ASSESSMENT OF EFFECT OF DIET AND EXERCISE ON INTERVENTION OF THYROID HORMONE, BODY COMPOSITION & BONE DENSITY

Saira Aziz Mughal, Syed Muhammad Bilal Gillani and Asad Hussain Shaikh

Abstract:

Every individual takes diet according to own race, climate, region and rituals. It can be obtained from cereals, vegetables, fruits, animal milk and meat. Globalization has genuinely impacted dietary patterns of people and convinced numerous individuals to eat fast foods having high amount of calories. Individuals need to engage in regular physical activity which causes to release a large number of hormones such as Thyroid hormone. It liberates energy which is helpful to do our daily-life activities. The objectives of this research are: 1) To study the effect of releasing of thyroid hormones during exercise. 2) To study the effect of different types of food on exercise endurance.3) To study the effect of exercise on bone strength and density. 4) To analyze the effect of exercise on body composition. 34 participants are selected for this study from Jinnah hospital at Lahore. They are weighed and height measured to calculate the BMI. Energy needs are comprised of 55% carbohydrates, 30% fat and 15% proteins for 3-month program. Each participant is advised to reduce their caloric intake 750 kcal/day from anticipated energy requirements, which are determined at baseline. Statistical analyses are performed with SPSS software. Data is shown as the mean ± standard deviation (SD). This research shows TSH level decreased and T3, T4 increased in intervention period. It explained as 70 % of participant's heart rate illustrated the best results to improve TSH. Moreover, large negative correlations between diet and BMI were observed. Analysis of variation shows decrease in body weight and body fat percentage and increase in body mass. CHO and PRO intakes increase while fat decreased from pre to post-intervention period. The results of CHO and PRO intakes showed high consumption. There is reduction in the bone mineral found among the three groups which denotes the reduction in bone mineral density with age. Least bone mineral density was observed in group C as compared to group A. It is suggested that RMR plays a crucial role in better health regarding thyroid hormones development. Hence this research concludes that diet and exercise have positive and strong relationship with thyroid hormones, body composition and bone density. Body remains healthy while taking regular exercise with proper diet.

Keywords: *Diet, Exercise, Thyroid Function, Physical Activity, Weight Loss, Bone Density*

Introduction:

The present world has been adjusted to a system of diet which has numerous unfavorable effects on the health of humans. The lifestyle of people has constrained them in such a way that no one truly think what they are consuming is a healthy diet or not. Less free time and competitive economy has also changed the habits of the people. Due to the unhealthy lifestyle, changes in the physical activity have changed body composition and bone density as well. Moreover, globalization has genuinely impacted dietary patterns of people and convinced numerous individuals to eat fast foods having high amount of calories. There are many researches made on the usage of such fatty foods which help us to keep away from them, but tragically these measures are not taken as effective as they should be. Diseases like obesity, food contamination, dehydration, heart issues, diabetes and arthritis have seen a significant ascent in developing nations. It is clear that low quality nourishment, processed food, high calorie amount of food is the main elements of poor health. The consumption of unhealthy diet at huge level has now become a global problem, therefore, its effect on human wellbeing should be accentuated and infuse the education of healthy diet at ground level within the country which can enormously add to its restricted usage and replacing with good dietary habits to improve health.

Diet is the food which an individual takes according to its race, climate, region and rituals. Food comes from cereals, vegetables, fruits, animal milk and flesh. The food taken is digested in the digestive tract to liberate its constituents as fats are broken into fatty acids, proteins into amino acids and carbohydrates into glucose. The vitamins, minerals and water play important role in its utilization to provide energy to body.

Taking healthy diet alone is not considered to be healthy because there must be output of every input; therefore, we need to do exercise regularly along with a healthy diet. Exercise is helpful in warding off or treating coronary illness, osteoporosis, diabetes,

overweight, and anxiety. Fortifing activities give proper protection to the muscles to build perseverance and strength. Heart restoration practices are created to upgrade the cardiovascular system for prevention and recovery of heart issues and illnesses. An even exercise mechanism can improve health; assemble endurance, and moderate huge numbers of the impacts of aging. The advantages of exercise also improve emotional health. Exercise also delaying or preventing musculoskeletal problems, for example, low back agony, neck and shoulder torment and diminishing the danger of expanding coronary diseases, hypertension, osteoporosis and colon cancers. It fortifies the muscles, bones, and enhances the skin, good sleep, maintaining cholesterol levels and strong immune system. Exercise is also connected with numerous physiological advantages that help a person to work viably and feel better.

If diet and exercise are focused equally then fat should be consumed with care in our daily routine. Dietary fat provides energy as our bodies can't make them. Dietary fat provides almost 9k calories per gram. A diet moderate in fat includes about 2 to 3 tablespoons (30mL to 45mL) of unsaturated oils. Unsaturated fats help to reduce risk of heart disease and stroke. There are two main types of unsaturated fats: monounsaturated and polyunsaturated.

