Food Habits and Nutritional Status of Fiji Rugby Players

Jimaima Lako, Subramaniam Sotheeswaran, and Ketan Christi

***Abstract*—**The 15-a-side Fiji rugby team trains well in preparations for any rugby competition but rarely performs to expectations. In order to help the Fiji local based rugby players to identify some key basic areas in improving their performance, a series of workshops were conducted to assess their nutritional status and dietary habits in relation to energy demand during rugby matches. The nutrition workshop included the administration of questionnaires to 19 local based rugby players, requesting the following information: usual food intakes, training camp food intakes, carbohydrate loading, pre-game meals and post-game meals. The study revealed that poor eating habits of the players resulted in the low carbohydrate intake, which may have contributed to increase levels of fatigue leading to loss of stamina even before the second half of the game. It appears that the diet of most 15-a-side players does not provide enough energy to enable them to last the full eighty-minutes of the game.

***Keywords*—**Fiji rugby, Food habits, Physical fitness Training meals,

I. Introduction

RUGBY (union) is widely considered as one of the most popular sports watched by millions of people throughout the world. There are various types of rugby games in the Pacific Island countries including Fiji, where rugby is a widely favourite sport among males. The two major types of rugby commonly played are the 15-a-side and the 7-a-side games. Both the game types feature in the rugby world cup games. The South Pacific teams including the Samoan and Fijian teams have been immensely popular and successful at the international scene especially in the world cup sevens competitions.

Elite rugby players are expected to be physically fit, skilled and fast as well as being psychologically alert. Being fit, skilled and psychologically prepared may be reflected in their performance, especially in making fewer mistakes and being less prone to injury. To achieve peak performance in the game requires discipline, especially training and exercise, accompanied by proper nutrition. Proper nutrition has been demonstrated to improve and enhance sports performance especially in reducing the onset of fatigue [1], [2]. Studies have shown that fatigue during exercise and performances are due to depletion and insufficient supply of glycogen in the liver and muscles, leading to accumulation of lactate in muscle tissues [3], [4], [5].

Athletes in general have special nutrient needs due to the additional demands of training and competition. Therefore, appropriate food intake to maintain good nutritional status is essential for athletes who exercise regularly. This includes proper meals at pre-training, during - and post-training periods. According to [1], there are certain goals that need to be achieved to enhance sustained performance. Some guidelines include the following; an energy guideline of carbohydrate requirement is based on muscle glycogen that needs to replace energy consumed during daily exercises. This requirement is calculated based on the amount of training/competition and size of the muscles of individuals. Examples of carbohydrate requirement for various training levels are shown in Table 1 below.

In the South Pacific there is little information on the food habits and nutritional status of athletes, especially in elucidating relationships between food intake and sports performance. This paper is the first to assess the current nutritional status of Fiji rugby players' usual food intakes, training camp food intakes, carbo-loading, pre-game meals, and post-game meals and rugby performance of elite rugby players during the competitive season in Fiji. Information gathered is anticipated to help the team refine and modify their various nutritional intakes and training strategies based on energy demands of the match day.

TABLE I
Energy Guidelines of Carbohydrate Requirements at Different Intensities in Daily [1]

Training intensity level	Duration of training	Carbohydrate(g)/ kg bwt
General sports activity of unlimited low-intensity	60 min or unlimited	5-6g
Moderate training of lengthy medium intensity	60-120 min	6-8 g
Endurance training at intense level	Over 120 min	8-10g
Extreme exercise at intense level e.g. cycle tour	5-6+ hours	10g+
General sports activity of unlimited low-intensity	60 min or unlimited	5-6g

Jimaima Lako is lecturer at the Faculty of Science, Technology and Environment, The University of the South Pacific, Suva, Fiji Islands (corresponding author phone:+679-3232416; e-mail: lako_ji@usp.ac.fj).

Subramaniam Sotheeswaran was Professor of Chemistry with the University of the South Pacific, Suva, Fiji Islands (e-mail: sotheeswaran@hotmail.com).

Ketan Christi is a Sr. Lecturer, Division of Biological Sciences, Faculty of Science, Technology and Environment, The University of the South Pacific, Suva, Fiji Islands (presenting author phone: +679-3232425; e-mail: christi_k@usp.ac.fj).

