Effect of Different Types of Exercise Programmes on Daily Dietary Intake of Nutrients in Females

Anuradha Lehri, Ph.D.

Lecturer, Department of Physiotherapy & Sports Science, Punjabi University, Patiala-147002, Punjab

Abstract

The present investigation studied the effect of different types of exercise programmes (aerobic, strength, mixed i.e. combination of aerobic & strength) on daily dietary intake of nutrients in 120 females ranging in age from 20-40 years. The subjects were divided into four groups' viz. aerobic, strength, mixed and control depending upon the type of exercise programme administered to them. Exercise programme was administered for six weeks and five days a week as per the details given in the paper. Information related to the dietary content of food ingested by the subjects was obtained from daily dietary records of the subjects. Subjects were instructed to identify every food and drink and the amount ingested over a period of 45 days (three days before the starting of exercise programme till the end of six weeks period of study). From this information average daily dietary intake of nutrients was calculated using Dine Healthy Software. The results indicate that with the progression of the exercise programme, the aerobic group demonstrated a significant reduction in the daily dietary energy intake, while in the remaining groups this was not the case. Effect of different exercise programmes on the daily dietary intakes of nutrients vary with the nature of exercise schedule and is discussed at length in the research report.

Key Words: C**arbohydrates, Fats, Proteins, Body Mass Index**

Introduction:

Some people believe that exercise generates an increase in hunger and a drive to eat while others say that physical activity can suppress appetite. From the literature reviewed, regarding the impact of physical activity on the dietary intake, it is gathered that physical activity influences food intake varying from either no change to suppression of appetite *(Thompson et al, 1988; Kissileff et al, 1990; Lawton et al, 1993; King et al, 1994; King et al, 1996; Imbeault, 1997 and King et al, 1997)*. Overall, the body of evidence points to a rather weak pairing between energy intake and physical activity induced energy expenditure *(King et al, 1997; Blundell & King, 1998 and King, 1998)*. Literature is silent as far as the effect of different types of exercise programmes on intake of energy and nutrients in the daily diet is concerned.

The investigation was undertaken to study the effect of different types of exercise programmes on daily dietary intake of nutrients in females.

Materials and Methods:

The study was conducted on 120 females ranging in age from 20 to 40 years. These subjects were grouped into the following categories on random basis and each group comprised of 30 subjects who lasted till the end of the study.

Group I: Aerobic (These subjects were given six weeks of aerobic exercise programme)

Group II: Control (These subjects acted as control and were not subjected to any exercise programme)

Group III: Mixed (These subjects were given six weeks of aerobic plus strengthening exercise programme)

Group IV: Strength (These subjects underwent six weeks of strengthening exercise programme.

Information related to the dietary content was obtained from dietary records of the subjects. Subjects were instructed to identify every food and drink and the amount ingested over a period of 45 days (three days before the starting of exercise programme till the end of six weeks period of study). From this information average daily dietary intake of nutrients was calculated using Dine Healthy Software.

Following three types of exercise programmes were administered to the various groups of females.

Sr. No	Name of the Programme	Group
I	Aerobic Exercise Programme	Aerobic
II	Strength Exercise Programme	Strength
III	Mixed Exercise Programme (Aerobic Plus Strength)	Mixed

The details of the exercise programmes are given below:

A. Aerobic Exercise Protocol:

Based on the principles of aerobic exercise prescription, the aerobic exercise protocol was prepared and included the following important components.

Warm Up (10 minutes)
Mode of Exercise (Brisk Walking)
Exercise Period (30 minutes/session, 5 days/week for 6 weeks)
Cool Down (slow walking plus static stretching exercises for 8-10 minutes)

Following is the list of warm up exercises, which closely resembles the actions central to the training programme. Standing Spinal Twist, Low Back Press, Side Bends, Crossed Leg, Seated Straight Leg, Legs Spread, Legs Spread progression, Side Stretch, Double Knee to the Shoulders, Abdominal Stretch, Inverted Hurdler.

B. Strengthening Exercise Programme

Following strengthening exercise programme was designed for administration to a group of females in the present study. The exercise programme consisted of the following components as is typical of any strength exercise programme.

Warm up:

Same exercises as given under the sub heading of warm up in the aerobic exercise protocol were given for warm up.

Stretching Exercises: - Shoulder Stretch- Anterior & Posterior, Back Extensions Lying & Cross Over Stretch Lying, Back Stretch- Upper One Arm Rows, Push Ups Wide, Neck Stretch Chin-Shoulder, Lying Oblique & Vertical Leg Crunches, Quadriceps Stretch Lying and Toe Drag

Strengthening Exercises: - Back Extensions Standing, Fly Dumbbells, Shrug Dumbbells, Abdominal Oblique Twists, Step Ups

Cool Down:

Exercises given under the subheading of cool down in the aerobic exercise protocol were used after the strengthening/stretching exercises for cool down.

The focus of strength training programme was to develop muscular strength endurance and to achieve this, high repetition, low resistance principle was followed. While administering strengthening exercises to the subjects, a mixture of stretching and strengthening exercises were used in the protocol. Each exercise was repeated 8-12 times and carried in sets of 2-4 with interval of about 40 seconds. Where stretching was involved,

the subject in general was instructed to hold the stretch for 10 or more seconds.

C. Mixed Exercise Protocol

This exercise protocol comprised of both aerobic as well as strengthening exercises. The details of these protocols have already been given above. The aerobic and the strengthening exercises were used alternately during the six weeks period. By alternating, it is meant that on one-day aerobic exercise programme was given and the following session was devoted to the strength building exercises. Frequency of exercise programme was kept five days/week. The subjects performed warm up and cool down exercises in the same manner as described for other exercise programmes.

Statistical Analysis:

SPSS version 10.0 was used for the statistical analysis of the data collected on females of the present study. Usual statistical derivatives like mean and standard deviation were obtained for the various dietary variables before, during and after the exercise programmes for the different groups.

To test the impact of different types of exercise programmes on the dietary intake, paired't' test was applied.