Along with dietary fats, dietary carbohydrates are our primary source of fuel. The body uses them to make glucose, which can be used for energy or stored in our liver and muscles. Carbohydrates should give about 45–65% of total calories per day. Sugars and starches mainly provide glucose. The energy value of digestible carbohydrates is generally 4 kcal/g. 25% of added sugars intake is suggested. People should decrease consumption of caloric carbohydrates to balance energy needs and maintain ideal weight.

Similar to carbohydrates, proteins is also crucial to health. The Recommended Dietary Intake (RDI) for protein is 0.75 g/kg for adult women and 0.84 g/kg for adult men. It is recommended that 15% to 25% of total energy intake per day is from protein sources. If a man weighs 75 kg, then he

should eat approximately 21 g of protein at three meals each day. Physically active people, who are taking enough fats, carbohydrates and proteins, actively engage during exercise and different events. A large number of hormones are released in this way. Thyroid hormone is one of them. This hormone liberates energy which is used to move body parts mechanically [1]. Release of thyroid hormone occurs from thyroid tissue which is present in the lower part of front of neck around Adam Apple on either side of Trachea; wind pipe. Thyrotropin or TRH is synthesized by anterior hypothalamus (part of midbrain) and release thyroid stimulating hormone (TSH) from Anterior Pituitary (commonly known as Master Gland) lying close and below hypothalamus [2] [3]. This TSH acts on thyroid tissue to synthesize thyroxin: iodinated tyrosine, T_3 & T_4 as free. It is utilized by active tissues. That means more T_3, T_4 inversely affect TRH and TSH release resulting in a biologically working negative feedback process [4].

Cardiovascular, respiratory, neuromuscular, gastro intestinal, kidney, and brain make use of thyroid due to energy demand in work outs. More food is taken and utilized thus more thyroid hormone is released [5]. Body temperature is raised. Exercising muscles grow in size and weight along with the strong bones. Bones are the organs which not only increase the blood cells but also provide structure to muscles. Bones undergo stress, its density increases [6]. More density means more bone forming material (osteoid) per unit (gram) bone mass.
As we know that bone density determines the health of any individual which includes other concepts such as body composition. Body composition is measured by Body Mass Index, as body weight divided by square of height: -

$$BMI = Kg/meter^2.$$

The effect of thyroid is to keep composition of body mass; active issues utilize T_3. More active muscles increase in weight which puts load on bones which is measured by Dexa Scan. Thyroid hormone affects metabolic processes which yield energy and produce heat in exercise. Temperature is measured by thermometer and cardiovascular assessment is done by blood pres-

sure measurement by using Sphygmomanometer. Thyroid levels are chemically evaluated as TSH, T_3 and T_4 levels by using ELISA technique [7][8][9] [10].

Literature Review:

The fitness of human body, the pattern of exercises and motor skill development is an important factor of physical education (PE) curriculum. These factors are also the prospective indicators of the overall health of child (Lovecchio et al.) [11]. The positive health of an adult is directly linked to the level of fitness in childhood and adolescence (Loprinzi P.D. et al.) [12]. Furthermore, success in children can also be identified on the basis of their level of physical activities and fitness.

Physical active tissues from children to adults are active biologically when a human body is at rest and not dieting. (Laurberg et al.) [13]. The diet we take in the form of food containing carbohydrates, fats proteins, minerals and water are processed metabolically is body to yield energy (Mullur et al.) [14]. If a person exercises regularly then this energy is used by that person that provides great health benefits. As we know that there is growing scientific evidence that there lies an interaction between exercise and function of thyroid (Laurberg et al.) hormone to increase metabolic pathways to liberate energy from diets containing lipids, proteins and carbohydrates, i.e., cells of tissues work bioactivity at the expense of energy released by metabolism. This energy demand is directly proportional to the amount of physical work.

It was observed that acute effect of metabolic activity due to Thyroid hormone release in proportion to intensity of exercise. Normal, elevated or low thyroid functions has been found with active physical life with different types of diet (Fontenelle et al.) [15]. Thyroid hormone and body composition has also been observed and fat mass and free fat mass has been correlated TSH is associated with visceral fat deposition (Chen et al.) in both genders.

Among the sportsman/ sportswomen there is a trend to lose weight or craze to become lean. All of these restrict diet to low caloric levels this induces

thyroid hormone level and metabolism to fluctuate (De Andrade et al.). Exercise has profound beneficial effects in improving cardio respiratory fitness, Glucose Control (carbohydrate diet) and quality of life (Swift et al.).

According to Irene Coll-Risco et al. simultaneous exercise program diminishes BMI and fat mass and builds BMC, contrasted with a control group that have health advising intervention in 16 week research. It further uncovered more decrease BMC in the activity contrasted with the control group, proposing a possible clinical viability of exercise to lessen all BMC issues. They noticed no impacts on other significant adiposity, for example, absolute fat mass, fat mass rate, or instinctive fat tissue. The decreases observed in fat mass of gynoid and android were related with least pharmacological consumption [16].

