.2^{NS}
Walking without load	3.2	0.8±0.4	1.7±0.8	3.9*	1.2±0.5	0.9±0.6	1.0^{NS}	1.2±0.6	0.6±0.5	3.0*	1±0.5	1.03±0.2	0.3^{NS}	1.05±0.2	1.06±0.4	0.0^{NS}
Exercise, yoga and sports	4.8	3.8±1.2	2.9±1.2	1.9*	4±1.3	2.8±1.4	2.1*	3.3±1.4	4.4±1.7	1.9*	3.7±1.7	4.6±0.2	2.5*	3.7±0.3	3.67±1	0.1^{NS}

Values are Mean ± SD, *Significant at 5% level, NS-non significant, °Physical Activity Ratio

A significantly ($p \leq 0.05$) higher time was spent by female athletes of hockey than male athletes of hockey in walking throughout the day whereas male athletes of badminton spent significant ($p \leq 0.05$) higher time in walking as compared to female athletes of badminton while there was no significant overall difference in time spent while walking was observed.

Regarding time spent in athletes' respective sport, a significant ($p \leq 0.05$) difference was observed between male and female athletes of all the selected sports, but male athletes of hockey and athletics spent more time in workout as compared to their corresponding female athletes. However, female athletes of badminton and lawn tennis spent more time in workout as compared to their male counterparts. Therefore, no overall significant difference regarding time spent in workout between male and female athletes was found.

4.3.2 Physical activity level (PAL) of athletes

FAO/WHO/UNU (2004) classification had been used to categorize the selected athletes into lifestyle pattern of sedentary/moderate/vigorous. Table 4.25 displays calculated values of physical activity level which revealed an overall higher physical activity level of male athletes as compared to female athletes but the difference was not found to be significant. A significantly ($p \leq 0.05$) higher physical activity level was observed among male athletes of athletics was found as compared to their female counterparts while among athletes of lawn tennis, a significantly ($p \leq 0.05$) higher physical activity level had been observed among female athletes than their corresponding male athletes.

Consequently, no overall significant difference was observed between selected male and female athletes regarding physical activity level.

4.3.3 Classification of athletes according to physical activity level

Categorization of athletes into sedentary, moderate and active lifestyle was done according to their physical activity level and is being presented in Table 4.26. The data revealed that 51.7% of total athletes had vigorous or vigorously active lifestyle while 44.2% of them had active or moderately active lifestyle, whereas only 4.2% of total athletes lived sedentary or light activity lifestyle which included a small percentage i.e. 13.6 and 11.1% of female athletes of hockey and athletics, respectively.

An equal percentage (49.2%) of male athletes fell under the category of moderately active and vigorously active lifestyle while a majority of female athletes i.e. 54.5% lived vigorously active lifestyle as compared to 38.2% of them who fell under moderately active lifestyle.

Table 4.25 Physical Activity Level (PAL) of Athletes (N=120)

Particulars	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
	Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Physical Activity Level (PAL)	2.00	1.94	0.8^{NS}	2.07	1.87	2.9*	1.97	2.06	1.0^{NS}	1.99	2.11	2.2*	2.0±0.0	1.99±0.1	0.2^{NS}

^FAO/WHO/UNU (2004) Values are Mean ± SD, *Significant at 5% level, NS-non significant

Table 4.26 Classification according to Physical Activity Level (PAL) of Athletes (N=120)

Particulars	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total		Total
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Sedentary or light activity lifestyle	0	3 (13.6)	0	1 (11.1)	0	0	1 (4.5)	0	1 (1.5)	4 (7.3)	5 (4.2)
Active or moderately active lifestyle	5 (62.5)	11 (50)	8 (38.1)	6 (66.7)	9 (64.3)	4 (25)	10 (45.5)	0	32(49.2)	21 (38.2)	53 (44.2)
Vigorous or vigorously active lifestyle	3 (37.5)	8 (36.4)	13 (62)	2 (22.2)	5 (35.7)	12 (75)	11 (50)	8 (100)	32 (49.2)	30 (54.5)	62 (51.7)

*Figures in the parenthesis represent percentages

4.4 KNOWLEDGE, ATTITUDE AND PRACTICE (KAP)

4.4.1 KAP score of athletes

The individual knowledge, attitude and practice score along with total KAP score have been presented in Table 4.27 with its % marks in Table 4.28 and is discussed below:

Knowledge

The knowledge score revealed no significant difference between all the male and female athletes of the selected sports. The % marks reveals an overall better knowledge among female athletes scoring 72.1% marks while males scored 71.8% marks. The overall knowledge score of all the 120 athletes was found to be 71.2%. This statistics is further supported by the study of Kong (2009) in which the female athletes were observed to have a higher knowledge score as compared to their male counterparts.

Attitude

Table 2 shows attitude of elite athletes regarding sports nutrition which revealed a statistically significant ($p \leq 0.05$) higher score of male athletes of hockey as compared to female athletes of hockey while male and female athletes of other sports did not exhibit any significant difference. Higher marks (63%) were found to be secured by male athletes while female athletes scored 61% marks as shown in Table 3. However, overall score of all the 120 athletes was found to be 62%. A similar finding had been reported by Sobana (2016) in which the mean attitude score of male cricketers was observed to be higher as compared to female cricketers.

Practice

The practice score in male and female athletes of athletics as well as lawn tennis showed a statistically significant ($p \leq 0.05$) difference, where male athletes of athletics scored higher as compared to their female counterparts whereas female athletes of lawn tennis scored higher as compared to their male athletes of lawn tennis. The athletes of other two sports did not show any significant difference between males and females. The overall male athletes scored 74.3% marks while female athletes scored 74.4% marks indicating no significant difference among them. A similar study showing no statistical significant difference in male and female cricketers regarding their mean practice score was reported by Sobana (2016).

KAP Score

The KAP score exhibited a significant ($p \leq 0.05$) difference between male and female athletes of hockey and lawn tennis because of their significant difference in practices regarding sports nutrition. A similar result was observed where male athletes of hockey scored higher compared to their female counterparts, whereas female athletes of lawn tennis scored higher KAP score than male athletes. However, the difference between overall male and female athletes was observed to be statistically non-significant. Also, the overall % KAP marks of a total of 120 athletes were found to be 69.9%. Low mean KAP scores of both male and female adolescent cricketers were also reported by Sobana (2016) and suggested a necessity for continuous nutrition education particularly through a sports nutritionist.

Table 4.27 Knowledge, Attitude and Practice score of athletes (N=120)

Particulars	Hockey (n=30)			Athletics (n=30)			Badminton (n=30)			Lawn Tennis (n=30)			Total (N=120)		
	Male (n=8)	Female (n=22)	t-value	Male (n=21)	Female (n=9)	t-value	Male (n=14)	Female (n=16)	t-value	Male (n=22)	Female (n=8)	t-value	Male (n=65)	Female (n=55)	t-value
Knowledge	11±1.2	10.3±1.9	1.2^{NS}	10.4±1.2	9.7±1.3	1.4^{NS}	9.1±3.04	9.8±2.1	0.8^{NS}	9.7±3.5	10.7±5.1	0.8^{NS}	10.05±0.8	10.1±0.9	0.9^{NS}
Attitude	6.12±1.5	4.3±1.04	3.2*	5.0±2.4	5.7±1.7	0.9^{NS}	6.8±2.7	7.4±2.4	0.3^{NS}	7.2±1.5	6.8±2.7	0.8^{NS}	6.28±1.1	6.05±0.7	0.1^{NS}
Practice	8.12±1.6	8.2±2.6	0.1^{NS}	9±1.4	7.1±1.5	3.3*	8.1±2.03	8.4±1.2	0.4^{NS}	7.4±2.4	9±1.4	2.2*	8.17±0.7	8.18±0.8	0.0^{NS}
KAP Score	25.3±3.1	22.9±2.9	1.9*	24.3±3.7	22.4±3.04	1.5^{NS}	24±4.7	25.6±1.7	1.2^{NS}	24.3±2.7	26.5±1.5	2.7*	24.5±0.6	24.4±2	0.1^{NS}

Values are Mean ± SD, *Significant at 5% level, NS-non significant

Table 4.28 Knowledge, Attitude and Practice score (in percent) of athletes (N=120)

Particulars	Total Score	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total (%)		Total (%)
		Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Knowledge	14	78.6	73.7	74.3	69.3	65	70	69.3	76.4	71.8	72.1	71.2
Attitude	10	61.3	43	50	57	68	74	72	68	63	61	62
Practice	11	73.8	74.5	81.8	64.5	73.6	76.4	67.3	81.8	74.3	74.4	74.3
KAP Score	35	72.1	65.4	69.4	64	68.6	73.1	69.4	75.7	70	69.7	69.9