Results and Discussion:

Each one of the exercise programme administered to the females has been divided into four phases as follows:

Pre Programme Phase	Exercise Phase		
	Phase I	Phase II	Phase III
Three days before the start of the exercise programme	First 14 Days (1-14)	Next 14 Days (15-28)	Next 14 Days (29-42)

The average values of daily energy intake alongwith the nutrients in the daily diet during the different phases of exercise programmes have been computed right from pre programme phase to phase III of the exercise programme (Table 1). The notable changes in the daily dietary intake of nutrients because of the administration of exercise programme have been analysed with respect to both the type of exercise regimen and the phase of the programme.

i) Changes in Daily Energy Intake in Females Subjected To Different Types of Exercise Programmes

On an average, the energy intake is observed to significantly increase in females undergoing aerobic, strength and aerobic plus strength exercise programmes as well as in the control group from the pre exercise programme phase to phase I of the exercise schedule. In general, the increase in the energy intake ranges from 102 to 121 Cal among the various groups. The average daily dietary intake of energy is observed to record a continuous increase from phases I to II of the exercise programme in the three experimental groups, but this is not the case with the control group in which opposite is observed (Figure 1).

With the progression of the exercise programme, the aerobic group demonstrates a significant reduction in the daily dietary energy intake, while in the remaining groups the mean values relating to phases II and III of the exercise programme are not observed to be statistically different from each other (Table 2).

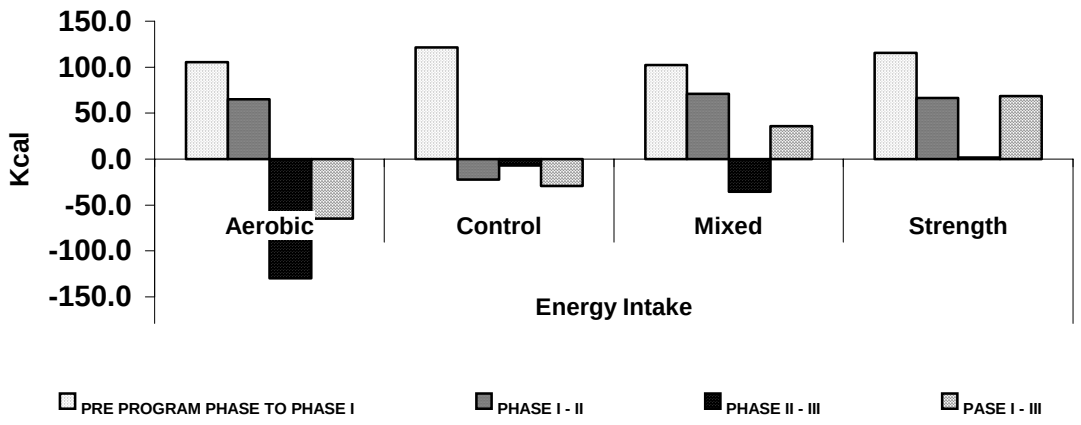

Figure 1: Comparison of mean changes in dietary intake of energy in different groups from one phase of exercise programme to another

It is apparent that different types of physical exercise regimens administered to the females produced varied types of changes in the daily dietary intake of nutrient energy. For example, aerobic exercise regimen caused a significant drop in the intake of dietary energy during the course of the programme. On the other hand, the group of females who underwent programme of strength building exercise and another group that was administered a mixture of strength and aerobic exercises for six weeks duration, though demonstrated a significant increase in the intake of dietary energy at some or the other stage of the programme but failed to record a significant reduction in energy intake at any stage of the study. In the literature, the body of evidence points to a rather week coupling between energy intake and physical activity induced energy expenditure *(King et al, 1997; King, 1998 and Blundell & King, 1998)*. The failure of some investigators to report a linkage between energy intake and physical activity may be the fact that the energy intake might not had been tracked in their studies for sufficiently long period of time after increasing the physical activity. *Edholm et al (1955)* put forth his view that although there is no relationship between energy expenditure and energy intake on the same day but there may be a positive relationship between energy expenditure on one day and energy intake two days later. This led *Edholm et al (1977)* to comment that 'We do not eat for today but for the day before yesterday'. In the present investigation, the energy intake has been tracked for sufficiently long period; therefore, any impact of physical activity on the energy intake is likely to surface out prominently. Decrease in energy intake noticed during the exercise programme especially in the females subjected to aerobic exercise regimen, point to suppression of appetite. A number of investigators have also reported exercise-induced anorexia shortly after the period of vigorous or intense workout *(Thomson et al, 1988; King et al, 1994; King et al, 1996 and Westertrep et al, 1997). Westertrep et al (1997)* also reported that this suppression of appetite is more marked in persons undergoing aerobic training. The observations of the present study are in concurrence with Westertrep as

significant decrease in energy intake has been recorded in females who underwent a programme of aerobic exercises for six weeks. This may be one of the possible causes of greater weight loss potential associated with the aerobic type of exercises. This sight gets strength from the results of the present study also because the females who participated in the aerobic exercise regimen as well lost maximum body weight after the conclusion of the study.

ii) Changes in the Daily Dietary Intake of Nutrients in Females Subjected to Different Types of Exercise Programmes

Assessment of the mean intake of carbohydrates in females who were administered aerobic exercise programme reveal a continuous trend of increase in the average amount ingested by the females with the progression of the exercise programme.

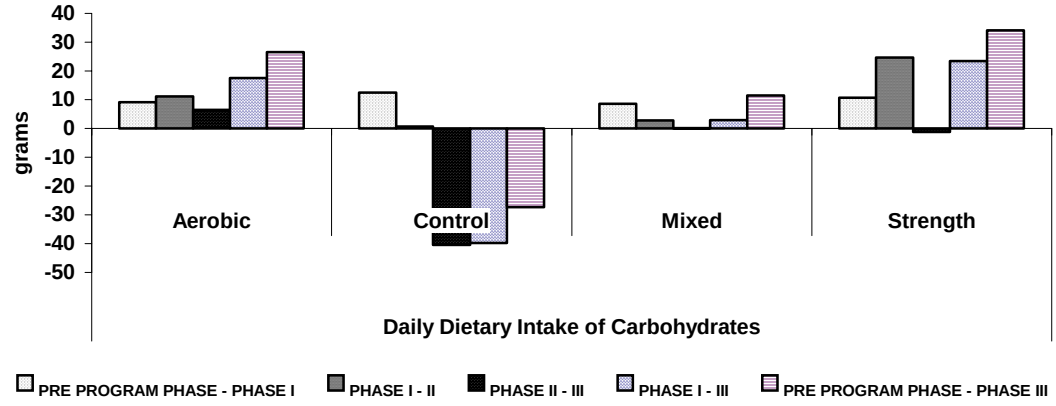

Figure 2: Comparison of mean changes in dietary intake of carbohydrates in different groups from one phase of exercise programme to another

Figures 2 & 3 compare the mean changes in dietary intake of carbohydrates in different groups from one phase of the exercise programme to another. It can be observed from the Figures that only in the aerobic group a continuous increase in the intake of carbohydrates is seen with the progression of exercise phase while in the strength and mixed groups a similar trend is observed except for a decrease in the intake of carbohydrates from phase II to phase III. Control group on the other hand demonstrated an initial increase in this nutrient from pre exercise programme state to phase I of the programme thereafter it recorded a continuous decrease with the progression of the exercise programme. In nutshell, the females who were subjected to different exercise programmes demonstrated a net increase in the carbohydrate intake during exercise as compared to their pre exercise programme stage. Control group on the other hand demonstrated the opposite. High carbohydrate diet is probably the most essential for physically active individual.