Christopher M Lockwood explained in his case study that in the absence of energy restriction or other dietary controls, provision of a commercially available high-protein/low-carbohydrate and fat, nutrient-dense food supplement, consumed daily, during a 10-week combined aerobic and resistance training intervention: 1) elicited a behavioral effect in previously sedentary, overweight adults such that subjects' macronutrient profiles were significantly modified (protein increased; carbohydrate and fat decreased) and total energy intake decreased spontaneously; 2) physiological adaptations to exercise were improved; and lastly, 3) though the significant mean differences between the exercise-only and EXFS groups may not be impressive in the absolute, consumption of the food supplement reduced the variability of individual responses for fat mass, muscle mass and time-to-exhaustion, all three variables improving in 100% of subjects in EXFS [17].

Objectives:

Following are the major objectives of this research work:

1. To study the effect of releasing of thyroid hormones during exercise.
2. To study the effect of different types of food on exercise endurance.

3. To study the effect of exercise on bone strength and density.
4. To analyze the effect of exercise on body composition.

Hypotheses:

Following are the major assumptions to propose hypotheses of the research study:

H_0 There is no correlation between exercise and release of thyroid hormones.

H_1 There is a correlation between exercise and release of thyroid hormones.

H_0 Diet and exercise endurance has no relationship.

H_1 Diet and exercise endurance has strong relationship.

H_0 Exercise doesn't effect on bone strength and density.

H_1 Exercise effects on bone strength and density.

H_0 There is no relationship between exercise and body composition.

H_1 There is a relationship between exercise and body composition.

Materials and Methods:

Participants under study are grouped as:

Group-A: 6 participants only on diet.
Group-B: 10 participants only on exercise.
Group-C: 8 participants on diet and exercise.
Group-D: 10 participants do not receive any treatment

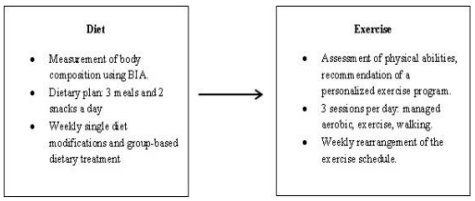
A total of 34 participants are selected for the study specifically patients of hypothyroid from Jinnah hospital at Lahore. All of the participants are undergo general physical examination for well-being with no physical defect. They are weighed and height measured to calculate the BMI. The multidisciplinary rational diet and exercise program are taught to the interventions. They have initial 1:1 consultation with clinical dietitian then followed by a normal caloric diet.

Energy needs are estimated using the diet comprised 55% carbohydrates, 30% fat and 15% proteins. All meals are prepared and provided to participants throughout for 3-month program.

Clinical dieticians offer individuals and group-based dietary counseling on weekly basis. The group format exercise program involves aerobic exercise training (5 days a week). Participants had every day: 30 minutes' sessions of land based exercise. All exercise sessions are developed and supervised by certified trainers / physiotherapists. Clinically biomechanical, body composition and bone density variables are measured before and at the end of the 3 month of study period.

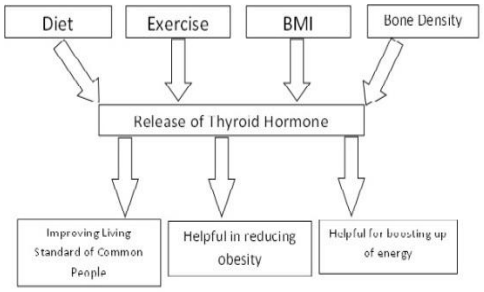
Fasting serum TSH, free T_3 and free T_4 concentration are measured by immunoassay at the Jinnah hospital pathology lab., using T4, T3, free T4, free T3, and TSH values are measured. Blood samples are taken. Body composition is determined in a bioelectrical impedance analysis; they are held up for 30 seconds or in bioelectrical impedance analyzer using ultrasound bone density ultrasound graphical machine. BMI is measured before and at the end of the 3-month reformation program. Following figure can explain the program:

Figure 1:
Diet and Exercise Program



Frame Work

Following framework depicts the above research:



Data Collection Procedure

At the start of the experimental research, pretest data was collected in respect of total sample population for randomization. During the intervention period the observations are recorded very carefully. After completion of the intervention period, the post test data was collected in respect of each group in the same procedure as per protocol for analysis.

Data Analysis Procedure:

Statistical analyses are performed with SPSS software (version10.0). Data is quote as the mean ± standard deviation (SD). Changes in clinical and biochemical variables between baseline and at the end of the intervention are assessed in a paired t-test. Spearman's test is used to identify correlations between changes in body weight or composition, bone density and hypo thyroid parameters. The threshold for statistical significance is set to $p < 0.05$.