Table 4.29 Classification of KAP level of Athletes (N=120)

KAP Total Score (35)	Hockey (n=30)		Athletics (n=30)		Badminton (n=30)		Lawn Tennis (n=30)		Total		Total
	Male (n=8)	Female (n=22)	Male (n=21)	Female (n=9)	Male (n=14)	Female (n=16)	Male (n=22)	Female (n=8)	Male (n=65)	Female (n=55)	N=120
Excellent (30-35)	1 (12.5)	0	3 (14.3)	0	0	0	1 (4.5)	0	5 (7.7)	0	5 (4.2)
Very Good (25-29)	5 (62.5)	5 (22.7)	6 (28.6)	1 (11.1)	3 (21.4)	7 (43.8)	3 (13.6)	4 (50)	17 (25.2)	17 (30.9)	34 (28.3)
Good (20-24)	2 (25)	14 (63.6)	10 (47.6)	4 (44.4)	6 (42.9)	4 (66.7)	14 (63.6)	2 (25)	32 (49.2)	24 (43.6)	56 (46.7)
Average to Poor (Score:< 20)	0	3 (13.6)	2 (9.5)	2 (22.2)	5 (35.7)	5 (31.3)	4 (18.2)	2 (25)	11 (16.9)	12 (21.8)	23 (19.2)

*Figures in parenthesis represent percentages.

4.4.2 Classification of KAP level of athletes

The athletes were categorized into having excellent, very good, good, average to poor KAP regarding sports nutrition on the basis of their achieved scores (Table 4.29) which revealed that overall 4.2% athletes had excellent KAP score which was comprised 12.5% of male athletes of hockey, 14.3% of male athletes of athletics and 4.5% of male athletes of lawn tennis and no female athlete fell in this category. Twenty-five percent of male athletes had very good KAP score while 30.9% of female athletes secured very good knowledge score.

A total of 46.7% of all the athletes had good nutrition KAP score comprising 49.2% of total male athletes and 43.6% of total female athletes. The highest percentage i.e. 63.6 and 66.7% of athletes who scored good KAP score were female athletes of hockey and badminton respectively while 63.6% male athletes of lawn tennis scored good KAP score. Nineteen percent of the total athletes scored an average KAP score including 16.9% of total male athletes and 21.8% of total female athletes. Fig. 13-17 displays percent distribution of knowledge, attitude, practice and overall KAP score.

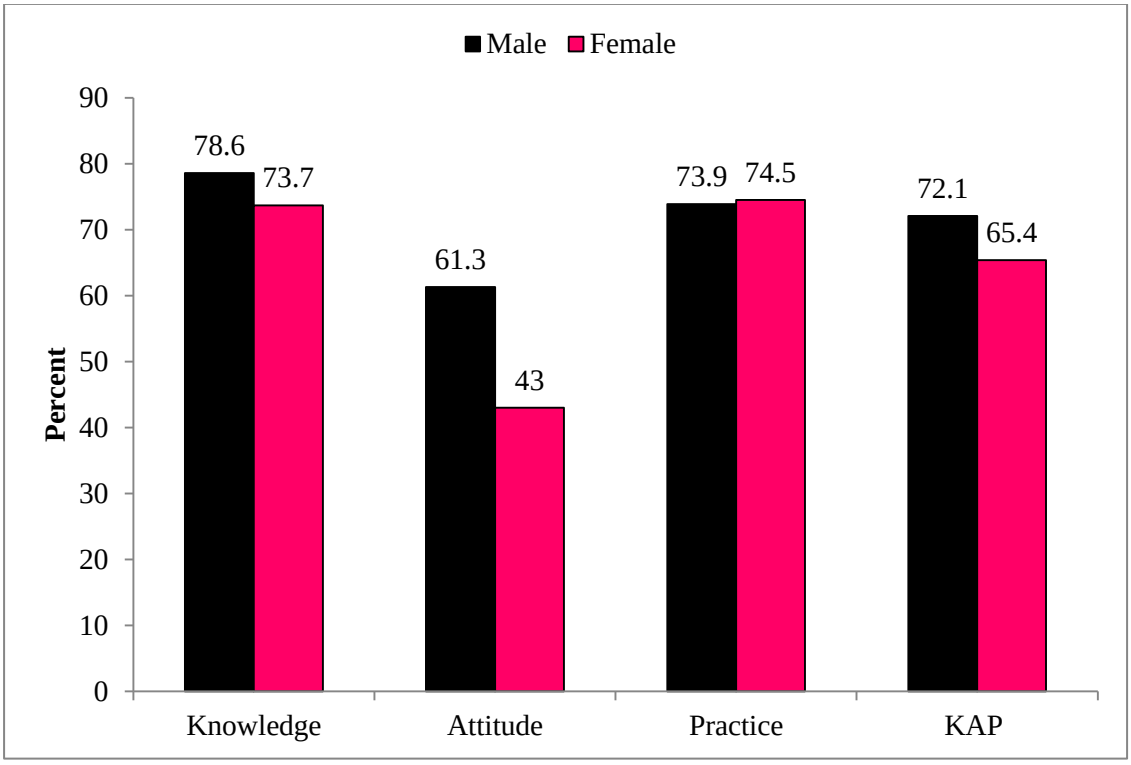

Fig.13: Percent KAP score regarding sports nutrition of athletes of Hockey (n=30)

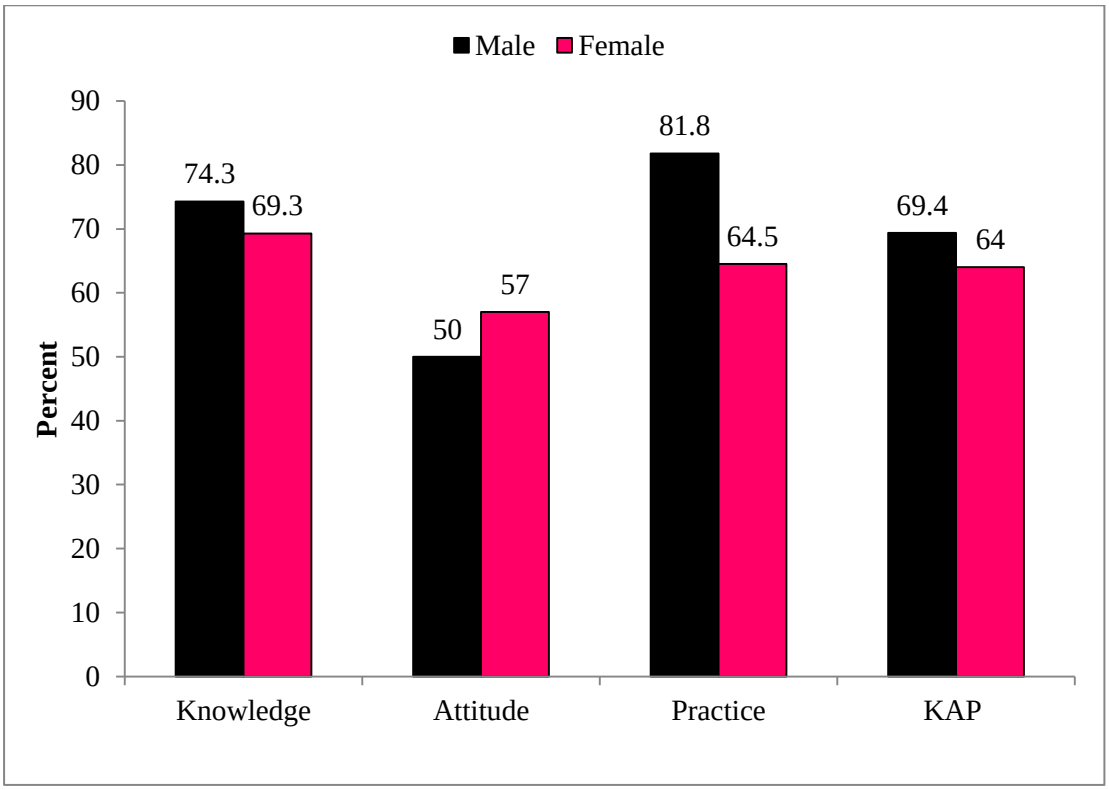

Fig. 14: Percent KAP score regarding sports nutrition of athletes of Athletics (n=30)