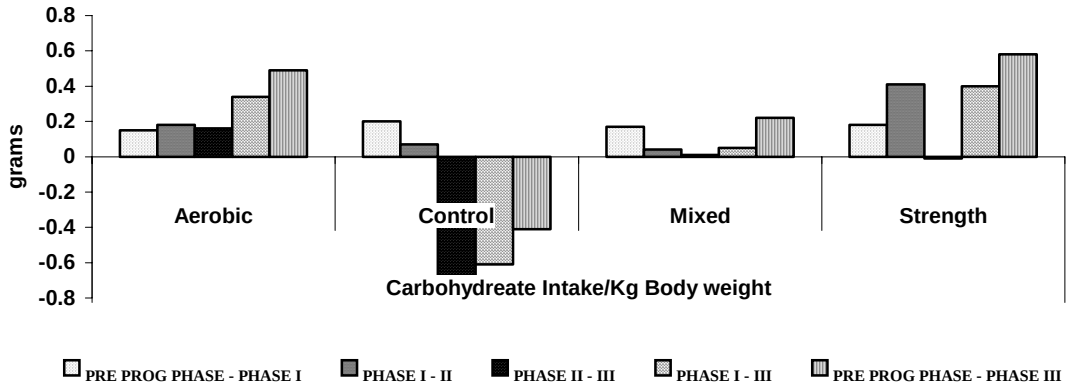

Figure 3: Comparison of mean changes in dietary intake of carbohydrate/kg body weight in different groups from one phase of exercise programme to another

Body carbohydrate stores are extremely important because they are the primary fuel source for the working muscles. It is well known that when muscle glycogen level drops too low, the ability to do exercise falls. *Christensen and Hansen (1939)* first demonstrated the effect of exercise intensity on the fuel used by the muscle during exercise. They reported that as the exercise intensity increased the relative contribution of carbohydrates as muscular fuel also increased. *Ivy (1991)* and *Nieman et al (1987)* in their studies revealed that ability to do hard muscular exercise such as aerobics and strength is closely linked to muscle glycogen level. In the present investigation although no dietary control on the subjects was exercised and the subjects were permitted to eat ad libido, still the increase in carbohydrate intake in the exercise groups occurred by itself, which is indicative of the natural adjustment in the dietary ingestion of nutrients to cope up with the needs of exercise.

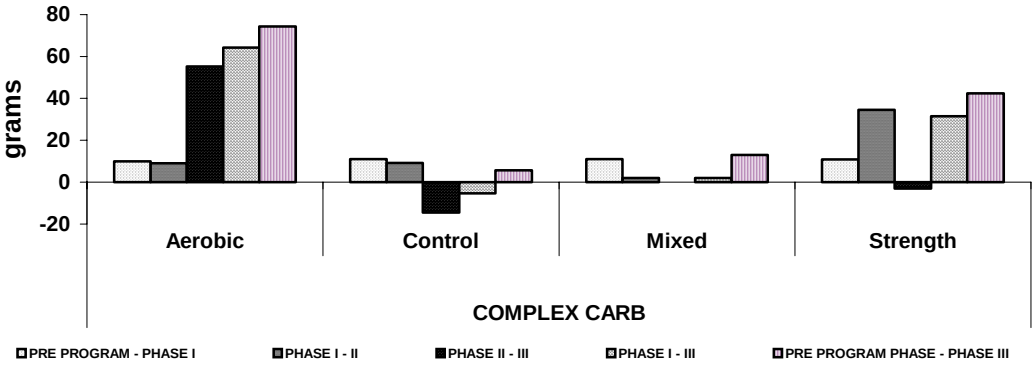

Figure 4: Comparison of mean changes in dietary intake of complex carbohydrates in different groups from one phase of exercise programme to another

It is interesting to observe that intake of complex carbohydrates in the daily diet by the females belonging to the aerobic group demonstrate a continuous significant increase from one phase to another during the progress of the aerobic exercise programme. A similar analysis for the other groups reveals only a slight change in the dietary intake of complex carbohydrates (Figure 4).

Another important component of carbohydrates is added sugar. The mean comparison of changes in the dietary uptake of this component is depicted in Figure 5. It is evident from the figure that in different exercise groups, changes of only very small magnitude are noticed in the subjects from one phase to another during the exercise programme. It is only in the control group that the added sugar intake exhibited a decrease of greater magnitude during the different phases of the study in comparison to the exercise groups.

Mean intake of fibres in the diet by females belonging to different groups is depicted in table 2. In general, changes in dietary intake of fibre are observed in females subjected to different types of exercise programmes from one phase to another (Figure 4). Aerobic and strength group of females demonstrate a greater magnitude of increase in the average ingestion of fibers in their daily diet as compared to the control and mixed group of females. Statistically speaking the average change in the dietary intake of fibers from pre programme phase of exercise to phase I in different groups is significant.

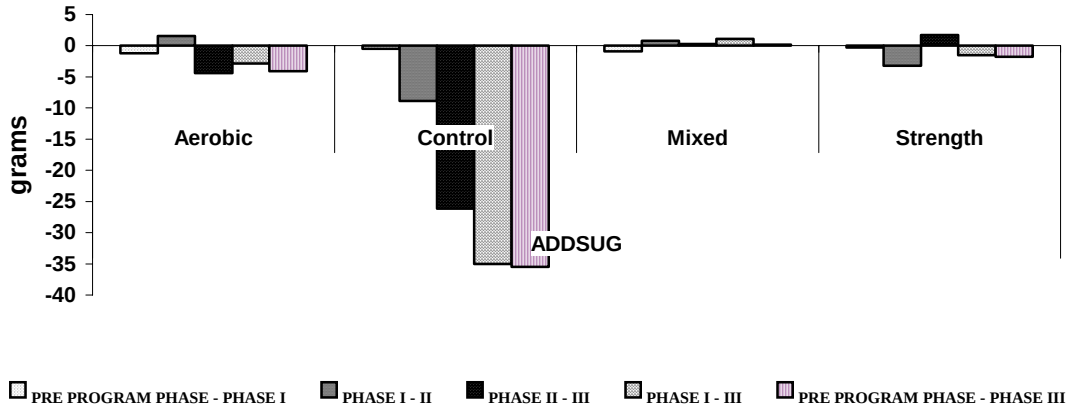

Figure 5: Comparison of mean changes in dietary intake of added sugar in different groups from one phase of exercise programme to another

