

# Effects of Healthy Eating and Physical Activity on Overweight and Obese Males and Relationship with the Levels of Some Hormones



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Healthy lifestyle; Leptin; Cortisol;  
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## ABSTRACT

The purpose of the study was to compare the efficiency of healthy lifestyle (healthy diet and exercise) in reducing weight gain risk. The study was a controlled experiment performed from 2023 to 2024, and three groups of males were selected (males with normal weight, overweight males, and males with type 1 obesity). Their daily lifestyle was determined. A healthy lifestyle was designed to prevent the risk of weight gain and related hormonal disorders. The study was conducted in the Maternity and Children Teaching Hospital in Ramadi City, Iraq. A total of 90 males were included: 60 males with body mass indices (BMIs) of more than 25 and 30 males with BMIs less than 25. The overweight and obese participants adopted the healthy lifestyle for four weeks. Anthropometric measurements, including BMI, waist circumference (WC), and fat percentage, were measured with a special formula, and serum leptin, testosterone, cortisol, and growth hormone (GH) concentrations were measured. Results showed considerable increases in BMI, WC, fat percentage, and cortisol and leptin hormone concentrations, whereas testosterone and GH concentrations considerably decreased in overweight and obese males compared with males with normal weight before they adopted the health lifestyle. Meanwhile, BMI, fat, WC, and leptin and cortisol concentrations decreased, and testosterone and GH concentrations increased. The concentrations of GH after 60 and 90 min of stimulation with clonidine in overweight and obese males considerably increased relative to their results before the adoption of the healthy lifestyle. Healthy eating and physical activity limited weight gain and improved hormonal results. Thus, lifestyle changes can improve overall health.

## Introduction

The human body consumes and utilizes food (raw material) to build the body, convert it to energy, and store it. Thus, our bodies have complex systems for controlling food consumption, and these systems are driven by hormones [1].

Endocrine glands produce chemical messengers known as hormones, which help to regulate metabolic activity and water and electrolyte coordination. The main bodily functions include regulating and stimulating the body's growth and promoting the development of sexual organs [2].

The endocrine system is a complex system consisting of hormone-producing glands, including the hypothalamus, pituitary gland, adrenal gland (cortex and medulla), thyroid gland, parathyroid gland, pancreas, and gonads (testes in males and ovaries in females) [3].

The word endocrine indicates response to stimuli.

Hormones secreted by endocrine glands are released directly into the surrounding fluid (interstitial fluid). Then, the hormones are transmitted via the interstitial fluid and blood vessels to target cells. Hormones interact with specific cell sites called receptors inside (cytoplasmic receptors) and outside cell surfaces (membrane-bound receptors) [4].

Hormones affect target cells (tissues) through interactions between hormones and receptors. Resulting reactions initiate a series of biochemical reactions that alter cells' functions or activities [5].

Growth hormone (GH) is a small protein synthesized in the pituitary gland and secreted into the bloodstream. Its major physiologic and bioactive component is a 22 kDa polypeptide chain containing 191 amino acids [6].

GH is intermittently secreted by the anterior pituitary gland when the hypothalamus releases GH-releasing

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hormone. The regulation of GH secretion is complex and can be induced by other hormones, including ghrelin, and inhibited by insulin-like growth factor 1 and somatostatin [7]. In addition, GH can be secreted peripherally through reproductive, respiratory, alimentary, neural, and immune tissues and in the skin (integumentary) and cardiovascular, muscular, and skeletal systems [8].

After it enters the circulatory system, GH targets the extracellular domain of the human GH receptor on the surfaces of cells, such as adipocytes, lymphocytes, and liver cells (hepatocytes) [9].

GH plays a crucial role in regulating peripheral, adipose, connective, and muscle tissues, internal organs, and endocrine glands and regulates the growth and development of sexual organs. In addition, it facilitates protein anabolism by increasing amino acid uptake and protein synthesis, and regulates the use of stored fat by stimulating the breakdown of triglycerides [10].

GH increases sugar glucose levels in the bloodstream by decreasing the amount glucose absorbed by muscle cells and adipose tissues and promoting gluconeogenesis (glucose production) from precursor molecules in the liver. That is, GH has functions opposite that of insulin [11].