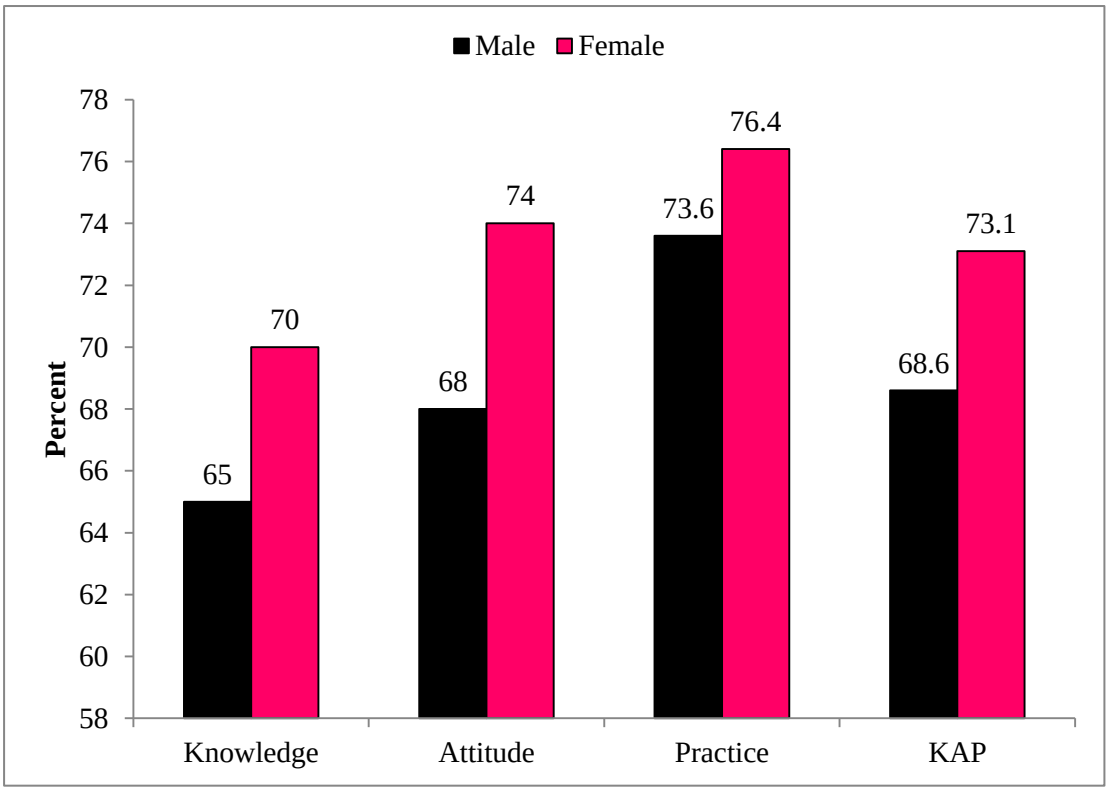

Fig. 15: Percent KAP score regarding sports nutrition of athletes of Badminton (n=30)

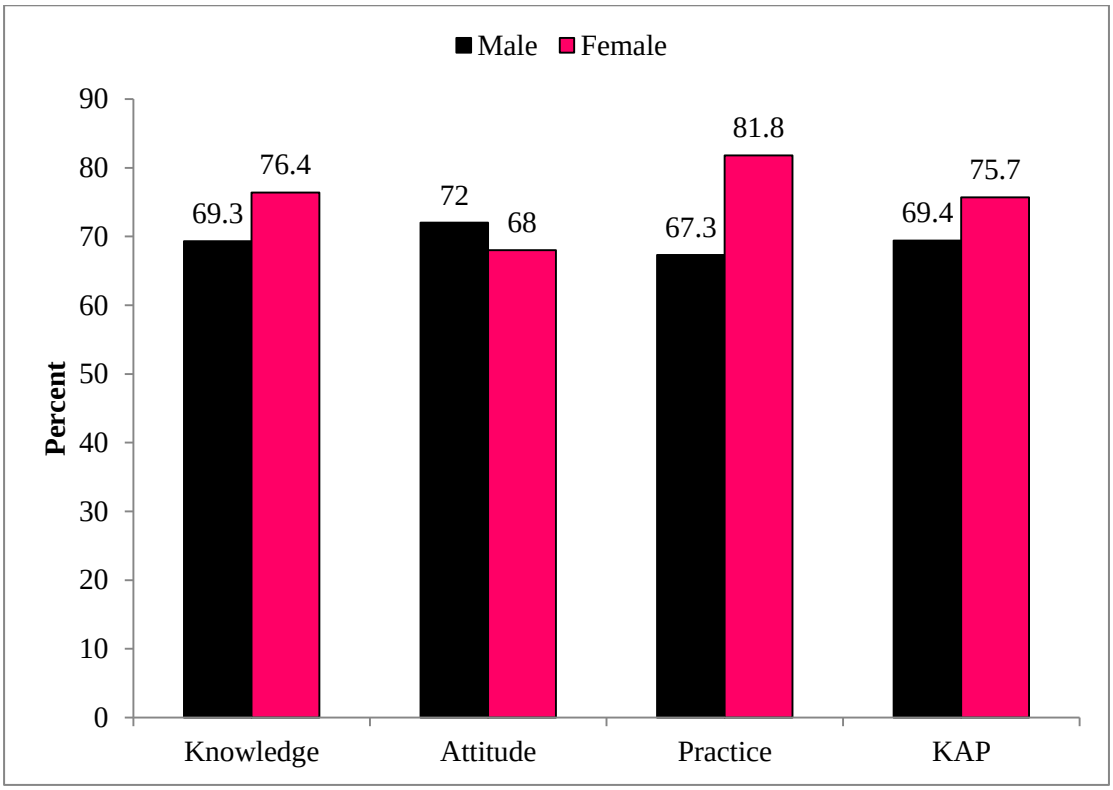

Fig.16: Percent KAP score regarding sports nutrition of athletes of Lawn Tennis (n=30)

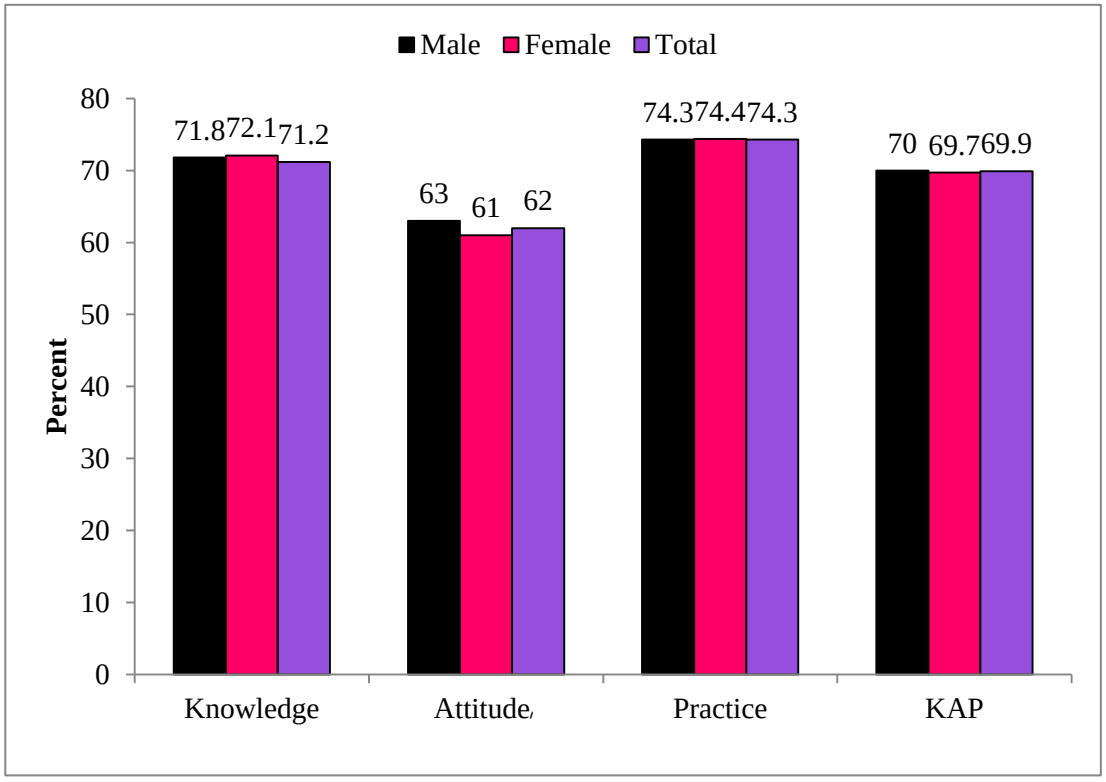

Fig.17: Percent KAP score regarding sports nutrition of the athletes (N=120)

4.4.3 General profile of coaches

The general information of the coaches i.e. family size, family composition, family income, level of education has been presented in Table 4.30 and information regarding their qualification and training regarding sports nutrition has been tabularised in Table 4.31.