Dietary fiber, commonly known as "Bulk" or "Roughage" consists of carbohydrate plant substances that are difficult or impossible for the humans to digest. Instead, fiber passes all the way through the intestinal tract and provides bulkiness for faeces in the large intestine, some types of fibers are broken down by bacteria into acids and gases which explicate why consuming a great deal of fiber can lead to intestinal gas. Nutritionists categorize dietary fibers as soluble or insoluble. Soluble fibers slow the body's assimilation of glucose and bind cholesterol

containing compounds in the intestine, lowering blood cholesterol level and lessen the risk of cardiovascular diseases. On the other hand, insoluble fibers unite water, making the faeces bulkier and softer, so they pass more rapidly and effortlessly through the intestine. As per the recommendations of Dine Healthy System, an intake of 20 to 35gms/day of dietary fibers in the diet is considered good. The three experimental groups of the study comprising of females belonging to the aerobic, strength and mixed groups consume the dietary fiber much in excess of the recommended range of 20 to 35gms, but females belonging to the control group take dietary fibers as per the recommendation of the Dine Healthy System even at the pre exercise programme phase. The administration of exercise programme has further caused a rise in the intake of fibers in the experimental groups. There is no doubt that diet high in dietary fiber can help to prevent a variety of health problems including Constipation, Haemorrhoids and Diverticulitis. In addition to this, some studies have associated high level of insoluble fiber in the diet with lower incidence of colon and rectal cancers. These subjects are therefore protected from the risk of running the above said diseases. The exercise groups, comprising of females who participated in the exercise programmes, are observed to consume too much fiber even before the start of the study and exercise further increased their intake of fibers. These females may be exposed to some medical problems such as large stools along with malabsorption of important minerals. It is therefore felt that for the fiber intake, as in all aspects of nutrition, balance and moderation as the key principle should be kept in mind while participating in exercise programmes of long durations

In general, the results of the study related to carbohydrate intake, indicate that various exercise programmes produce varying long-term effects on the intake of carbohydrates in the daily diet, but out of these exercise regimens, that involving aerobic exercises result in improving the quality of diet more than the other programmes.

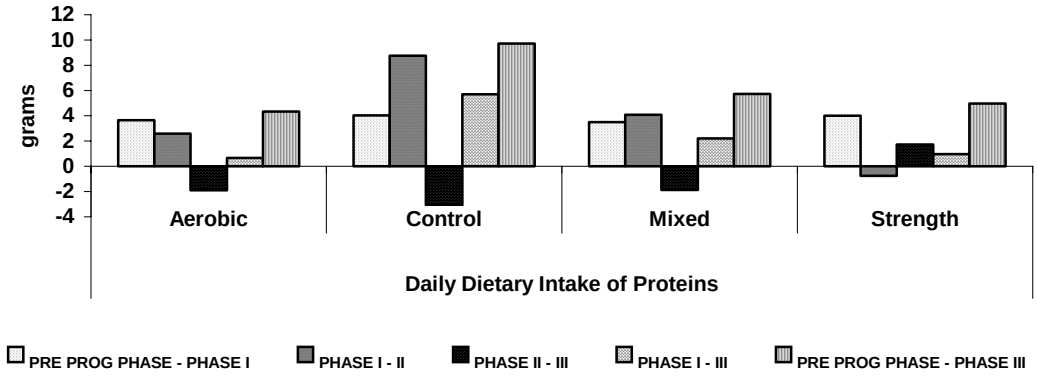

Figure 6: Comparison of mean changes in dietary intake of proteins in different groups from one phase of exercise programme to another

Mean values of total daily dietary intake of proteins by the females belonging to the different groups are presented in table 1. Before the start of the exercise

programme aerobic, mixed and strength group of females were found to consume greater amounts of proteins as compared to the control group. The administration of different types of exercise programmes resulted in varying degree of changes in the protein intake by the females during the different phases of exercise protocols (Figs 6 & 7). Statistical valuation of the changes in the intake of daily dietary proteins from one phase to another phase of exercise programme among the different groups is presented in tables 2 to 5. All the groups have demonstrated a significant increase in the intake of proteins through diet from pre programme phase to phase I of the exercise protocol.

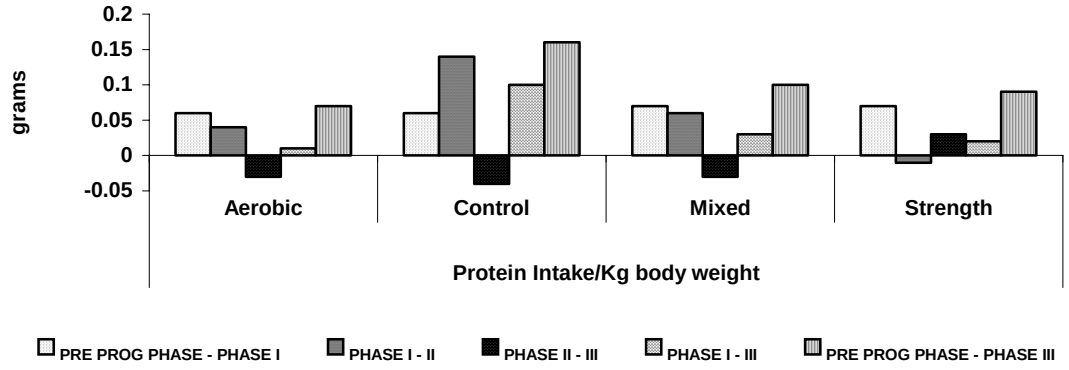

Figure 7: Comparison of mean changes in dietary intake of protein/kg body weight in different groups from one phase of exercise programme to another

The importance of proteins for athletes has continued to be debated over years. *Clark et al (1998)* reported that the primary fuel for muscular contractions was derived from muscle proteins and further suggested that large quantities of meat should be taken to replenish the supply. The studies conducted by *Lemon (1987)* and *Lamont et al (1990)* failed to confirm the above-mentioned results and gave the concept that changes in protein metabolism during exercise are non existing or minimal at best. However, studies using modern technology have concluded that proteins are a much more important fuel source during exercise than was previously thought *(Nair et al, 1987; Tarnopolsky et al, 1988 and Lemon et al, 1992).* The value of proteins to those persons who exercise is due to the fact that exercise cause significant muscle damage *(Evans, 1991),* increase in amino acid oxidation *(Dohm, 1985; Lemon, 1987; and Phillips et al, 1993)* and increase in gluconeogenesis *(Dohm, 1985 and Nair et al, 1987).* From the evidence available from these studies, it is understandable that the proteins should be available in the exercising individual's body in appropriate amounts to deal with the wear and tear caused by the work out. In the light of the reasons cited above, an increase in the protein intake of the females seems quite justified.