II. METHODOLOGY

Nineteen Fiji elite 15-a-side rugby players aged 22 to 31 years attended a two weeks nutrition workshop during a month - long training camp at the University of the South Pacific, Suva, Fiji Islands in preparation for a Pacific Nation Cup match in 2007. At the workshop, food questionnaires were administered. The food questionnaires administered had four sections; personal details (A), a food frequency (B), and a typical preparation diet 7 days before the match and the match day (C) and a 2 x 24 hour food diary (D). The food intake data was assessed with the foodWork software prior to data analysis by Microsoft Excel (version 2003).

III. RESULTS

A. Participants personal details

Personal details of the local based elite rugby players recruited for the study revealed that majority of the indigenous Fijians (92%) were selected as part of Fiji national elite rugby team compared to other ethnicity (8% others). Results showed that 52% of participants lived in the rural areas and 48% lived in the urban areas. The age of participants ranged from 22 to 31 years with an average age of 27. Marital status information showed that 57 % of the players were single while 43 % were married; however none of the single players lived alone. 76% of the players lived with their nuclear families compared to 24% that lived with their extended families, with the average number of people in the family to be 6, which ranged from 4 to 8 people per household. The educational background showed that 71% of the participants had secondary school education, 14% had technical tertiary education, 10% had university education and 5% only had primary education. It appears that participants current occupation reflects the types of educational qualification obtained in which 38% were full-time rugby players, 19% police officers, 15% farmers, 5% bank officers, 5% electricians and 5% gym instructors. The average height and weight of players were 1.8 meters, ranging from 1.73-1.98m and body weight of 102 kilograms, ranging from 84-127 kg respectively.

B. Food preferences

It is well established that dietary patterns are initially acquired in childhood in which tastes and preferences remain with the individual to some degree in life, although diet is shaped and modified by a myriad of factors including financial circumstances, food availability and nutritional beliefs [1]. This acquisition of dietary patterns also applies to elite athletes, despite subsequent nutrition training and awareness. Information gathered on the players' food likes and dislikes (data not shown) revealed that chicken was the most preferred protein (52%) food, followed by fish (29%) and pork (14%). Taro on the other hand appears to be the most liked carbohydrate (33%), followed by cassava (19%) while vegetables such as Edible Hibiscus (*Bele*) appeared to be disliked (24%).

C. Typical training diet

For the purpose of this study, training diets are foods that were consumed three days before the main match. The results are shown in Table 2. The food choices of players' average intake for three days; breakfast, lunch and dinner showed that the most popular breakfast foods included bread (76%) spread with butter (67%), fried eggs (57%), a cup of coffee and slices of pawpaw (33%) and watermelon (33%). The rating of breakfast foods revealed that vegetables rated the least. This appears to correlate with the list of dislike foods discussed earlier. Similarly for lunch, the most popular food choice were taro (67%), beef (38%), cabbage (43%), watermelon (57%) and fruit juice (57%) while the most popular foods for dinner included taro (43%), chicken (33%), watermelon (67%), beans (24%) and fruit juice (43%).

D. Pre-match meal

As part of training diets discussed above, pre-match meals, post-match meals and carbohydrate loading were also assessed separately as shown in Table 3. Pre-match meals are usually the last main meals or snacks consumed prior to the match. Eating prior to match prevents hunger during the match, thus the importance of pre-match meals. Results from this study showed that pre-match meals were taken 3 hours before the match and the average total energy consumed was 980 kcal. The contribution of energy from the three major macronutrients, carbohydrate, protein and fat, was 49 %, 15 % and 36 % respectively.

E. Post-match meal

The post-match diet is usually the food consumed 15-60 min after the match. Results of the nutritional composition of post-match diet revealed that the average total energy consumed was 1125 kcal. The percentage contribution of the three major macro-nutrients revealed that carbohydrate, protein and fat contributed 44 %, 20 % and 36 % respectively.

F. Carbo-loading meal

For the purpose of this study, carbo-loading information considered the foods consumed three to seven days before the competition and revealed that the average total energy consumed was 4204 kcal. The percentage distribution of total energy revealed that carbohydrate, protein and fat contributed 47 % (476g), 18 % (171g) and 35 % (154g) respectively.

G. Two-days food diary

Table 3 also shows the nutritional composition of a 2-days food diary. The average total energy consumed in any of the two days during training to be 2,350 kcal/day. The percentage distribution of total energy revealed that carbohydrates contributed 39 % (271g), protein was 24 % (170g) and fat was 37 % (115g).