It was revealed that 56.7% of total coaches from all the sports belonged to nuclear family while 43.3% of them belonged to joint family and 70% of coaches had medium family having 4 to 8 members. Sixty-three percent coaches had medium family income and 36.7% belonged to high income group. The data also revealed that 53.3% of coaches forming majority had an experience of < 10 years, 33.3% coaches had and experience ranging from 10 to 20 years while only 13.3% coaches had an experience of > 20 years which included 28.6% of hockey coaches and 25% of badminton coaches. It was further revealed 43.3% of overall coaches were undergraduate while 33.3% among them were post-graduate and only 23.3% had qualification till 10+2 (Table 4.30).

Data presented in Table 4.31 revealed that 96.7% of coaches did not have any formal training regarding sports nutrition while 12.5% of badminton coaches had formal training of one year duration from 'Prakash Padukone Badminton Academy' and was sponsored either by university or the sports department. Ninety percent of sports coaches did not have an access to dietician or nutritionist while only 3.3% had this service which included 14.3% of hockey coaches and 20% of lawn tennis coaches. Seven percent of dieticians available were post-graduate while 3.3% had diploma in nutrition. Majority of coaches i.e. 70% revealed that they themselves were the major source of dissemination of sports nutrition knowledge to their athletes while other sources included parents, magazine or internet, books, media and doctor etc. Eighty-four percent of sports coaches provided nutrition advice to their players as reported by Zinn *et al* (2006).

4.4.4 KAP score of coaches

The individual knowledge, attitude and practice score along with total KAP score have been depicted in Table 4.32 with percent marks in Table 4.33 and is discussed below:

Knowledge

There was no significant difference observed in the sports nutrition knowledge of all the sports coaches of the selected sports with total % marks of 76.6%. The highest knowledge score of 77.1% was scored by hockey coaches among all selected coaches.

Table 4.30 General Profile of Coaches (N=30)

Characteristics	Hockey (n=7)	Athletics (n=5)	Badminton (n=8)	Lawn Tennis (n=10)	Total N=30
Family Size					
Nuclear	4 (57.1)	2 (40)	5 (62.5)	6 (60)	17 (56.7)
Joint	3 (42.9)	3 (60)	3 (37.5)	4 (40)	13 (43.3)
Family composition					
Small (<4)	1 (14.3)	0	1 (12.5)	3 (30)	5 (16.7)
Medium (4 to 8)	5 (71.4)	4 (80)	6 (75)	6 (60)	21 (70)
Large (>8)	0	1 (20)	1 (12.5)	1 (10)	3 (10)
Family income (Rs/ annum)					
Medium (50,000-2,50,000/-)	3 (42.9)	5 (100)	6 (75)	5 (50)	19 (63.3)
High (>2,50,000/-)	4 (57.1)	0	2 (25)	5 (50)	11 (36.7)
Years of coaching					
< 10 years	3 (42.9)	1 (20)	4 (50)	8 (80)	16 (53.3)
10-20 years	2 (28.6)	4 (80)	2 (25)	2 (20)	10 (33.3)
>20 years	2 (28.6)	0	2 (25)	0	4 (13.3)
Level of Education					
Matric	0	0	0	0	0
10+2	2 (28.6)	1 (20)	1 (12.5)	3 (30)	7 (23.3)
UG Degree	1 (14.3)	3 (60)	3 (37.5)	6 (60)	13 (43.3)
PG Degree	4 (57.1)	1 (20)	4 (50)	1 (10)	10 (33.3)

*Figures in parenthesis represent percentages.

Table 4.31 Qualification/ Training regarding sports nutrition by the Coaches (N=30)

Characteristics & Sport	Hockey (n=7)	Athletics (n=5)	Badminton (n=8)	Lawn Tennis (n=10)	Total N=30
Formal Training in Sports Nutrition					
Yes	0	0	1 (12.5)	0	1 (3.3)
No	7 (100)	5 (100)	7 (87.5)	10 (100)	29 (96.7)
If yes,					
Training Institute	0	0	Prakash Padukone academy	0	1 (3.3)
Duration	0	0	1 Yr	0	1 (3.3)
Sponsored by Department/Institution					
Yes	0	0	1 (12.5)	0	1 (3.3)
No	0	0	0	0	0
Access to Registered Dietician/ Equivalent					
Yes	1 (14.3)	0	0	2 (20)	3 (3.3)
No	6 (85.7)	5 (100)	8 (100)	8 (80)	27 (90)
Qualification of Dietician					
Diploma	0	0	0	1 (10)	1 (3.3)
UG Degree	0	0	0	0	0
PG Degree	1 (14.3)	0	0	1 (10)	2 (6.7)
Other sources of nutrition knowledge					
Coach	4 (57.1)	5 (100)	6 (75)	6 (60)	21 (70)
Parents	1 (14.3)	0	1(12.5)	1 (10)	3 (10)
Internet/ Magazine/other media	2 (28.6)	0	1 (12.5)	2 (20)	5 (16.7)
Doctor	0	0	1 (12.5)	0	1 (3.3)

*Figures in parenthesis represent percentages.

Attitude

There was a statistically significant ($p \leq 0.05$) difference in the attitude score of coaches of different sports. Coaches of lawn tennis had the highest score, followed by hockey and athletics coaches. The reason could be their higher education and more experience.

Practice

The overall practice score of the athletes did not show any significant difference among all the selected coaches. The total average practice score achieved by sports coaches was discovered to be 82% as per percent marks with a highest practice score of 85.5% by badminton coaches.

KAP score

The total average KAP score as shown in Table 4.32 also showed no significant difference between all the coaches of selected sports. According to percent marks, the average KAP score was found to be 71.6% (Table 4.33). Individually, highest score of 76.3% was found among lawn tennis coaches due to their high knowledge and practice score followed by hockey and badminton coaches scoring 71.1% and 69.7% respectively and athletics coaches scoring 69.1%. Similar statistical data was revealed in the study of Cockburn *et al* (2014) stating that 60% coaches correctly responded to all knowledge questions irrespective of them disseminating their knowledge to athletes or not. In this study it was also revealed that the coaches who had attended formal nutrition training scored higher than those who did not have.

Table 4.32 Knowledge, Attitude and Practice score of Coaches (N=30)

Particulars	Hockey (n=7)	Athletics (n=5)	Badminton (n=8)	Lawn Tennis (n=10)	ANOVA
Knowledge	10.9±0.9	10.8±1.6	10.6±1.5	10.6±1.6	0.06^{NS}
Attitude	5.4±2.1	4.6±1.5	4.4±1.9	6.8±1.4	3.4*
Practice	8.6±1	8.8±0.4	9.4±1.4	9.3±1.3	0.84^{NS}
KAP Score	24.9±2.9	24.2±2.04	24.4±3.7	26.7±3.8	1.0^{NS}

Values are Mean ± SD, *Significant at 5% level, NS-non significant

Table 4.33 Knowledge, Attitude and Practice score (in percent) of Coaches (N=30)

Particulars	Total Score	Hockey (n=7)	Athletics (n=5)	Badminton (n=8)	Lawn Tennis (n=10)	Total N=30
Knowledge	14	77.9	77.1	75.7	75.7	76.6
Attitude	10	54	46	44	68	53
Practice	11	78.2	80	85.5	84.5	82
KAP Score	35	71.1	69.1	69.7	76.3	71.6

Table 4.34 Classification of KAP Level of Coaches (N=30)

KAP Total Score (35)	Hockey (n=7)	Athletics (n=5)	Badminton (n=8)	Lawn Tennis (n=10)	Total N=30
Excellent (30-35)	0	0	1 (12.5)	2 (20)	3 (10)
Very Good (25-29)	4 (57.1)	2 (40)	3 (37.5)	7 (70)	16 (53.3)
Good (20-24)	3 (42.9)	3 (60)	3 (37.5)	0	9 (30)
Average to Poor (< 20)	0	0	1 (12.5)	1 (10)	2 (6.7)

*Figures in parenthesis represent percentages.

4.4.5 Classification of KAP level of coaches

Table 4.34 categorizes the selected sports coaches into excellent, good, very good, good and average to poor KAP according to their achieved scores. The coaches having excellent sports nutrition knowledge, attitude and practice comprised 10% of all the coaches. Fifty-three percent of coaches forming majority were found to have very good while 30% had good KAP. Very less proportion of coaches i.e. 6.7% had average to poor knowledge, attitude and practice towards sports nutrition. The KAP distribution has been displayed in Table 4.34.