Fats constitute the most concentrated energy rich nutrient of the diet. It is known to play an important role during a work out especially if it is of long duration. Table 1 compares the mean values of daily dietary

intake of fats as well as the components of fat in the diet during the different phases of the exercise programmes.

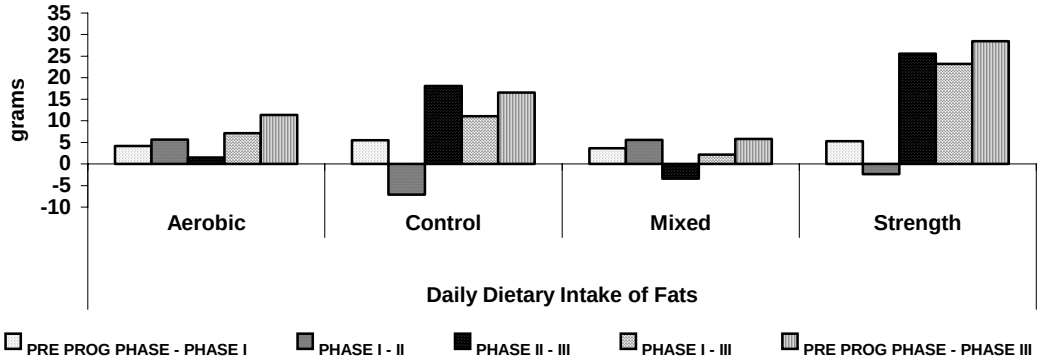

Figure 8: Comparison of mean changes in dietary intake of fats in different groups from one phase of exercise programme to another

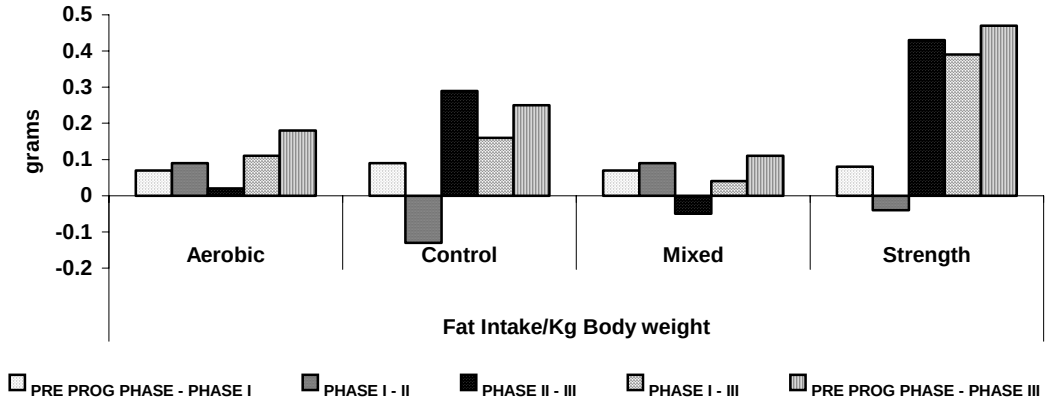

Figure 9: Comparison of mean changes in dietary intake of fat/kg body weight in different groups from one phase of exercise programme to another

Average consumption of total fats in the daily diet by the females in general; exhibits a trend of increase with the progression of the exercise programme. In case of aerobic group fat intake continue to increase from one phase to another while control and the strength groups demonstrate a slight decrease in the fat intake from phase I to phase II of the programme (Figure 8).

Consumption of total fats when expressed in relation to the body weight of the subjects also demonstrates a similar picture as seen in case of total fats (Figure 9)

Comparison of mean changes the dietary intake of saturated fats in different groups also reveals almost a similar picture as seen in case of total fats (Figure 10). Mean intakes of unsaturated fats consumed in the daily diet by the females of different groups during the course of the study are depicted in Table 1 and illustrated with the help of Figures 11& 12.

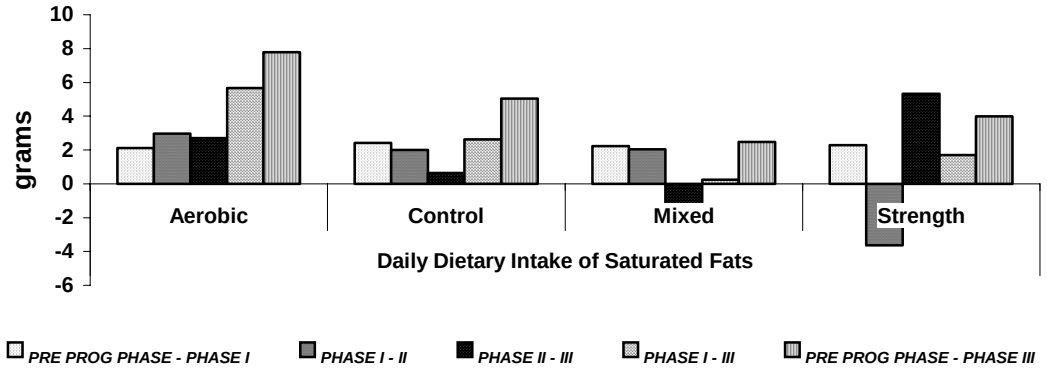

Figure 10: Comparison of mean changes in dietary intake of saturated fats in different groups from one phase of exercise programme to another