Procedure of Intervention:

The intervention was given to experimental and exercise group according to protocol. Intervention/experimental diet were given 5 to 7g each sampled. Exercise was provided at moderate and high intensity level which measures at max hypo thyroid hormone. Each participant is advised to reduce their caloric intake 750 kcal/day from anticipated energy requirements, which are determined at baseline. At baseline inspection, participants with diabetes or hypertension taking medications which can affect their body weight or having less motivation are omitted.

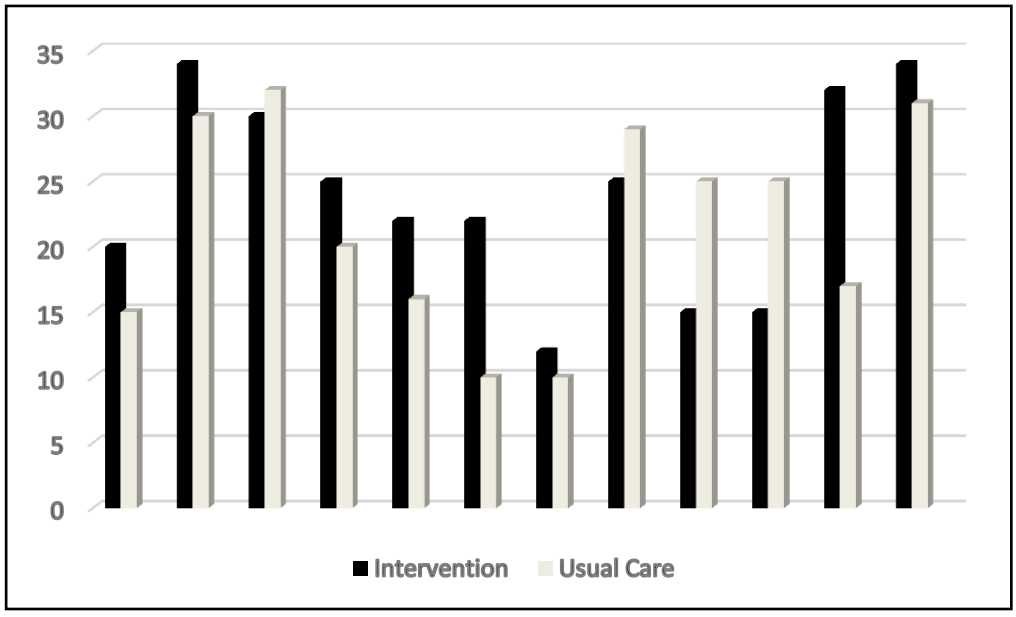
Serum free T3, free T4 and TSH are measured by electro chemiluminescence immunoassay. Serum samples during fasting from the participants were examined by the same medical staff randomly. The coefficient of variation is from 2.3–3.5% for free T3, 3.4–6.8% for free T4 and 2.0–5.5% for TSH. Height is also determined at baseline for BMI which includes weight divided by the square of height. Blood pressure is measured with an automated device at baseline and 3 months. Information on age, gender, race, smoking behavior, background of education and hormone replacement therapy is gathered through questionnaires. The values are calculated on the basis of physical activity at work, exercise and during free time.

Blood sampling for post test

At the end of the intervention period, blood samples are collected from the samples of each group in clean sterile tubes for analysis of hypo thyroid hormone. The hypo thyroid hormone was measured through Elisa technique. The data of all groups was collected and recorded accordingly as a post test for statistical analysis.

The bar chart illustrated below shows that participants are healthier generally as compared to usual care. On x-axis, the number of participants is shown while on y-axis, 3-month time period is shown. In the first week of intervention period, the participants are representing healthier in usual care in the comparison of intervention but with the passage of time, it's started to rise in the next two weeks. While focusing in the second last week of first month, it is clear that the participants are taking more diet and exercise in usual care. If we look into the second month, then it is signified that usual care is being remained low than intervention which means that the participants have taken proper diet care and so proper treatment of thyroid problems in them. The first week of last month gives us the information that intervention care regarding BMI is becoming less. It needs to be more focused on body composition whereas in the coming weeks of third month, there is smooth growth of participants regarding thyroid hormones and bone density.

Figure-3:
Intervention Period and Usual Care Period



Twelve Week Treatment Program

In this 3-month program, Pilates Exercise was planned for the participants for their controlled intervention time period. Following table illustrates the plan used for this research:

Table-1: Twelve Week Treatment Program

Duration	Occurrence of the Exercises	One Session Period	Concentration of the Exercise	Description of the Exercise	BMI	Bone density Test	Thyroid profile	Diet
Twelve weeks	Mon-Sat per week	15 min for warming up and cooling down body	Mild Exercise Moderate Vigorous exercise	Warm up 15 min (Walking) Jogging and running (20 min) Stepping up and down= (12 min) with interval of 2 min Jumping=5min) Pushups (5 min) with 3 min interval Relaxing= 10 min (walking)	Skin fold Thicknes s test	Dexa Scan	Elisa Test	High rich carbohydrates High rich fats High rich protein Mix diet

The relationships between thyroid hormones at baseline and changes in weight or body composition at 1 month, 2 month and at 3 months are calculated using linear regression. Possible confounders in analysis such as age, gender, race, smoking habits, education, physical activity and hormone replacement therapy, the intervention groups and body weight have also been adjusted.