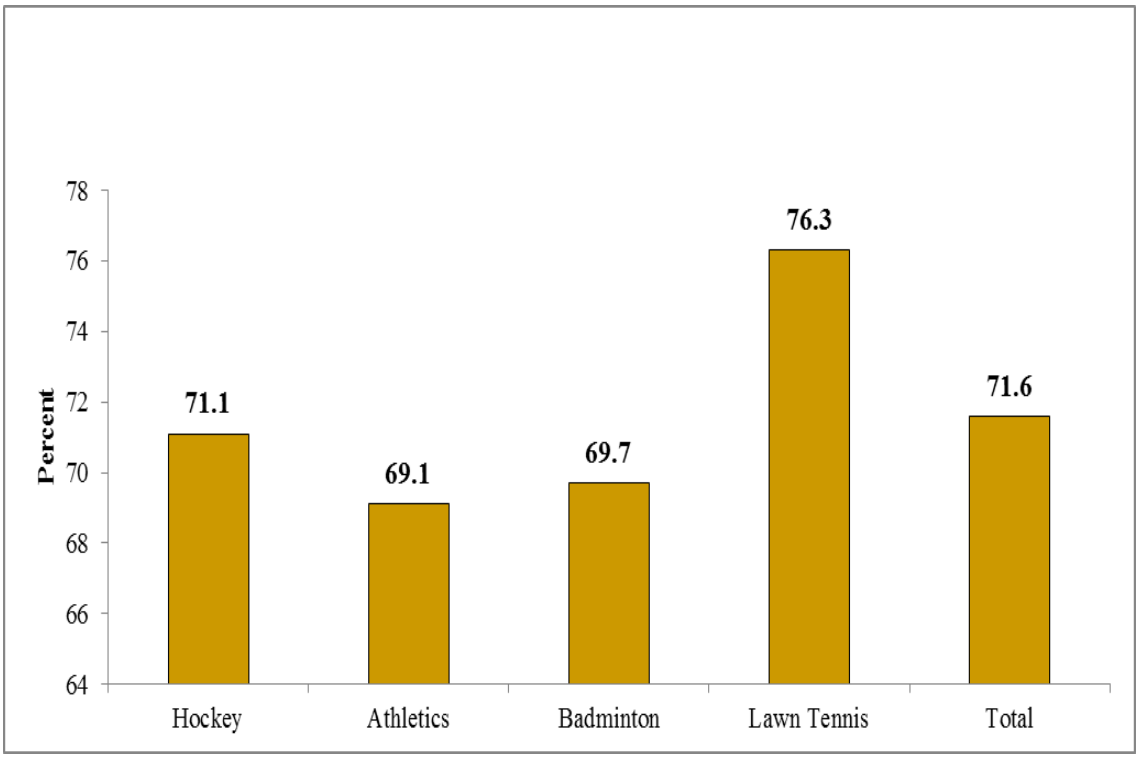

Fig. 18: Percent KAP score regarding sports nutrition of the coaches (N=30)

4.4.6 Correlations

As depicted in Table 4.35, pre-exercise intake of nutrients including energy, protein and carbohydrates had a positive but non-significant correlation with the time spent in respective sports. Similarly, intake of protein supplements was also found to be non-significantly correlated with the time spent in the respective sport.

However, haemoglobin level of the athletes was found to be significantly ($p \leq 0.05$) correlated with the time spent in sports. Higher the haemoglobin level more is the oxygen carrying capacity of the body's system to various cells and tissues. As a result, the athletes feel less fatigued and can spend more time in their sports.

Correlation coefficient (r) values of KAP scores of coaches in relation to various other factors were calculated and have been presented in Table 4.36. It was found to be positively but non-significantly correlated with their qualification. However, a positively significant correlation ($p \leq 0.05$) was observed with the years of experience, indicating that as the experience of the coaches increases, they tend to acquire more knowledge. Furthermore, KAP score of athletes had a significantly ($p \leq 0.05$) positive correlation with the KAP score of coaches which associates well with the earlier finding of this study that coaches are the main source of nutrition knowledge for their athletes. However, KAP score of athletes was found to be non-significantly correlated with the nutrients (energy, protein & iron) intake and their Body Mass index (BMI).

Table 4.35 Correlation of various factors with time spent in respective sports

S.No.	Factor-1	Factor-2	Correlation coefficient (r)
1.	Pre-exercise intake of - Energy Protein Carbohydrates	Time spent in respective sport	 0.28^{NS} 0.33^{NS} 0.57^{NS}
2.	Protein supplement intake	Time spent in respective sport	0.24^{NS}
3.	Haemoglobin level	Tim spent in respective sport	0.72*

*Significant at 5% level
NS-Non-significant

Table 4.36 Correlation of KAP score of coaches and athletes with other factors

S.No.	Factor-1	Factor-2	Correlation coefficient (r)
1.	KAP score of coaches	Qualification of coaches	0.20^{NS}
2.	KAP score of coaches	Sports experience of coaches	0.74*
3.	KAP score of coaches	KAP score of athletes	0.79*
4.	KAP score of athletes	Energy intake Protein intake Iron intake	0.42^{NS} 0.33^{NS} 0.46^{NS}
5.	KAP score of athletes	Body Mass Index of athletes	0.44^{NS}

*Significant at 5% level
NS-Non-significant

CHAPTER V

SUMMARY

A combination of appropriate work out and a sensible attitude towards nutrition is fundamental to effective athletic performance. A number of elements are there which stimulate the energy expenditure such as type, duration and intensity of exercise along with body size, fat free mass (FFM) and nutritional status prior to exercise. Ample nutrition education certainly affects an athlete's dietary intake hence the nutritional status. Therefore, in the present study, assessment of nutritional status of elite athletes with special reference to nutrition knowledge of the athletes and the coaches was studied.

A total of 120 elite athletes (30 in each category) in the age-group of 16-25 years and their coaches (total 30 combined from all categories) were selected from five universities of Punjab who were participating in four different physical sports such as hockey, athletics, badminton and lawn tennis. The dietary survey comprised food habits, meal pattern, food frequency and pre, during and post exercise meals of the athletes. The nutrient intake of the athletes was analysed using 24 hour recall method for 3 consecutive days. Anthropometric measurements such as height, weight, waist circumference, hip circumference and triceps skinfold thickness were measured by using standard procedures (Jelliffe 1966). The blood samples of the athletes were collected and their haemoglobin analysis was done at their respective universities or associated hospital laboratories using Cyanmethemoglobin method. The physical activity level of the athletes was recorded followed by assessment of knowledge, attitude and practice score regarding sports nutrition of athletes and their coaches.

The collected data revealed that a majority of athletes belonged to nuclear family with 4 to 8 members in the family. It was further revealed that 74.2% of athletes belonged to high income group and 75.8% were participating at national level especially all the athletes of hockey. Furthermore, a similar percentage of 34.1% and 34.2% athletes used to spend 0-2 hours and 4-6 hours respectively per day in workout while a very few of 3.3% male athletes spent 6-8 hours a day in workout. A considerable number of male and female athletes i.e. 50.8% and 65.5% respectively experienced feeling of fatigue specifically after their morning training session. Junk food consumption was found common among almost all the selected athletes including 87.3% female athletes forming majority.

Majority of all the athletes i.e. 53.3% were observed to consume non-vegetarian foods comprising 66.2% male athletes and 38.2% female athletes. It was further observed that 66.7% of selected athletes did not skip meals to maintain weight and 56% of female athletes rejected the notion of skipping meals. Sixty-one percent of the total athletes used to consume pre exercise meal an hour before their training schedule. Most of the athletes i.e. 60% consumed primarily banana and apple before training, while 28.3% percent preferred lunch,

tea or coffee. It was also observed that 37.5% of total athletes consumed mostly banana during break or halftime of their event and majority of them i.e. 58.3% indulged in heavy exercises. Fifty six percent of athletes consumed a post exercise meal 30 minutes after completing their exercise regime, also 42.5% athletes particularly females used to consume fruits especially bananas while 46.2% of male athletes preferred protein shake after exercise and 23.2% of them used to consume 2-4 eggs.

A significant population of male and predominantly female athletes i.e. 87.7% and 96.4% respectively consumed milk and milk products daily. Green leafy vegetables were consumed by 46.2% of male athletes and 61.9% of female athletes followed by inadequate consumption of roots and tubers by 29.2% male and 30.1% of female athletes. The data also revealed a daily consumption of fruits among majority of male and female athletes i.e. 60% and 67.3% respectively. Daily consumption of egg whole was observed to be higher among male athletes i.e. 37% as compared to female athletes i.e. 14.5%. Chicken, white meat, fish and red meat consumption was found to be rare among both male and female athletes.