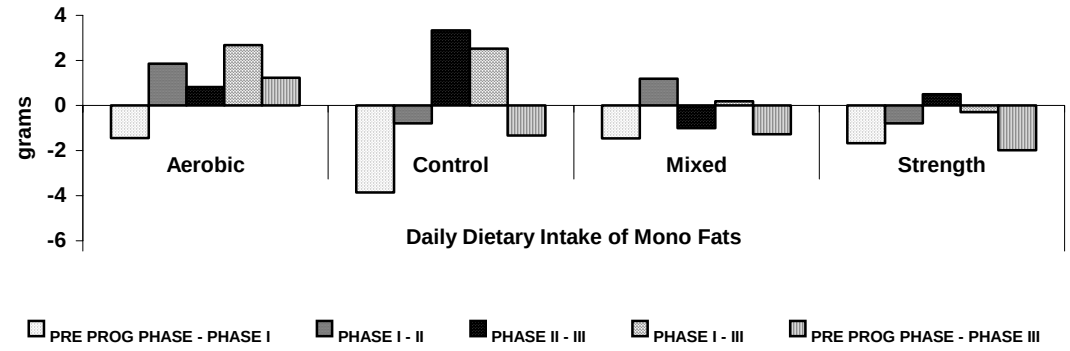

Figure 11: Comparison of mean changes in dietary intake of mono fats in different groups from one phase of exercise programme to another

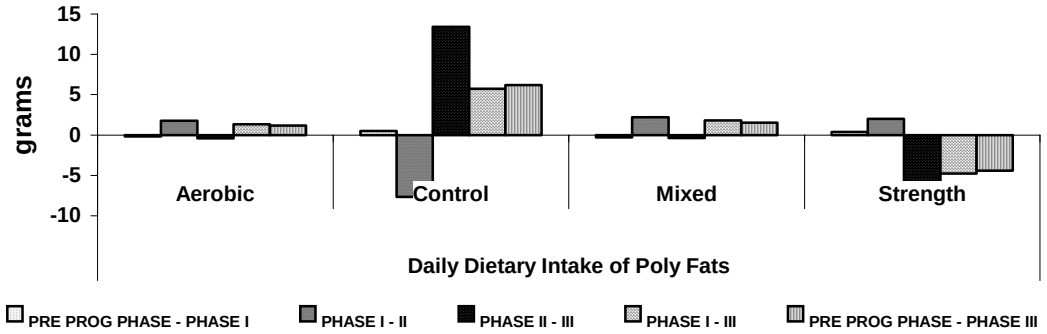

Figure 12: Comparison of mean changes in dietary intake of poly fats in different groups from one phase of exercise programme to another

Aerobic group in general demonstrate a pattern of increase in the daily dietary consumption of mono and polyunsaturated fats, a trend similar to that seen for saturated fats. Strength group on the other hand exhibit a trend of decrease in the daily dietary intake of mono and poly groups of unsaturated fats with the progress of the programme, a trend opposite to that observed in case of saturated fats in this group.

Statistical evaluation has revealed the existence of significant differences in the mean changes recorded for both saturated and unsaturated fat intakes in the daily diet by different groups of females from one phase of the programme to another (Tables 2 – 5).Fats no doubt are known to be the most concentrated source of energy and are linked with a number of important functions in the body, but health experts are of the view that excessive consumption of fats especially if their energy contribution exceeds the upper limit of 30-35%, can lead to a number of health problems, most important of which is arteriosclerosis.

In the present investigation, the dietary analysis has very clearly revealed an increase in the intake of saturated fats with the progression of exercise regimen in all the groups. The polyunsaturated fats on the other hand have shown only a slight increase in females who were subjected to aerobic and mixed type of exercise protocol, while in case of strength group on the contrary a decrease was recorded with the progression of the exercise regimen. From the view point of quality of diet, the changes in the consumption of fats and its components do not seem to be positive in nature because high fat consumption especially of the saturated fats are reported by many investigators to lead to weight gain and also increase the risk of developing diseases like high blood pressure, coronary heart disease, diabetes and even cancer etc *(Doll & Peto, 1981; Margetts & Nelson, 1991; Powels & Ruth, 1994 and Lucas, 1998).*

In the present investigation, the subjects were allowed to eat at liberty and no dietary restrictions were imposed on them during the course of the study. It is observed from the results related to fat intake that a variety of physical workouts as administered through different exercise programmes to the females, failed to check the excessive consumption of saturated fats in their daily diets. Therefore, it is believed that there is a need of interventions in the form of dietary constraints in those adopting for any physical exercise programme with a specific aim of reducing body weight as well as for deriving the necessary health related fitness benefits linked with the exercise.

Many research studies have revealed that athletes have no guarantee of protection from heart diseases unless they follow prudent habits of exercise and diet and further stress that even during training a high-saturated fatty diet can raise serum cholesterol to alarmingly high levels indicating thereby that exercise is not powerful enough to fully negate bad nutritional habits. These investigators advocate that even during any physical exercise programme, wise dietary practices should be followed *(Lukaski, 1984; Miller et al, 1984 and Vukovich et al 1993).*

Table 1: Comparison of mean values of daily dietary intake of nutrients in females of various groups during different stages of exercise programme