H.Percentage energy contribution on different training meals

Figure 1 shows that the percentage contribution of energy from the three major macronutrients (carbohydrate, fat and protein) in the different types of training meals. Comparison shows that the energy contributions are comparable despite differences in the consumption time and energy demands; carbo-load was 47 % (476g), 18 % (171g) and 35 % (154g); pre-event was 49 %, 15 % and 36; 44 %, 20 % and 36 %; and food diary was 39 % (271g), 24 % (170g) and 37 % (115g) of carbohydrate, protein and fat respectively

IV. DISCUSSION

In any sports competition and especially in endurance sports, fatigue during the game is to be avoided as it negatively affects sports performance. Studies have shown that when fatigue sets in during a game, it is accompanied by formation of free radicals. This leads to increased levels of stress and increases the chances of committing mistakes and injuries [6], [7], [8], [9]. .

It is well documented that fatigue during exercise and sports competition may be due to any or combinations of the following; low iron intake, inadequate carbohydrate intake, low blood glucose level, dehydration, over training and increased levels of stress [2], [10]. When working muscle becomes fatigued, it produces lactic acid in the muscle tissues as the end product of glycolysis [2], [11] which has been linked to muscle fatigue [3], [4], [5]. It appears that the onset of fatigue could be avoided and delayed by consuming ideal training or competition diets that supply the necessary nutrients required for optimal performance. Studies have revealed that high carbohydrate intake resulted in lower levels of lactate formation during hard intensity exercise which may suggests that carbohydrate intake may have contributed to the delay in the formation of lactate in the blood and its accumulation in muscle tissues [12], [13], [14], [15]. Results from this study have shown that food intake of elite athletes in Fiji is similar to that of the ordinary population, even during training or in preparation for a sports competition. The average 2-day food diary of the elite rugby food intake in the current study is comparable with the median energy food intake of adult males of the 2004 Fiji National Nutrition Survey [16] which showed 2,350 kcal/day and 2,243 kcal/day respectively. It is important to note that due to extra energy demand by the elite rugby players' from exercising and training; energy intake of 2,350kcal/day is perhaps well below the recommended intake for endurance athletes. This appears to be 1,450kcal deficient compared to the recommended energy intake for generally very active individuals of about 3,800kcal/day. The low intake of carbohydrate by the rugby players during the training days may be one of the reasons for their early fatigue during the competition. It is therefore important that good training diets or competition diets need to be carefully selected and consumed by the rugby players to achieve the full energy demands of the training and competition days. Studies have shown that optimal training diet such as good pre-exercise meals, sports drinks during exercise and post-exercise meals improve and enhance sports and training performance [17].

Studies have shown that carbohydrate meals increase muscle glycogen concentrations which enhances glycogen storage in the liver and muscles to fuel muscle activities [18]. Stored glycogen in muscles drives tricarboxylic acid (TCA) cycle that generates ATP to fuel the muscular activity during exercise and performance. Therefore, depletion of carbohydrate and glycogen stores in the liver and muscles may lead to the onset of fatigue and results in the buildup of lactic acid in the muscle tissues. Carbohydrates are of different types, which include low glycaemic index carbohydrate (LGI) and high glycaemic index carbohydrate (HGI). LGI carbohydrates are believed to release sugar into the blood in a relatively slow and at a sustained rate while HGI releases sugar at a faster rate which may cause marked increase in blood insulin levels leading to a fast break down the sugar compared to the slow release and low blood insulin levels for LGI. Studies have shown that LGI carbohydrates appeared to improve endurance capacity to a greater extent compared to HGI carbohydrates [19], [20]. However no studies have been conducted on carbohydrates that are normally consumed by the Pacific local sports personnel. It is therefore suggested that further investigation on the effects of local carbohydrate food in enhancing endurance performance in our local sportspersons.

Studies have shown that pre-exercise carbohydrate meals improved total performance time [4], [21], [22], [23], [24]. These studies further supported the idea that endurance during prolonged exercise and performance could be maintained by adequate and sufficient supply of carbohydrates that are required for proper functioning of muscles to avoid and prolong fatigue. The current study revealed that the rugby players had low carbohydrate intake, high fat intake and low antioxidant intakes all throughout the training sessions including carbo-loading, pre-event meals, during game drinks and post-event meals.