Anthropometric measurements such as height, weight, BMI, waist circumference, hip circumference and waist hip ratio was found to be higher among male athletes as compared to female athletes, while the overall triceps skinfold thickness of male athletes was found to be significantly ($p \leq 0.05$) lesser as compared to female athletes. A total of 57% selected athletes had a normal body mass index (BMI). The haemoglobin level of the athletes was found to be 13.8g/dL among male athletes which was significantly ($p \leq 0.05$) higher than the average haemoglobin level of 10.8g/dL in the female athletes. Majority of all the selected male athletes i.e. 95.4% were non-anaemic while 41.8% of the female athletes were found to be mildly anaemic. Overall, higher percentage of female athletes was found to be anaemic.

The consumption of cereal, grains and products was found to be significantly ($p \leq 0.05$) higher among female athletes of hockey as compared to their male counterparts whereas other sports had no significant difference among male and female athletes. The intake of pulses and legumes was found to be significantly ($p \leq 0.05$) higher among female athletes of hockey and athletics than male athletes pursuing same event. Male athletes had been observed to consume more milk and milk products as compared to female athletes in all the selected sports but the difference was statistically non-significant. A significant ($p \leq 0.05$) higher consumption of fats and oils by male athletes of hockey than female athletes of hockey while male and female athletes pursuing other selected sports had no significant difference regarding fats and oil consumption.

The consumption of fruits was found to be higher in comparison to the suggested dietary intakes for athletes. Also, a significant ($p \leq 0.05$) higher consumption of fruits among

female athletes of athletics as compared to their male counterparts was observed. The overall consumption of green leafy vegetables by male as well as female athletes was observed to be low as compared to standard dietary intakes particularly among female athletes. Percent adequacy consumption of other vegetables was also found to be low in all male and female athletes followed by an inadequate consumption of roots and tubers. The consumption pattern of roots and tubers in female athletes in two of the sports namely athletics and hockey was found to be significantly ($p \leq 0.05$) higher than their corresponding male athletes. The findings also suggested that the overall protein intake of male athletes was higher than female athletes. There was no overall significant difference regarding fat intake by both male and female athletes of almost all the sports except athletics which observed a significantly ($p \leq 0.05$) higher fat intake by males as compared to females.

The overall iron intake by male athletes was found to be significantly ($p \leq 0.05$) higher i.e. 22.1mg/day than female athletes who consumed 18.6 mg/day of iron particularly in sports such as athletics, badminton and lawn tennis while hockey male and female athletes consumed similar amount of iron per day. The average daily consumption of calcium was found to be higher among male athletes as compared to female athletes but the difference was non-significant. The overall average daily pre-exercise intake of energy was found to be significantly ($p \leq 0.05$) higher (336 Kcal) among selected male athletes as compared to female athletes who consumed 185 Kcal on an average before exercise. Protein intake before exercise was also observed to be 11.6g which was significantly ($p \leq 0.05$) higher among overall male athletes than overall female athletes who consumed 5.6g protein. A significant ($p \leq 0.05$) higher intake of carbohydrates was observed by male athletes of athletics as compared to female athletes of athletics.

A low intake of energy, protein and fat during exercise could be attributed to consumption of light meals, particularly fruits such as banana and apple. Water intake during this period was also found to be high while no source of protein was ingested as it might have made the player feel heavy, which was undesirable as the workout regime was yet to be completed. Male athletes were found to consume a significantly ($p \leq 0.05$) higher amount of carbohydrates as compared to female athletes during post exercise period.

Regarding time spent by athletes in their respective sport, male athletes of hockey and athletics spent more time in workout as compared to their corresponding female athletes. The female athletes of badminton and lawn tennis spent more time in workout as compared to their male counterparts. Therefore, no overall significant difference regarding time spent in workout between male and female athletes was found. A significant ($p \leq 0.05$) higher physical activity level among male athletes of athletics was observed as compared to their female

counterparts while, among athletes of lawn tennis, a significant ($p \leq 0.05$) higher physical activity level was observed among female athletes than their corresponding male athletes.

The KAP score exhibited a significant ($p \leq 0.05$) difference between male and female athletes among the athletes of hockey and lawn tennis while no significant difference between the KAP score of overall male and female athletes was observed. However, the difference in the KAP score of overall male and female athletes was observed to be statistically non-significant. The data revealed that overall 4.2% athletes had excellent KAP score which comprised 12.5% of male athletes of hockey, 14.3% of male athletes of athletics and 4.5% of male athletes of lawn tennis. Apparently, no female athlete fell into this category. Twenty-five percent of male athletes had very good KAP score while 30.9% of female athletes secured very good knowledge score.

The data regarding general information of coaches revealed that 56.7% of total coaches belonged to nuclear family and had medium family size of 4 to 8 members. Sixty-three percent of the coaches had medium family income while, 36.7% belonged to high income group. The data regarding their experience in coaching revealed that 53.3% of coaches forming majority had an experience of < 10 years, 33.3% coaches had experience ranging from 10 to 20 years while only 13.3% coaches had an experience of > 20 years. The level of education was also analysed which suggested, 43.3% of overall coaches were undergraduate while, 33.3% were post-graduate and only 23.3% had qualification till 10+2. Ninety-Six percent of coaches did not have any formal training regarding sports nutrition. Ninety percent of sports coaches did not have an access to a dietician or a nutritionist. Majority of coaches i.e. 70%, quoted that they themselves were major source of dissemination of sports nutrition knowledge to their athletes while other sources included parents, magazine or internet, books, media and doctor, etc.

The total average KAP score also displayed no significant difference between all the coaches of selected sports. According to percent marks, the average KAP score was found to be 71.5% with a highest score of 76.3% among lawn tennis coaches due to their high knowledge and practice score. The coaches having excellent sports nutrition knowledge, attitude and practice comprised 10% of all the coaches. Fifty-three percent of coaches forming majority were found to have very good KAP while 30% had good KAP. Very few coaches i.e. 6.7% had average to poor knowledge, attitude and practice towards sports nutrition.

Haemoglobin level of the athletes was found to be significantly ($p \leq 0.05$) correlated with the time spent in sports. Higher the haemoglobin level more is the oxygen carrying capacity of the body's system to various cells and tissues. As a result, the athletes feel less fatigued and can spend more time in their sports.

KAP score of athletes had a significantly ($p \leq 0.05$) positive correlation with the KAP score of coaches which associates well with the earlier finding of this study that coaches are the main source of nutrition knowledge for their athletes. However, KAP score of athletes was found to be non-significantly correlated with the nutrients (energy, protein & iron) intake and their Body Mass index (BMI).

CONCLUSIONS

- Majority of the selected athletes i.e. 75.8% were National level players and belonged to high income group.
- Consumption of non-vegetarian foods was higher in male athletes as compared to female athletes.
- Majority of the athletes (71.7%) did not suffer with any disease during last one year.
- The consumption of cereal grains & products and pulses & legumes showed a significant ($p \leq 0.05$) difference between male and female athletes of hockey and badminton respectively.
- Female athletes of athletics consumed significantly ($p \leq 0.05$) higher amount of fruits than their male counterparts.
- A significant ($p \leq 0.05$) higher consumption of eggs was observed among male athletes of hockey and badminton as compared to their female counterparts.
- The overall consumption of nutrients by the athletes was found to be inadequate as compared to Recommended Dietary Allowances (RDAs).
- However, consumption of calcium, vitamin A and vitamin C was found to be adequate to highly adequate, which can be attributed to a higher consumption of milk & milk products, eggs and fruits respectively.
- Twenty percent of the female athletes were found to be in the underweight category.
- Twenty-two percent of total athletes were at risk of obesity which comprised 35.4% male athletes.
- A significant proportion of female athletes i.e. 34.5% and 41.8% fell under category of moderate and mild anaemia respectively.
- Majority of athletes were observed to be non-anaemic.
- Majority of total athletes i.e. 51.7% fell under the category of vigorously active lifestyle while 44.2% of total athletes had active lifestyle comprising 49.2% of male athletes and 38.2% female athletes.
- The KAP (Knowledge, Attitude and Practice) score of overall male and female athletes did not exhibit any significant difference.
- Majority of selected coaches (96.7%) had no formal training in sports nutrition.
- Ninety percent of them did not have any access to registered dietician or equivalent.