Variable	Group	N	Pre Programme Phase		First Phase		Second Phase		Third Phase	
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Energy Intake [Cal]	Aerobic	30	2210.33	275.55	2315.92	267.21	2380.99	301.91	2251.32	287.64
	Control	30	2152.33	426.68	2273.70	414.99	2251.50	394.52	2244.50	359.62
	Mixed	30	2322.27	219.06	2424.56	216.05	2495.68	243.14	2460.32	256.18
	Strength	30	2211.55	398.69	2327.10	386.64	2393.73	447.83	2395.50	416.86
Body Weight [Kg]	Aerobic	30	63.92	7.50	63.88	7.44	62.17	7.13	61.60	6.88
	Control	30	63.05	6.09	63.08	5.98	63.13	5.80	62.95	5.97
	Mixed	30	59.90	3.72	59.68	3.77	58.58	3.52	57.80	3.32
	Strength	30	61.98	4.13	61.92	4.09	61.63	4.05	61.58	4.19
Total Carbohydrate [gm]	Aerobic	30	290.54	32.17	299.60	28.29	310.68	39.44	317.12	118.19
	Control	30	292.79	102.54	305.27	99.76	305.90	102.96	265.47	82.80
	Mixed	30	345.41	34.22	353.95	32.60	356.74	40.47	356.88	35.64
	Strength	30	288.88	87.26	299.57	84.90	324.23	97.72	323.03	113.40
Complex Carbohydrate [gm]	Aerobic	30	247.34	29.64	257.34	27.82	266.42	33.19	321.62	182.73
	Control	30	219.12	99.71	230.07	100.37	239.23	90.79	224.77	85.40
	Mixed	30	318.51	35.09	329.52	34.27	331.44	42.49	331.44	36.80
	Strength	30	242.53	93.76	253.43	94.31	288.00	93.42	284.93	113.25
Added Sugar [gm]	Aerobic	30	46.29	14.95	45.07	14.15	46.61	17.29	42.21	13.76
	Control	30	75.90	67.16	75.43	63.95	66.57	71.69	40.43	31.06
	Mixed	30	25.39	12.83	24.47	12.36	25.26	13.12	25.55	13.33
	Strength	30	39.78	36.69	39.50	35.00	36.27	39.14	38.00	36.29
Dietary Fibre	Aerobic	30	43.22	8.00	44.20	7.75	53.48	41.63	52.09	35.52
	Control	30	35.07	26.31	36.41	26.56	38.00	26.43	35.83	26.78
	Mixed	30	54.59	7.75	55.38	7.40	57.99	8.98	56.84	7.85
	Strength	30	41.34	22.70	42.36	22.57	51.15	28.84	46.02	28.40
Total Protein [gm]	Aerobic	30	74.03	10.28	77.68	9.99	80.26	7.79	78.35	9.59
	Control	30	64.28	19.81	68.30	20.56	77.07	22.73	74.00	19.95
	Mixed	30	78.68	9.95	82.18	9.91	86.26	9.35	84.39	9.59
	Strength	30	73.13	20.59	77.13	20.70	76.37	19.30	78.10	17.97
Total Fats [gm]	Aerobic	30	85.51	14.86	89.69	14.72	95.32	20.78	96.83	26.26
	Control	30	88.69	26.45	94.20	27.31	87.10	29.46	105.23	30.38
	Mixed	30	81.95	12.10	85.58	12.16	91.13	14.37	87.75	15.43
	Strength	30	94.05	27.90	99.33	28.53	96.93	22.18	122.53	142.21
Mono Saturated FAT	Aerobic	30	25.40	3.50	23.95	3.67	25.81	6.99	26.63	9.80
	Control	30	28.73	12.14	24.87	7.88	24.07	8.40	27.40	6.52
	Mixed	30	24.15	3.33	22.69	3.67	23.88	3.57	22.88	4.12
	Strength	30	26.81	9.46	25.13	6.63	24.33	5.51	24.83	6.20
Poly unsaturated FAT [gm]	Aerobic	30	28.88	5.87	28.71	5.26	30.47	9.26	30.05	8.69
	Control	30	29.92	17.76	30.40	17.29	22.73	9.29	36.13	24.04
	Mixed	30	21.10	4.69	20.79	4.43	23.00	8.37	22.61	6.85
	Strength	30	33.80	25.10	34.17	24.79	36.17	21.01	29.40	17.53
Cholesterol	Aerobic	30	173.11	79.50	171.76	76.29	188.74	80.96	168.50	66.09
	Control	30	135.50	83.67	139.47	86.46	167.23	95.11	160.67	106.78
	Mixed	30	163.39	30.03	161.06	27.99	168.55	33.91	161.25	31.01
	Strength	30	149.66	93.03	150.70	91.98	122.80	67.17	157.40	84.87

Table 2: Effects of aerobic exercise programme on daily dietary nutrient intake as evaluated by paired't' test in females

Variable	Pre Prog to Phase I	Phase I to II	Phase II to Phase III	Phase I to Phase III
Body Weight	-0.57	8.13*	5.19*	11.33*
Daily Energy Intake	23.53*	-1.27	2.01*	1.40
Proteins	18.10*	-1.27	0.99	-0.35
Fats	19.02*	-1.64	-0.27	-1.54
Saturated Fats	23.22*	-2.04*	-0.95	-1.82
Mono Fats	-6.66*	-1.61	-0.44	-1.57
Poly Fats	-0.96	-0.92	0.19	-0.75
Total Carbohydrates	7.40*	-1.44	-0.29	-0.78
Complex Carbohydrates	11.15*	-1.37	-1.63	-2.00*
Added Sugar	-2.69*	-0.47	1.23	1.02
Dietary Fibers	4.39*	-1.17	0.15	-1.27

Table 3: Mean differences in daily dietary nutrient intake as evaluated by paired't' test in the control females

Variable	Pre Prog to Phase I	Phase I to II	Phase II to Phase III	Phase I to Phase III
Body Weight	1.98*	0.42	-0.65	2.48*
Daily Energy Intake	1.14	23.33*	1.05	0.30
Proteins	-1.58	11.75*	-2.22*	0.73
Fats	-1.72	12.25*	1.24	-3.01*
Saturated Fats	-0.71	9.76*	-0.56	-0.18
Mono Fats	-1.55	-3.02*	0.54	-2.22*
Poly Fats	-1.22	1.64	2.13*	-3.11*
Carbohydrates	2.74*	9.40*	-0.04	2.41*
Complex Carbohydrates	0.31	12.54*	-0.59	1.32
Added Sugar	2.75*	-0.43	0.66	1.96
Dietary Fibers	0.11	4.71*	-0.40	0.67

Table 4: Effects of mixed exercise programme on daily dietary nutrient intake as evaluated by paired 't' test in females

Variable	Pre Prog to Phase I	Phase I to II	Phase II to Phase III	Phase I to Phase III
Body Weight	-3.79*	15.83*	10.50*	15.50*
Daily Energy Intake	32.73*	-3.76*	1.23	-1.75
Proteins	27.62*	-2.96*	1.15	-2.38
Fats	28.19*	-2.52*	1.25	-1.13
Saturated Fats	39.38*	-1.98	1.31	-0.25
Mono Fats	-3.90*	-1.89	1.23	-0.29
Poly Fats	-3.79*	-1.25	0.21	-1.72
Total Carbohydrates	8.69*	-0.49	-0.02	-0.58
Complex Carbohydrates	15.06*	-0.31	0.00	-0.36
Added Sugar	-4.21*	-0.41	-0.13	-0.41
Dietary Fibers	5.04*	-1.95	0.63	-1.15

Table 5: Effects of strength exercise programme on daily dietary nutrient intake as evaluated by paired't' test in females

Variable	Pre Prog to Phase I	Phase I to II	Phase II to Phase III	Phase I to Phase III
Body Weight	-0.85	15.83*	10.50*	15.50*
Daily Energy Intake	25.15*	-3.76*	1.23	-1.75
Proteins	17.10*	0.20	-0.23	-0.23
Fats	13.44*	-2.52*	1.25	-1.13
Saturated Fats	11.87*	-1.98	1.31	-0.25
Mono Fats	-1.66	-1.89	1.23	-0.29
Poly Fats	1.05	-0.48	1.71	0.91
Carbohydrates	8.60*	-1.63	0.09	-1.31
Complex Carbohydrates	12.14*	-1.97	0.21	-1.41
Added Sugar	-0.49	0.33	-0.18	0.15
Dietary Fibers	5.55*	-1.62	1.14	-0.61