The data gathered provides awareness for a need of a well-qualified nutritionist to support coach, trainer, physiotherapist, and psychologist. It may appear that the abundance of traditional root crops in the market place, however, people are faced with the dilemma of choosing traditional foods in the face of competition from other carbohydrate alternatives promoted in supermarkets. It is thus important that further work to identify appropriate carbohydrate diets suitable for before, during and after sports events would be important for the sports players and thus boost energy supply during the competition. Even though various carbohydrate foods have been shown to increase endurance performance in different sports elsewhere; none of the Pacific locally grown carbohydrate foods have been investigated on our Pacific sports people. Similarly, no studies have been carried out on the effects of local Pacific carbohydrate foods on the Pacific rugby teams, thus the importance of this research. Further work including clinical trials is to be conducted on the physiological impacts of different Pacific foods on exercise performance.

V. CONCLUSION

This is the first ever study conducted on the Fiji rugby players, thus information gathered would be important to set the baseline for further research for the purpose of enhancing rugby performance nationally, regionally and internationally. It is thus recommended that the identified nutritional imbalance to be rectified. Educational programs on the importance of dietary structure base principle common ground shared by all athletes to be understood and practiced. Each player need to fine-tune his eating plan to account for particular nutritional needs and dietary goals in which case he needs to take control of his choice of food; learn and understand the components and nutrition of foods and know how to prepare them. Further understanding and practice appropriate training diets and serving portions, adapting to altitude and temperature change, traveling, pre- training meals and recovery meals. Conditioning and getting accustomed to competition diets suitable for carbo-loading, pre-events, during and recovery diets to be further enhanced. In order to meet nutritional training goals, emphasis on enhancement of sports performance rather than eating for pleasure should be emphasized. It is therefore, recommended that the Fiji Rugby Union needs to employ a senior sports nutritionist to plan and implement appropriate nutrition programs to enhance rugby performance.

VI. ACKNOWLEGMENT

We wish to take this opportunity to thank the Fiji Rugby Union and Fiji rugby players for their participation, Ms Sarai and Mr.Lal for their assistance in the workshop and the University of the South Pacific Research Committee for funding this research work.

REFERENCES

[1] L. Burke and V. Deakin, in Clinical Sports Nutrition, 3rd ed.: McGraw-Hill, 2006.
[2] R. Wildman and B. Miller, Sports and Fitness Nutrition. Thomas and Wadsworth, Australia.
[3] C. Wilborn and D. Willoughby, "The role of dietary protein intake and resistance training on myosin heavy chain expression," *J. International Society Sports Nutr.* , vol. 1, pp. 27-34, 2004.
[4] C. Kerksick, T. Harvey, J. Stout, B. Campbell, C. Wilborn, R. Kreider, "International society of sports nutrition position stand: Nutrient timing," *J. International Society Sports Nutr.* , vol. 5, pp. 1-17, 2008.
[5] J. Berardi, E. Noreen, and P. Lemon, "Recovery from cycling time trial is enhanced with carbohydrate-protein supplementation vs isoenergetic carbohydrate supplementation. *J. International Society Sports Nutr.* , vol. 5, pp. 24-34, 2008.
[6] W. Chao, E. Askew, D. Roberts, S. Wood and J. Perkins, "Oxidative stress in humans during work at moderate altitude," *J. Nutr.*, vol. 129, pp 2009-2012, 1999.
[7] J. Nelson, P. Bernstein, M. Schmidt, M. Tress and W. Askew, "Dietary modification and moderate antioxidant supplementation differently affect serum carotenoids, antioxidant levels and markers of oxidative stress in older humans," *J. Nutr.* vol. 133, pp. 3117-3123, 2003.
[8] R. Jenkins and A. Goldfarb, "Introduction: oxidant stress aging, and exercise," *Medicine and Science in Sports and Exercise,* vol. 25, pp. 210-212, 1993.
[9] M.M. Kanter, "Free radicals, exercise and antioxidant supplementation," *International J. Sports Nutr.*, vol. 4, pp. 205-220, 1994.
[10] L. Burke, in The complete guide to food for sports performance: Peak nutrition for your sports, 2nd ed. : Mc Graw-Hill, 1995.
[11] S.G. Eberle, in Endurance sports Nutrition: Eating plans for optimal training, racing and recovery, Human Knetics.
[12] J. White, J. Wilson, K. Austin, B. Greer, N. John and L. Panton, "Effect of carbohydrate-protein supplement timing on acute exercise-induced muscle damage," *J. International Society Sports Nutr*., vol. 5, pp. 1-7, 2008.
[13] M. Marcil, A. Karelis, F. Peronnet, and P. Gradiner, "Glucose infusion attenuates fatigue without sparing glycogen in rat soleus muscle during prolonged electrical stimulation in situ," *European J. Applied Physiology,* vol. 93, pp. 569-574, 2005.
[14] J. Hoffman, J. Kang, N. Ratamess, M. Hoffman, C. Transchina, and A. Faigenbaum, "Examination of a pre-exercise, high energy supplement on exercise performance," *J. International Society Sports Nutr.*, vol. 6, pp. 1-8, 2009.
[15] J. Kirwan, R. Hickner, K. Yarasheski, B. Kohrt, B. Wiethop and J. Holloszy, "Eccentric exercise induces transient insulin resistance in healthy individuals," *J. Applied Physiology*, vol. 72, pp. 2197-2202, 1992.
[16] National Food and Nutrition Center, Fiji Nutrition Survey Main Report, Suva, Fiji, 2007.
[17] C. Williams and L. Serratosa, "Nutrition on match day," J. Sports Science, vol 24, pp. 687-697, 2006.
[18] C. Chryssanthopoulos, W. Williams, C. Nowitz and G. Bogdanis, "Skeletal muscle glycogen concentration and metabolic responses following a high glycemic carbohydrate breakfast," *J. Sports Science,* vol. 22, pp. 1065-1071, 2004.
[19] D. Thomas, J. Brotherhood, and J. Brand, "Carbohydrate feeding before exercise: Effect of glycemic index," *International J. Sports Medicine,* vol. 12, pp. 180-186, 1991.
[20] C. Wu and C. William, "A low glyecemic index and meal before exercise improves endurance running capacity in men," *International J. Sports Nutr. Exercise Metab*, vol. 16, pp. 510-527, 2006.
[21] J. Wismann and D. Willoughby, "Gender differences in carbohydrate metabolism and carbohydrate loading," *J. International Society Sports Nutr.*, vol. 3, pp. 28-34, 2006.
[22] E. Coyel, A. Coggan, M. Hemmert and J. Ivy, "Muscle glycogen utilization during prolonged strenuous exercise when fed carbohydrate," *American Physiological Society*, pp. 165-172, 1986.
[23] J. Kirwan, D. O'Gorman, and W.A. Evans, "A moderate glycemic meal before endurance exercise can enhance performance," *J. Applied Physiol.*, vol. 84, pp. 53-59, 1998.
[24] A. Jeukendrup, A. Wagenmakers, J. Stegen, F. Gijsen, F. Brouns, and W. Saris, "Carbohydrate ingestion can completely suppress endogenous glucose production during exercise," *American J. Physiol ,Endocrino. and Metab.*, Vol. 276, pp. E762-E683, 1999.