- The coaches stated self as the chief source of nutrition information to their athletes.
- KAP score of coaches had a positive correlation with their experience and KAP score of athletes.

RECOMMENDATIONS

- Coaches are the primary source of nutrition knowledge for the athletes; hence their functional efficiency needs to be enhanced by providing them formal trainings regarding sports nutrition. If athletes have better nutrition knowledge, it will definitely help to improve their nutritional status, resulting in enhancement of performance.
- There should be a provision of sports nutritionists/dietician in sports departments and universities of the country.

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ANNEXURE-1

Performa No._____

Interview Schedule

Interview schedule for assessing the nutritional status of athletes

A. General information

1. Name of Subject :

2. Age/Sex :

3. Address :

4. Contact No. :

5. Education :

6. Type of family : Nuclear/ Joint

7. No. of family members :

8. Family income :

9. Pocket money of subject:

10. Family Composition :

Sr. No.	Member	Age	Education	Income	Relation to subject
1.					
2.					
3.					
4.					
5.					

B. Anthropometric measurements

Waist and hip circumference

1. Height :

2. Weight :

3. BMI :

4. Waist Circumference :

5. Hip circumference :

6. Waist Hip Ratio :

7. Triceps skinfold thickness :

C. Biochemical assessment

Hemoglobin level : _____gm//100ml of blood.

D. Physical performance

1. Game played by subject :

2. Level of participation : State/National level

3. Total time spent on workout :

4. Feeling of fatigue : Yes / No

If yes, When:

- Morning
- During workout
- Evening
- Whole day

E. <u>Food habits</u>

1. Vegetarian/Non Vegetarian/ Ovo- Lactovegetarian :

If Non vegetarian, how frequently do you consume meat products?

- Daily
- Weekly
- Fortnightly
- Monthly

2. Do you consume junk food : Yes / No.

If yes, how frequently you consume:

- Daily
- Weekly
- Fortnightly
- Monthly

3. Do you skip meals: Yes/No

Which meal : Breakfast ☐ Lunch ☐ Dinner ☐

If yes, Give reason:

4. Type of milk consumed by you?

- Cow's milk ☐
- Buffaloes milk ☐
- Skimmed milk ☐

F. <u>Personal information</u>

1. Do you take any supplements: Yes / No

2. If yes, do you take it at your own or at physician's advice? _____

3. What kind of supplement do you take? _____

Name of supplement :

Purpose of supplement :

Quantity :

Composition :

- Energy
- Protein
- Carbohydrates
- Fat

Cost :

3. Sickness during last year : Yes / No

If Yes, mention:

- Name of disease :
- Duration of disease :

G. <u>Exercise meals</u>

i. PRE- EXERCISE MEALS

Time of the meal : 1 Hour before exercise ☐

: 2 Hours before exercise ☐

: More than 2 Hours before exercise ☐

Type of meal (Foods included)

Shake/Fruits/Juice/Egg :

Which shake/Juice/Fruit:

Any other :

ii. DURING EXERCISE MEALS

Time/ Interval of the meal : Eg. Halftime, 15 mins or 30 mins after exercise

After how long, Specify : _____

Type of meal (Foods included)

Shake/Fruit/Juice/Egg :

Which shake/Juice/Fruit :

Any other :

Type of exercise : Light ☐

: Heavy ☐

Specify_____

Duration of exercise : 1 Hour ☐

: 2 Hours ☐

: More than 2 Hours ☐

Specify_____

iii. POST EXERCISE MEALS

Time of the meal : After 15 minutes of exercise ☐

: After 30 minutes of exercise ☐

: Specify

Type of meal (Foods included) _____

Shake/Fruit/Juice/Egg :

Which Shake/Fruit/Juice:

Any other :

Give reason for consumption of type of meals:

Before exercise: _____

During exercise: _____

After exercise: _____

iv. HYDRATION SCHEDULE

a. Before exercise : Immediately before exercise ☐
: 10-15 minutes before exercise ☐
: 30 minutes before exercise ☐
: 1 Hour before exercise ☐
: More than 1 Hour before exercise ☐

Amount of water : ☐
Amount and type of juice :
Other beverage :

b. **During exercise** : During break/ Halftime ☐
: After how long,

specify_____
Amount of water :
Amount and type of juice :

Other beverage :

c. After exercise : Immediately after exercise ☐
: 10-15 minutes after exercise ☐
: 30 minutes after exercise ☐
: 1 Hour after exercise ☐
: More than 1 Hour after exercise ☐

Amount of water : ☐

Amount and type of juice :

Other beverage :

Give reasons for consumption of type of fluid:

Before exercise: _____

During exercise: _____

After exercise: _____

H. <u>Dietary pattern</u>: Food Frequency

- **For vegetarians**

Meals	Daily	Thrice a week	Twice a week	Weekly	Fortnightly	Rarely
Parantha						
Poori						
Bread						
• Brown						
• White						
Rice						
• Boiled						
• Fried						
• Parched						
Suji						
Dalia						
Maida						
Maize						
Whole pulses						
Dehusked pulses						
Sprouts						
Milk and milk products						
Green leafy vegetables						
Roots & Tubers						
Fruits						
Sweets						
Fried Foods						

- **For Non Vegetarians :**

Meals	Daily	Thrice a week	Twice a week	Weekly	Fortnightly	Rarely
Parantha						
Poori						
Bread						
• Brown						
• White						
Rice						
• Boiled						
• Fried						
• Parched						
Suji						

Meals	Daily	Thrice a week	Twice a week	Weekly	Fortnightly	Rarely
Dalia						
Maida						
Maize						
Whole pulses						
Dehusked pulses						
Sprouts						
Milk and milk products						
Green leafy vegetables						
Roots & Tubers						
Fruits						
Sweets						
Fried Foods						
Egg (Whole)						
Egg Yolk						
Egg white						
Chicken						
Fish						
Red Meat						
White meat						

DIETARY INFORMATION – 24 hour recall method **First day**

Time period	**Food item**	**Portion size**	**Ingredients**	**Quantity**
Early Morning				
Breakfast				
Mid Morning				
Lunch				
Evening Tea				
Time period	**Food item**	**Portion size**	**Ingredients**	**Quantity**
Dinner				
Bed time				

DIETARY INFORMATION – 24 hour recall method **Second day**

Time period	Food item	Portion size	Ingredients	Quantity
Early Morning				
Breakfast				
Mid Morning				
Lunch				
Evening Tea				
Dinner				
Bed time				

DIETARY INFORMATION – 24 hour recall method **Third day**

Time period	Food item	Portion size	Ingredients	Quantity
Early Morning				
Breakfast				
Mid Morning				
Lunch				
Evening Tea				
Dinner				
Bed time				

PHYSICAL ACTIVITY PATTERN

Time (spent in each activity)	Activities								
	Day 1			Day 2			Day 3		
	I.	II.	III.	I.	II.	III.	I.	II.	III.
5:00 am-6:00 am									
6:00 am-7:00 am									
7:00 am-8:00 am									
8:00 am-9:00 am									
9:00 am-10:00 am									
10:00 am-11:00 am									
11:00 am-12:00 pm									
12:00 pm-1:00 pm									
1:00 pm-2:00 pm									
2:00 pm-3:00 pm									
3:00 pm-4:00 pm									
4:00 pm-5:00 pm									
5:00 pm-6:00 pm									
6:00 pm-7:00 pm									
7:00 pm-8:00 pm									
8:00 pm-9:00 pm									
9:00 pm-10:00 pm									
10:00 pm-11:00 pm									
11:00 pm-12:00 am									
12:00 am-5:00 am									

QUESTIONNAIRE

Knowledge Attitude and Practices (KAP)

S.No. _____ Name: _____

Date: _____ Score: _____

KNOWLEDGE

Tick the correct answer out of the following:

S.No.	QUESTIONS	YES	NO
1.	Do you have access to nutrition counseling?		
2.	Do you read the nutrition facts label on packed food items?		
3.	Taking nutritious diet would improve athletic performance?		
4.	Consulting a sports nutritionist is beneficial for an athlete.		
5.	All sportspersons should consume same type of diet.		
6.	Carbohydrates and fats are main sources of energy.		
7.	Food supplements are needed in addition to food to improve athletic performance		
8.	Vitamin and mineral supplements provide energy to my body.		
9.	Proper eating along workout is important.		
10.	Milk is a good source of calcium and Vitamin D.		
11.	Caffeine can increase risk of dehydration.		
12.	High fat foods should be reduced in my diet.		
13.	Carrot is a good source of Vitamin A.		
14.	Ergogenic aids should be used in sports.		