* $p < 0.05$

References:

1. Blundell, J.E. and King, N.A. (1998) Effects of exercise on appetite control: loose coupling between energy expenditure and energy intake. *Int. J. Obes.,* 22: 1 – 8.
2. Christensen, E.H. and Hansen, O. (1939) Respiratorischer Quotient and O2 Aufnahme. *Scand. Arch. Physiol.,* 81: 180 – 189.
3. Clark, N., Nelson, M. and Evans, W. (1988) Nutrition education for elite female runner. *Phys. Sports med.*, 16(2): 124.
4. Dohm, G.L. (1985) Protein Metabolism during endurance exercise. *Federation Proceedings,* 44: 348 – 352.
5. Doll, R. and Peto, R. (1981) The Causes of Cancer. *Journal of the National Cancer Institute,* 66: 1191 – 1208.
6. Edholm, O.G., Fletcher, J.G., Widdowson, E.M. and McCance, R.A. (1955) the energy expenditure and food intake of individual men. *Br. J. Nutr.*, 9: 286 – 300.
7. Evans, W.J. (1991) Muscle Damage: Nutritional Considerations. *Int. J. Sport. Nutr.*, 1: 214 – 224.
8. Imbeanit, P., Saint-Pierre, S., Almeras, N. and Tremblay A. (1997) Acute effects of exercise on energy intake and feeding behaviour. Br. *J. Nutr.,* 77: 511 – 521.
9. Ivy, J.L. (1991) Muscle glycogen synthesis before and after exercise. *Sports Med.*,11: 6 – 19.
10. King, N.A. (1998) The relationship between physical activity and food intake. *Proc. Nutr. Soc.*, 57: 1 – 9.
11. King, N.A., Tremblay, A. and Blundell, J.E. (1997) Effects of exercise on appetite control: Implications for energy balance. *Med. Sci. Sports Exercise*, 29: 1076 – 1089.
12. King, N.A., L. Snell, R.D. Smith and J.E. Blundell (1996) Effects of short term exercise on appetite response in unrestrained females. Eur. J. Clin. Nutr. 50: 663 – 667.
13. King, N.A., Burley, V.J. and Blundell, J.E. (1994) Exercise – induced suppression of appetite: effects on food intake and implications for energy balance. *Eur. J. Clin. Nutr.*, 48: 715 – 724.
14. Kissileff, H.R., P-Sunyer, X.F., Segal, K., Meltzer, S. and Foelsch, P.A. (1990) Acute effects of exercise on food intake in obese and non-obese women. *Am. J. Clin. Nutr.,* 52: 240 – 245.
15. Lamont, L.S., Patel, D.G., Kalhan (1990) Leucine kinetics in endurance – trained humans. *J. Appl. Physoil.*, 69: 1 – 6.
16. Lawton, C.L., Burley, V.J., Wales, J.K. and Blundell, J.E. (1993) Dietary fat and appetite central in obese subjects : weak effects on satiation and satiety. *Int. J. Obes.*, 17: 409 – 416.
17. Lemon, P.W.R. (1987) Protein and Exercise: Update 1987. *Med. Sci. Sports Exercise,* 19: S179 – S190.
18. Lemon, P.W.R. (1987) Protein and Exercise: Update 1987. *Med. Sci. Sports Exercise,* 19: S179 – S190.
19. Lemon, P.W.R., Tarnopolsky, M.A., MacDougall, J.D., Atkinson, S.A. (1992) Protein requirements and muscle mass, strength changes during intensive training in Nov-ice body builders. *J. Appl. Physiol.* 73: 767 – 775.
20. Lucas, A. (1998) Programming by early nutrition: An experimental approach. *J. Nutr.*, 128: 401S - 406S.
21. Lukaski, H.C. (1984) Influence of type and amount of dietary lipid on plasma lipid concentrations in endurance athletes. *Am. J. Clin. Nutr.,* 39: 35 – 44.
22. Margetts, B.M. and Nelson, M. (1991) *Design concepts in nutritional epidemiology.* Oxford: Oxford Medical Publications.
23. Miller, W.C., Bryce, G.R. and Conlee, R.K. (1984) Adaptations to a high diet that increase exercise endurance in male rats. *J. Appl. Physiol.,* 56: 78 – 83.
24. Nair, K.S., Welle, S.L., Matthews, D.E. (1987) Leucine, Glucose and energy metabolism after 3 days of fasting in healthy human subjects. *Am. J. Clin. Nutr.*, 46: 557 – 562.
25. Nieman, D.C., K.A. Carlson, M.E. Brandstater et al (1987) Running exhaustion in 27-h fasted humans. J. Appl. Physiol. 63: 2502 – 2509.
26. Philips, S.K., Rook, K.M., Siddle, N.C., Bruce, S.A. and Woledge, R.C. (1993) Muscle weakness in women occurs at an earlier age than in men, but strength is preserved by hormone replacement therapy. *Clin. Sci.*, 84: 95 – 98.
27. Powles, J.W. and Ruth, D. (1994) Diet – mortality associations. In: M.L. Wahlqvist and J.S. Vobecky, eds. Medical Practice of Preventive Nutrition. London: Smith – Gordon. 75 – 90.
28. Tarnopolsky, M.A., Macdougall, J.D., Atkinson, S.A. (1988) Influence of protein intake and training status on nitrogen balance and lean body mass. *J. Appl. Physiol.*, 64: 187 – 193.
29. Thompson, D.A., Wolfe, L.A. and Eikelboom, R. (1988) Acute effects of exercise intensity on appetite in young men. *Med. Sci. Sports Exerc.,* 20: 222 - 227.
30. Vukovich, M.D., Costill, D.L., Hickey, M.S. (1993) Effect of fat emulsion infusion and fat feeding muscle glycogen utilizations during cycle exercise. *J. Appl. Physiol.,* 75: 1512 – 1518.
31. Westerterp–Plantenga, M.S., Verwegln, C.R.T., Injedema, M.J.W., Wijckmans, N.E.G. and Saris, W.H.M. (1997) Acute effects of exercise or sauna on appetite in obese and non obese men. *Physiol. Behav.*, 62: 1345 – 1354.