The thyroid hormone levels are used to test the linear trend as continuous variables. To know the relationship between thyroid hormones and body composition as well as the bone density, Spearman correlation coefficients is also calculated after adjusting the possible confounders. Moreover, participants with hyperthyroidism are excluded with TSH <0.38 mIU/L in an analysis.

Results and Discussion

This research study has been divided into three main categories, i.e. diet and exercise effect on thyroid hormones, body composition and bone density, therefore, each one is calculated and observed separately.

Table 2: Variables

Variables	Usual Care		Intervention Period	
	Mean	SD	Mean	SD
Age (Year)	43	9.21	44.5	7.12
Height (cm)	161.7	5.83	159	8.59
Weight (kg)	75.16	10.4	77.16	4.84

Table-3:
Usual Care with and Without Exercise Thyroid hormones

Usual Care Time Period				
Test	With Exercise	Without Exercise	t value	p value
T3	2.3± 1.28	2.1± 1.25	-0.652	0.5168
T4	9.09± 1.45	9.64± 1.97	1.311	0.1944
TSH	3.51± 1.24	2.92± 1.85	-1.545	0.1272

In case of T3, t value is -0.652 and p value is 0.5168 which explains that diet and exercise has normal relationship with thyroid hormones. Difference is -0.200 and Standard error is 0.307. In case of T4, t value is 1.311 and p value is 0.1944 which illustrates that it has strong evidence against the null hypothesis, so we have to reject the null hypothesis which was "There is no correlation between exercise and release of thyroid hormones". Difference is 0.550 and Standard error is 0.420. In case of TSH, t value is -1.545 and p value is 0.1272 which explains that strong evidence against the null hypothesis, so we have to reject the null hypothesis which was "Diet and exercise endurance has no relationship". Difference is -0.590 and Standard error is 0.382.

Table-4:
Tests in Usual Care and Intervention Period

Test	Usual Care	Intervention Period	t Value	p value
T3	2.3±1.28	3.33±2.03	2.503	0.0148
T4	9.09± 1.45	12.34±2.98	5.718	< 0.0001
TSH	3.51± 1.24	1.61±1.42	-5.877	< 0.0001

In case of T3, t value is 2.503 and p value is 0.0148, explains that diet and exercise has normal relationship with thyroid hormones in both usual and intervention periods. Difference is 1.030 and Standard error is 0.412. In case of T4, t value is 5.718 and p value is < 0.0001 which illustrates that it has strong evidence against the null hypothesis, so again we reject the null hypothesis of "There is no correlation between exercise and release of thyroid hormones". Difference is 3.250 and Standard error is 0.568. In case of TSH, t value is -5.877 and p value is < 0.0001 which explains that strong evidence against the null hypothesis, so we again reject the null hypothesis of "Diet and exercise endurance has no relationship". Difference is -1.900 and Standard error is 0.323.

Moreover, total 34 participants were evaluated for thyroid function. First they are evaluated on the basis of exercise and without exercise then under usual care and intervention care. Serum T3, T4 and TSH was analyzed for 3 months in both cases. The present study is the clarification of the effect of regular physical exercise and diet on thyroid disorder status in the region. According to present study, thyroid functions can improve in hypothyroid patients while doing regular exercise and with controlled diet. This research shows TSH level decreased and T3, T4 increased in intervention period. Exercising keeps metabolism system active which is helpful in burning more calories and keep weight down. It also classified as 70 % of participant's heart rate produced the best results in order to improve TSH. Hence some improvement in thyroid function can be reflected as decreasing in weight in intervention patients. May be it is due to better perfusion of thyroid gland. Peripheral metabolism of TSH can be changed due to various reasons like of physiological and pathological conditions which can reduce or rise in iodination process of glands. A connection is able to establish between exercise and elevated level of thyroid hormones successfully [18].

Body Composition

Table-5:
Variables in pre and post Intervention

Variables	Pre-Intervention	Post-Intervention	t-value	p-value
Weight (kg)	45.05 ± 6.45	40.3 ± 5.9	-3.168	0.0023
BMI (kg/m2)	15.25 ± 1.3	13.75 ± 1.3	-4.757	< 0.0001
Body Fat (%)	20.65 ± 2.95	17.85 ±3.55	-3.537	0.0007
TEI (kcal)	1223.95 ± 513.4	890.75± 224.25	-3.468	0.0009
CHO (%)	19.25± 3.9	22 ± 3.05	3.239	0.0019
PRO (%)	8.65 ± 1.75	9.55 ±1.25	2.440	0.0174
FAT (%)	20.35 ± 3.95	16.7 ± 2.75	-4.422	< 0.0001