Obesity and overweight are common conditions in many countries, including Iraq, and are defined as the unusual accumulation of fat tissues in the body. These conditions are caused by numerous factors, poor diet, lack of exercise or sleep, certain medicines, and genetic factors [12].

Obesity leads to the development of health problems, including cardiovascular diseases, high blood pressure, high cholesterol, breathing troubles (asthma), sleep disorders, metabolic syndromes, and type 2 diabetes [13].

The objectives of the study are as follows:

- 1- Measure GH, testosterone, leptin, and cortisol levels in overweight and obese men before and after they adopt the healthy lifestyle.
- 2- Explores how obesity and overweight affect hormone secretion and how aerobic and resistance exercises stimulate the secretion of hormones in obese or overweight males.

## Materials and Methods

### Study participants

The study was conducted in the Maternity and Children Teaching Hospital in Ramadi City, Iraq, from November 2023 to May 2024. Ethical consent was obtained from the review board, and a verbal consent of participation was obtained from each individual.

The study included 90 males aged 18–22 (30 obese males, 30 overweight males, and 30 males with normal weight). The males participating in the study did not possess intestinal and immune illnesses or any disease.

### Anthropometric Assessment

All the study participants were weighed using the same scale. Height was determined with a measuring tape. Body mass index (BMI) was measured as weight divided by height ( $\text{kg/m}^2$ ) according to universal formula.

### BMI= weight (kg)/square height ( $\text{m}^2$ )

BMI was measured (CDC Growth Charts, 200) [14], and the males were classified (Table 1).

**Table 1:** World Health Organization (WHO) body mass index (BMI) Classification

Groups	BMI
Underweight	<18.5
Normal weight	18.5-24.9
Overweight	25-29.9
Obesity class I	30-34.9
Obesity class II	35-39.9
Obesity class III	≥40.0

Waist circumference (WC) was measured from the umbilicus at the horizontal level around the center with a flexible and nonstretchable tape measure. Each participant was asked to relax while exhaling during the measurement.

### Protocol

We aimed to design a four-week healthy diet program with calculated calories for obese individuals. This program, along with regular exercise, was implemented to improve GH and testosterone secretion levels, increase muscle mass, and lose weight.

### Lifestyle interventions

A healthy lifestyle program was then designed for all study participants, and its implementation was supervised by a diet specialist and an athletic coach.

The healthy dietary program used food with high fiber content, low amounts of simple and complex carbohydrates, high protein content, and low fat content.

### Workout plan designed

The aim of prescribing exercise (aerobic and resistance) for obese individuals is to stimulate GH secretion. This procedure may serve as a nonpharmacological method for reducing adipose tissue deposits and increasing lean muscle mass. Several factors were considered in the design of exercises:

- 1- Exercise
- 2- Order exercise choice
- 3- Load
- 4- Volume and rest period length.

### Blood Collection

Blood samples (5 ml) were collected through vein puncture by using a sterile medical syringe from each individual in the morning after 12 h of fasting. Each blood sample was placed in a gel tube free of coagulants and left at room temperature. Then, it was separated with a centrifuge at 3000 cycles for 15 min, placed in special tubes, and stored in a refrigerator under 20 °C. Blood samples were collected from obese and overweight males one month before and one month after the adoption of the healthy diet and exercise program. Specimens from the control group were collected once.

### Leptin Assessment

Serum leptin concentration was measured utilizing leptin (sandwich) and enzyme immunoassay kit. This assay is only intended for in vitro analysis and is a solid-phase enzyme-linked immunosorbent assay (ELISA) based on the sandwich principle [15].

### Testosterone hormone Assessment

Serum testosterone hormone concentration was determined with an ELISA kit (USA) [16].

### Cortisol hormone Assessment

A Minividas device was used to measure the cortisol level according to the manufacturer’s instructions [17].

### Human growth hormone Assessment

ELISA was performed using a kit from Biocheck HGH.

Blood samples were collected from all the participants, and basal GH level and GH levels after 60 min (GH2) and 90 min (GH3) of induction with clonidine were determined [18].