TABLE II
AVERAGE TRAINING DIET CONSUMED IN A DAY: DURING BREAKFAST, LUNCH AND DINNER (N=19 PLAYERS)

Major group	Breakfast		Lunch		Dinner	
	Food consumed (%)	Quantity (g)	Food consumed (%)	Quantity (g)	Food consumed (%)	Quantity (g)
CHO	bread (76%)	130 (4 medium slices)	taro (67%)	289	taro (43%)	248
	cornflakes (14%)	50 (1.5 cups)	cassava (19%)	270	cassava (29%)	278
					rice (10%)	110
Protein	fried eggs (57%)	93 (2 small)	beef (38%)	151	chicken (33%)	190
	scrambled eggs (10%)	100 (2 medium)	lamb chops (10%)	190	fried egg (14%)	180
	boiled eggs (10%)	100 (2 medium)	fish-fried (14%)	50	beef (14%)	125
	baked beans (5%)	100	chicken (5%)	190	corned beef (10%)	120
Fat	butter (67%)	44	lolo (5%)	50	cooking oil (19%)	20
					butter (10%)	15
Fruits	pawpaw (33%)	140 (1 slice)	---	10	watermelon (67%)	200
	watermelon (33%)	136	watermelon (57%)	176	banana (19%)	75
	banana (19%)	100	pawpaw (10%)	120	pawpaw (5%)	100
	pineapple (10%)	200	pineapple (5%)	190	pineapple (5%)	190
Vegetables	lettuce (14%)	50	apple (5%)	120	beans (24%)	127
	cabbage (10%)	110 (1 serving)	cabbage (43%)	178	lettuce (19%)	100
					cucumber (14%)	127
	carrot (5%)	50	cucumber (19%)	83	cabbage (14%)	250
Beverage	fruit juice (10%)	3.5cup (250mL/cup)	lettuce (14%)	87	fruit juice (43%)	600
	coffee (29%)	1cup	fruit juice (57%)	300ml	tea (14%)	300
	tea (14%)	1.5cup	tea (5%)	250ml		
			milo (5%)	250ml		