In the above table, Pre-intervention and Post-intervention values are recorded in terms of body composition. In case of weight, t value is -3.168 and p value is 0.0023 which explains that weight puts an effect on body composition. Difference is -4.750 and Standard error is 1.499. In case of BMI, t value is -4.757 and p value is < 0.0001 which illustrates that it has strong evidence against the null hypothesis, so we have to reject the null hypothesis which was "There is no relationship between exercise and body composition". Difference is -1.500 and Standard error is 0.315. In case of Body Fat, t value is -3.537 and p value is 0.0007 which explains that strong evidence against the null hypothesis. Difference is -2.800 and Standard error is 0.792. In case of TEI, t value is -3.468 and p value is 0.0009 which explains that TEI (Total Energy Intake) has a positive impact on body composition. Difference is -333.200 and Standard error is 96.080. t value is 3.239 and p value is 0.0019 in CHO (Carbohydrate Intake). It means that if we will increase the intake of carbohydrates with exercise then body composition will also increase. Difference is 2.750 and Standard error is 0.849. At last, we have PRO (Protein Intake) and FAT (Fat Intake) having t-values 2.440 and -4.422; and p-values 0.0174 and < 0.0001 respectively which clearly indicates strong positive relationship between body composition and controlled diet and exercise. Difference is 0.900 and -3.650; and Standard error is 0.369 and 0.825 respectively.

Large negative correlations between diet and BMI were observed in 3-month program. Analysis of variation shows decrease in body weight and body fat percentage and increase in body mass. CHO and PRO intakes increase while fat decreased from pre-intervention to post-intervention period. In intervention period, fat intake shown decreases in groups. This study showed that decrease in fat intake will take to healthier life. The results of CHO and PRO intakes are excessive consumption in intervention period. Moreover, effective food choices could affect the consumption of particular nutrients with exercise. A significant decrease in TEI was observed in demonstrating the various types of exercise and activities. Our results confirmed that those individuals, who were strict to long-term weight management, didn't increase their energy intake with excessive rates. [19]

Bone Density:

Table-6:
Pre and post Intervention Mean±SD

Group	Age	Pre-Intervention Mean±SD (BMD) %	Post-Intervention Mean±SD (BMD) %	t-value	p-value
A	21-30	74.24±3.39	78.24±6.39	3.224	0.0020
B	31-40	68.14±4.23	71.14±7.23	2.088	0.0406
C	41-50	58.14±2.23	60.14±5.23	2.051	0.0442

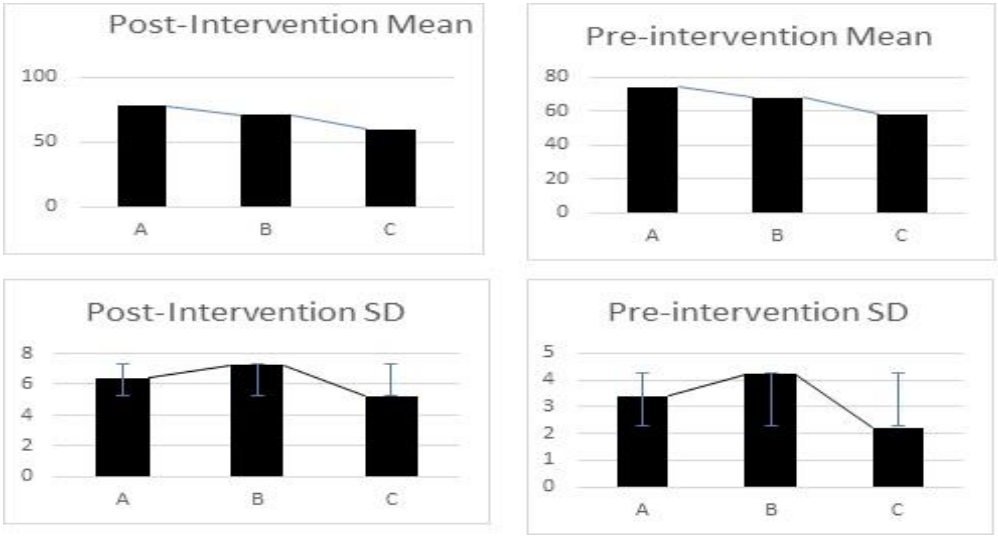
In order to calculate the bone density of the population, it is important to categorize the participants into groups related to age, as bones are dependent on age. Therefore, following age groups have been categorized and determined their mean and standard deviation and finally p-value has been obtained:

In the above table, t value is 3.224 and p value is 0.0020 of group A which explains that BMD has strong relationship with exercise and diet, therefore null hypothesis will be rejected which was "Exercise doesn't effect on bone strength and density". Difference is 4.000 and Standard error is 1.241. In case of Group B, t value is 2.088 and p value is 0.0406 which illustrates that it has strong evidence against the null hypothesis, so we have to reject the null hypothesis again. Difference is 3.000 and Standard error is 1.437. In case of Group C, t value is 2.051

and p value is 0.0442 which has again strong evidence against the null hypothesis. Difference is 2.000 and Standard error is 0.975. There is reduction in the bone mineral found among the three groups which denotes the reduction in bone mineral density with age. Least bone mineral density was observed in group C as compared to group A.