### Statistical Analysis

All data were analyzed using SPSS and shown as mean ± standard error. ANOVA was used in comparing means. A P value of ≤0.05 was considered statistically significant.

### Results

Table 2 shows the demographic characteristics (before applying the healthy lifestyle) of the participants. No significant difference in age ( $P \leq 0.05$ ) was found among overweight and obese males and males with normal weight. BMI, fat percentage, and WC in overweight and obese males significantly increased ( $P \leq 0.05$ ) compared with those of males with normal weight. BMI, fat percentage, and WC in obese males were significantly higher ( $P \leq 0.05$ ) than those of overweight males.

**Table 2:** Demographic characteristics (mean ± SE) of overweight, obese, and normal-weight groups before the adoption of the healthy lifestyle.

Parameters	Overweight Males (n=30)	Obese Males (n=30)	Normal Weight Males (n=30)	P value
Age (years)	20.69 ± 0.54	19.83 ± 0.32	20.38 ± 0.54	N.S
BMI (Kg/m <sup>2</sup> )	28.86 ± 0.21	33.82 ± 0.81	24.52 ± 0.93	0.000*
Fat %	33.65 ± 0.24	35.86 ± 1.05	27.04 ± 0.17	0.000*
WC (cm)	99.02 ± 1.05	109.01 ± 0.10	92.16 ± 0.09	0.000*

\*P ≤ 0.05 \*SE: Standard Error \*N.S: Not Significant  
\*BMI: Body Mass Index \*WC: Waist Circumference

Table 3 shows the demographic characteristics (after the adoption of healthy lifestyle) in the three groups. No significant difference in age ( $P \leq 0.05$ ) was found among overweight, obese, and normal-weight males. A

significant decrease ( $P \leq 0.05$ ) in BMI, fat percentage, and WC in obese people who adopted the healthy lifestyle.

**Table 3:** Demographic characteristics (mean  $\pm$  SE) of overweight, obese, and normal-weight groups after the adoption of healthy lifestyle.

Parameters	Overweight Males (n=30)	Obese Males (n=30)	Normal Weight Males (n=30)	P value
Age (years)	20.69 $\pm$ 0.54	19.83 $\pm$ 0.32	20.38 $\pm$ 0.54	N.S
BMI (Kg/m <sup>2</sup> )	26.92 $\pm$ 0.61	32.06 $\pm$ 1.08	24.52 $\pm$ 0.93	0.000*
Fat %	30.01 $\pm$ 0.58	33.85 $\pm$ 0.90	27.04 $\pm$ 0.17	0.000*
WC (cm)	95.05 $\pm$ 0.21	106.11 $\pm$ 1.09	92.16 $\pm$ 0.09	0.00*

\* $P \leq 0.05$  \*SE: Standard Error \* N.S: Not Significant  
\*BMI: Body Mass Index \*WC: Waist Circumference

Table 4 shows hormone concentration in the sera (before the adoption of the healthy lifestyle) in the three groups. Significant increases ( $P \leq 0.05$ ) in leptin and cortisol concentrations in overweight and obese males were observed compared with normal-weight males, and significant increases ( $P \leq 0.05$ ) in leptin and cortisol concentrations were observed in obese males compared with overweight males. Moreover, significant decreases ( $P \leq 0.05$ ) in testosterone concentration were observed in overweight and obese males compared with normal-weight males. Leptin and cortisol concentrations in obese males significantly increased ( $P \leq 0.05$ ) increase relative to those of overweight males, but testosterone concentrations in obese males significantly decreased ( $P \leq 0.05$ ) compared with those of overweight males

**Table 4:** Hormones (mean  $\pm$  SE) of overweight, obese, and normal-weight groups before the adoption of the healthy lifestyle.