TABLE III

Nutrient intake (n=17 players)

	T/Energy kcal	Protein g/kcal	Fat g/kcal	CHO g/kcal	Thiamin mg	Riboflav mg	Niacin mg	Vit C mg	Vit A (µg)	Retinol (µg)	B-car (µg)	Na mg	K mg	Mg mg	Ca mg	Fe mg	Zn mg
Carb Load																	
Gram/mg/µg		171.2 ±94	154.3 ±95	476.2 ±150	2.7 ±2	3.1 ±2	40 ±20	540 ±486	1776 ±211	581 ±482	14344 ±2256	3151 ±232	6770 ±319	970 ±326	880 ±575	27 ±12	31 ±19
Kcal	4204 ±1571	684 ±376	1386 ±855	1904 ±600													
Pre-event																	
Gram/mg/µg		29.6 ±25	38.28 ±38	117.27 ±53	0.5 ±0.3	0.6 ±0.5	10 ±15	85 ±12	468 ±57	276 ±129	2309 ±478	1100 ±336	1307 ±107	149 ±15	178 ±108	5 ±3	4 ±3
Kcal	980 ±489	120 ±100	342 ±342	468 ±212													
Post-event																	
Gram/mg/µg		56.3 ±33	44.10 ±31	119.75 ±56	0.7 ±0.4	1 ±0.5	12 ±7	87 ±10	588 ±75	207 ±103	4729 ±785	748 ±556	1641 ±866	216 ±95	186 ±35	7 ±4	10 ±7
Kcal	1125 ±365	224 ±132	396 ±279	480 ±224													
Food diary: 2-Day Av																	
Gram/mg/µg		169.9 ±107	115.3 ±65	271.5 ±119	5.6 ±5	5.9 ±5	67 ±55	102 ±79	728 ±375	435 ±218	3525 ±413	3064 ±939	5431 ±999	784 ±675	965 ±708	25 ±13	23 ±12
Kcal	2350 ±1469	680 ±428	1035 ±585	1084 ±476													
RDA		55			1.59	2.38		40	750				1950	320	800	7	12

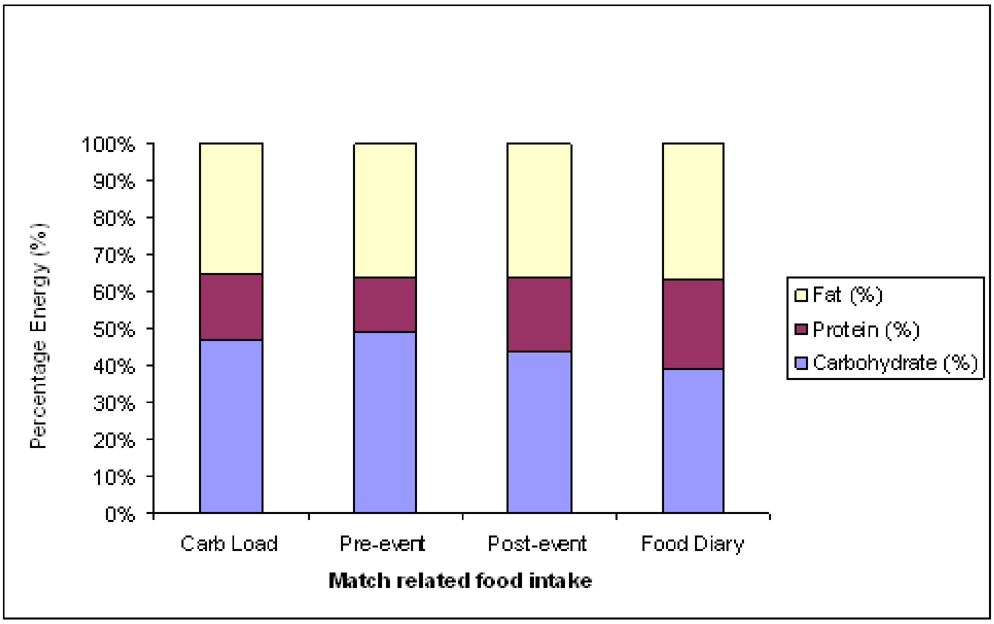

Fig. 1 Percentage energy contribution from the three major macronutrients