Diet is considered to be a standard in either improving or bad nutritional effects on the people of different genders, age and regions. Poor bone density leads to the osteoporotic condition. Foods like dairy, fruits, vegetables and meat has a definitive role in BMD throughout the life. If we consume more dairy products, then it leads to strong bone density as compared to other food items. It was also observed in data that meat products eating with the vegetables have a strong negative effect on BMD if they are taken with fast foods. BMD is directly linked with calcium and vitamin D. These must be intake regularly for good nutritional effects on the body. It is clear from the study if we had cut off beverages in the post-intervention time period then it would minimize harmful impacts on bone strength. Similarly, smoking and alcohol consumption are negatively attached with BMD [20].

Figure-4:
Pre and Post Invention with Mean and SD



From the above graphs, during pre-intervention period, bone density is decreasing with the age but in post-intervention period, age group B showed strong bone density percentage as compared to other groups. In post-intervention period, there is smooth downsizing in BMD of participants while in post intervention period of SD; it shows little increase in group B as well.

In the following table, we have combined T3, T4 and TSH for better understanding along with the variables as baseline values of the participants:

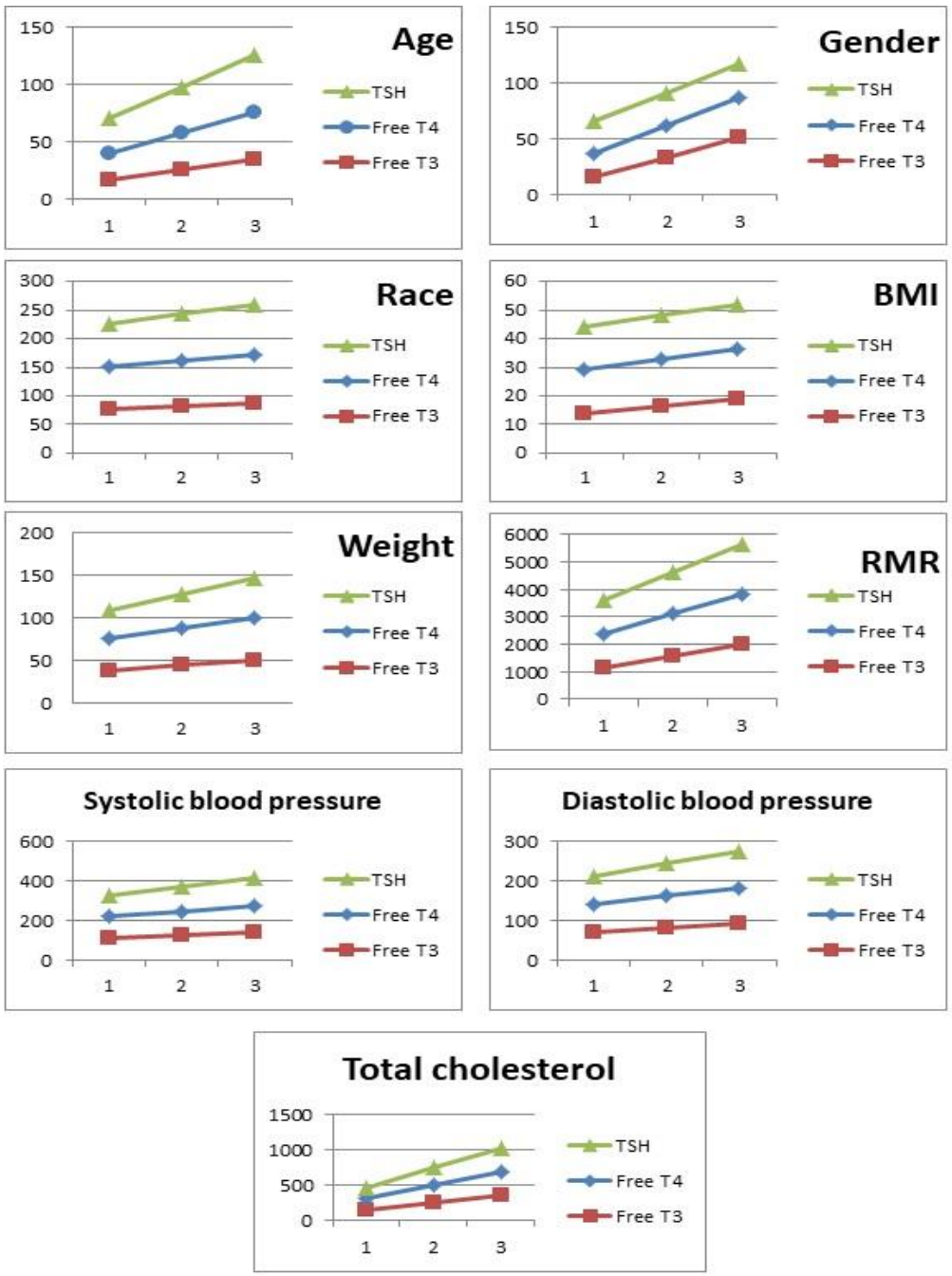
Table 7: Variables with Free T3, Free T4 and TSH