ATTITUDE / AWARENESS

Tick the correct out of following choices:

S.No.	QUESTIONS	CHOICES
1.	An excess of which vitamins is potentially dangerous?	a) Vitamin C b) Vitamin B c) Vitamin A
2.	Deficiency of which nutrient may affect sports performance ?	a) Zinc b) Vitamin C c) Iron
3.	The optimal time to consume a post exercise meal is	a) Immediately after exercise b) Within 1-2 Hours c) Wait till hungry
4.	Which of the following is not a physiological effect of caffeine?	a) Decrease metabolic rate b) Increase Heart rate **c)** Stimulates Central Nervous System

S.No.	QUESTIONS	CHOICES
5.	An athlete's strategy one day prior to competition is:	a) Eat a moderately high carbohydrate diet and perform light exercise **b)** Eat a low carbohydrate meal and do regular exercise **c)** Eat a high- carbohydrate meal and do intense exercise
6.	Significant losses of electrolytes (such as sodium, chloride, potassium, magnesium) during heavy exercise may lead to symptoms such as:	a) Drop in blood pressure b) Stress fracture, swelling **c)** Muscular cramps
7.	Good source of iron in diet.	a) Whole pulses and green leafy vegetables b) Roots and tubers **c)** Milk and milk products
8.	To safely increase muscle mass, it is recommended to increase:	a) Fat intake, carbohydrate intake b) Resistance training, caloric intake. **c)** Protein, water intake
9.	Which of the following is an ergogenic aid?	a) Health foods and supplements b) Sports kit (Jersey and shoes) c) Mental training d) All of above
10.	Which of the following statements regarding ergogenic aids is false?	a) Use of any aid that enhances sports performance is illegal. b) Endorsements of ergogenic aids by elite athletes does not ensures its effectiveness. **c)** Some nutritional supplements marketed as ergogenic aids may contain prohibited drugs.

PRACTICE

Tick the correct answer out of the following

S.No.	QUESTIONS	YES	NO
1.	Do you seek or read nutrition information?		
2.	If yes, From where? a) Team mates b) Coach c) Doctor d) Registered dietician/Nutritionist e) Internet/Magazine/Books		
3.	If not, why a) Not a major concern b) No time c) Have enough nutrition knowledge		
4.	Do you consume more calories than a normal individual?		
5.	Do you take fruits and vegetables **everyday**?		
6.	Do you consume sports/ high energy drink everyday?		
7.	Do you consume sports drink everytime before competition?		
8.	Do you skip meals to maintain weight?		
9.	Do you consume junk food after participating in competition?		
10.	Do you smoke or consume alcohol on daily basis?		
11.	Do you take protein supplements in addition to dietary protein?		

ANNEXURE II

INTERVIEW SCHEDULE

Interview schedule for assessing the nutrition knowledge of the coaches

General information

1. Name of Subject :

2. Age/Sex :

3. Address :

4. Contact :

5. Education :

6. Name of the University or Academy :

7. Occupational status :

8. Contract based coaching in Universities : Yes / No

9. If yes, which University :

10. Sport of coaching :

11. Years of Experience :

*12. Type of family : Nuclear/ Joint

*13. No. of family members :

*14. Family Composition :

Sr. No.	Member	Age	Education	Income	Relation to subject
1.					
2.					
3.					
4.					
5.					

13. Have you ever had any formal training regarding nutrition of athletes?
Yes / No

14. If yes,

i. When did you attend? _____

ii. From where? _____

iii. Duration: _____

iv. Was it sponsored by Sports department of the University/Academy?
Yes / No

15. Does your Sports Department have an access to a registered dietician/ nutritionist? Yes / No

16. If yes, what is the qualification of that person?
Diploma ☐
UG Degree ☐
PG Degree ☐
Specify _____

17. If no, who do you advice to provide Nutrition knowledge to your teams?
a. Coaches/Self b. Parents c. Magazine/Internet
d. Doctor e. Any other (specify) _____

QUESTIONNAIRE

Knowledge Attitude and Practices (KAP)

S.No. _____ **Name: _____**

Date: _____ **Score: _____**

KNOWLEDGE

Tick the correct answer out of the following:

S.No.	QUESTIONS	YES	NO
1.	Do you have access to nutrition counseling?		
2.	Do you read the nutrition facts label on packed food items?		
3.	Taking nutritious diet would improve athletic performance?		
4.	Consulting a sports nutritionist is beneficial for an athlete.		
5.	All sportspersons should consume same type of diet.		
6.	Carbohydrates and fats are main sources of energy.		
7.	Food supplements are needed in addition to food to improve athletic performance		
8.	Vitamin and mineral supplements provide energy to my body.		
9.	Proper eating along workout is important.		
10.	Milk is a good source of calcium and Vitamin D.		
11.	Caffeine can increase risk of dehydration.		
12.	High fat foods should be reduced in my diet.		
13.	Carrot is a good source of Vitamin A.		
14.	Ergogenic aids should be used in sports.		

ATTITUDE / AWARENESS

Tick the correct out of following choices:

S.No.	QUESTIONS	CHOICES
1.	An excess of which vitamins is potentially dangerous?	a) Vitamin C b) Vitamin B c) Vitamin A
2.	Deficiency of which nutrient may affect sports performance ?	a) Zinc b) Vitamin C c) Iron
3.	The optimal time to consume a post exercise meal is	a) Immediately after exercise b) Within 1-2 Hours c) Wait till hungry
4.	Which of the following is not a physiological effect of caffeine?	a) Decrease metabolic rate b) Increase Heart rate c) Stimulates Central Nervous System
5.	An athlete's strategy one day prior to competition is:	a) Eat a moderately high carbohydrate diet and perform light exercise b) Eat a low carbohydrate meal and do regular exercise c) Eat a high- carbohydrate meal and do intense exercise
6.	Significant losses of electrolytes (such as sodium, chloride, potassium, magnesium) during heavy exercise may lead to symptoms such as:	a) Drop in blood pressure b) Stress fracture, swelling c) Muscular cramps
7.	Good source of iron in diet.	a) Whole pulses and green leafy vegetables b) Roots and tubers c) Milk and milk products
8.	To safely increase muscle mass, it is recommended to increase:	a) Fat intake, carbohydrate intake b) Resistance training, caloric intake. c) Protein, water intake
9.	Which of the following is an ergogenic aid?	a) Health foods and supplements b) Sports kit (Jersey and shoes) c) Mental training d) All of above
10.	Which of the following statements regarding ergogenic aids is false?	a) Use of any aid that enhances sports performance is illegal. b) Endorsements of ergogenic aids by elite athletes does not ensures its effectiveness. c) Some nutritional supplements marketed as ergogenic aids may contain prohibited drugs.

PRACTICE

Tick the correct answer out of the following

S.No.	QUESTIONS	YES	NO
1.	Do you seek or read nutrition information?		
2.	If yes, From where? a) Team mates b) Coach c) Doctor d) Registered dietician/Nutritionist e) Internet/Magazine/Books		
3.	If not, why a) Not a major concern b) No time c) Have enough nutrition knowledge		
4.	Do you recommend athletes to consume more calories than a normal individual?		
5.	Do you recommend athletes to take fruits and vegetables everyday?		
6.	Do you recommend athletes to consume sports/ high energy drink everyday?		
7.	Do you tell athletes to consume sports drink everytime before competition?		
8.	Do you recommend athletes to skip meals to maintain weight?		
9.	Do you allow athletes to consume junk food after participating in competition?		
10.	Do you stop athletes if they smoke or consume alcohol on daily basis?		
11.	Do you encourage athletes to take protein supplements in addition to dietary protein?		

VITA

Name of student	:	Aditi Sewak
Father's name	:	Dr. Aditya Sewak
Mother's name	:	Mrs. Anu Sewak
Nationality	:	Indian
Date of birth	:	16th May, 1993
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EDUCATIONAL QUALIFICATIONS

Bachelor's degree	:	B.Sc. (Hons.) Home Science
University	:	Punjab Agricultural University, Ludhiana
Year of award	:	2015
OCPA	:	8.33/10.00
Master's degree	:	M.Sc. (Food and Nutrition)
University	:	Punjab Agricultural University, Ludhiana
Year of award	:	2017
OCPA	:	8.36/10.00
Title of Master's thesis	:	Assessment of nutritional status of elite athletes with special reference to nutrition knowledge of the athletes and the coaches
Awards/Scholarships	:	■ B.Sc. Gold Medallist ■ Roll of Honour Awardee 2015-16 ■ Dr. P.N. Thapar Gold Medallist 2014-15 ■ Dr. Charanjit Kaur Heera Memorial Scholarship 2015-16