	Free T3 (pg/ml)		Free T4(pg/ml)		TSH(IU/L)	
Tertile	<1.71	>3.71	<0.7	>1.48	<0.35	>4.94
Age (years)	25.4 ± 8.6	25.8 ± 9.6	31.4 ± 8.8	31.5 ± 9.6	41.0 ± 9.4	40.4 ± 8.5
Gender (men, women %)	15.9	51.3	20.8	35.7	29.0	30.1
Race (%)	76.3	88.3	75.8	84.8	73.5	87.1
BMI(kg/m²)	15.29 ± 1.3	17.74 ± 1.2	16.79 ± 1.5	15.75 ± 1.7	16.44 ± 1.3	13.78 ± 1.3
Weight (Kg)	45.05 ± 6.4	45.3 ± 5.45	42.5 ± 5.9	44.3 ± 4.8	40.0 ± 6.6	40.3 ± 6.3
Resting metabolic rate (kcal/24h)	1404 ± 254	1697 ± 291	1514 ± 291	1560 ± 289	1557 ± 305	1534 ± 288
Systolic blood pressure (mmHg)	122.4 ±14.1	127.1 ±13.1	124.8 ±14.5	124.4 ± 13.0	125.2 ±15.2	125.3 ±15.0
Diastolic blood pressure (mmHg)	78.3 ± 9.7	82.7 ± 9.9	80.4 ± 8.4	81.0 ± 9.6	80.9 ± 8.6	80.7 ± 9.1
Total cholesterol (mg/dL)	240.0 ±86.0	259.9±97.8	255.0 ±95.2	235.2 ± 89.7	238.9 ±96.4	242.8 ±99.5

The baseline features of all the participants in terms of tertiles of thyroid hormones are depicted in Table 7. There are noteworthy correlations between free T3 and free T4 (1.7–1.48, $P<0.001$). TSH is weakly related with free T4 ($P<0.001$) and not related with free T3. Age, gender, and race have been adjusted, then free T3 is positively related with weight, RMR and BMI ($P<0.01$) while free T4 has opposite correlations with all of them ($P<0.05$). Then, free T3 and free T4 ratio is positively related with blood pressure and body weight ($P<0.01$). Free T4 has opposite correlations with body weight ($P<0.05$).

The graphical representation of variables including the values of free T3, free T4 and TSH in a 3-month program is as follows:

Figure-5:
Variables with Free T3, Free T4 and TSH



Conclusion

In this analysis of effect of diet and exercise on intervention of thyroid hormone, body composition & bone density, we explained that greater levels of free T3 and free T4 are pointedly related with a weight loss in 3 month program with proper exercise. On the other hand, TSH levels do not show greater effect in this analysis. Moreover, alteration in free T3 and free T4 or TSH, are positively related with changes in body composition including RMR, and blood pressure.

Best of our knowledge, the present research is among those studies that worked on the role of exercise and diet with effect of thyroid hormones, bone density and body composition in a controlled environment. In this little intervention overweight and with high cholesterol participants can change their lifestyle through education and counseling. Then, after adjustment, this research found that greater levels of free T3 and free T4 are related with high effect in BMI in the start of the month. It is also suggested that RMR plays a crucial role in better health regarding thyroid hormones development. Our study showed that the baseline thyroid hormones depict changes of RMR along with other variables. However, more research is needed to explain the fundamental mechanism between exercise and body composition change among obese individuals.

Hence, in a nutshell, thyroid problems reduce the energy level of people but after hormone replacement methods with proper diet and exercise then thyroxine capacity can be achieved again. As a result, it also improves mental and physical status of participants. Therefore, every person who is suffering from thyroid problems should do regular physical exercise and controlled diet to improve one's health. As concerning with body composition, the study shows that the individuals who perform a long-term exercise program don't increase their energy intakes in a fast manner. Our results suggest that there is no adequate effect on body composition if individuals are not following good diet with regular exercise. So they must follow a strict exercise plan. Significant increases in carbohydrate and protein intakes and decrease in fats are observed regardless of the

gender and age. The study related to bone density reports a positive relationship of good diet habits and BMD of all participants. Only diet and exercise cannot be a sole factor which affects BMD as other factors also shown various impacts on bones' health. Regular physical exercise is also helpful in order to enhance the deposition of calcium making the bones stronger.

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