Parameters	Overweight Males (n=30)	Obese Males (n=30)	Normal Weight Males (n=30)	P value
Leptin (ng/ml)	29.88 $\pm$ 0.25	33.18 $\pm$ 0.58	19.56 $\pm$ 1.20	0.000*
Testosterone(ng/ml)	4.27 $\pm$ 1.08	3.16 $\pm$ 0.16	6.58 $\pm$ 0.14	0.000*
Cortisol (ng/ml)	119.2 $\pm$ 1.13	129.08 $\pm$ 1.01	103.1 $\pm$ 0.17	0.000*

\* $P \leq 0.05$  \*SE: Standard Error \* N.S: Not Significant

Table 5 shows hormone concentration (after the adoption of healthy lifestyle on overweight and obese males). Significant decreases ( $P \leq 0.05$ ) in leptin and cortisol concentrations were observed in overweight and obese males after they adopted the healthy lifestyle.

Significant increases ( $P \leq 0.05$ ) in testosterone concentrations were observed in overweight and obese males were observed after the adoption of the healthy lifestyle.

**Table 5:** Hormones (Mean  $\pm$  S.E) of overweight, obese and normal weight groups after applying the healthy lifestyle.

Parameters	Overweight Males (n=30)	Obese Males (n=30)	Normal Weight Males (n=30)	P value
Leptin (ng/ml)	25.03 $\pm$ 0.47	29.22 $\pm$ 1.09	19.56 $\pm$ 1.20	0.000*
Testosterone(ng/ml)	5.15 $\pm$ 0.76	4.78 $\pm$ 0.52	6.58 $\pm$ 0.14	0.000*
Cortisol (ng/ml)	113.01 $\pm$ 0.81	120.21 $\pm$ 0.92	103.11 $\pm$ 0.17	0.000*

\* $P \leq 0.05$  \*SE: Standard Error \* N.S: Not Significant

Table 6 shows that the serum concentrations of GH (before the adoption of the healthy lifestyle) in the three groups. Significant decreases ( $P \leq 0.05$ ) in basal GH were observed in overweight and obese males compared with the normal-weight males. Moreover, the concentrations of GH after 60 and 90 min of stimulation with clonidine (GH3) in overweight and obese males significantly decreased ( $P \leq 0.05$ ) compared with those of the normal-weight males.

**Table 6:** GH (mean  $\pm$  SE) of overweight, obese, and normal-weight groups before the adoption of the healthy lifestyle.

Parameters	Overweight Males (n=30)	Obese Males (n=30)	Normal Weight Males (n=30)	P value
Basal GH (ng/ml)	1.53 $\pm$ 0.63	1.16 $\pm$ 0.22	2.98 $\pm$ 0.65	0.000*
GH2 (ng/ml)	5.86 $\pm$ 1.12	4.84 $\pm$ 0.92	13.67 $\pm$ 1.03	0.000*
GH3 (ng/ml)	4.31 $\pm$ 0.18	3.42 $\pm$ 0.17	8.91 $\pm$ 0.48	0.000*

\* $P \leq 0.05$  \*SE: Standard Error \* N.S: Not Significant

Table 7 shows that the serum concentrations of GH (after the adoption of the healthy lifestyle on overweight and obese males only). Significant increase ( $P \leq 0.05$ ) in basal GH was observed in overweight and obese males after they adopted the healthy lifestyle. Moreover, the concentrations of GH after 60 and 90 min of stimulation with clonidine (GH3) in overweight and obese males significantly increased ( $P \leq 0.05$ ) after the adoption of the healthy lifestyle.

**Table 7:** GH (Mean ± S.E) of overweight, obese and normal weight groups after applying the healthy lifestyle.

Parameters	Overweight Males (n=30)	Obese Males (n=30)	Normal Weight Males (n=30)	P value
Basal GH (ng/ml)	2.40 ± 0.12	2.58 ± 0.50	2.98 ± 0.65	0.000*
GH2 (ng/ml)	6.28 ± 0.70	5.78 ± 1.12	13.67 ± 1.03	0.000*
GH3 (ng/ml)	5.63± 0.55	6.02 ± 0.69	8.91 ± 0.48	0.000*

\*P ≤ 0.05 \*SE: Standard Error \* N.S: Not Significant

**Discussion**

Three groups of males were compared: groups with BMIs of <25 or >25 kg/m<sup>2</sup> and another group divided into overweight and obese groups according to the WHO classification.

All the parameters for overweight and obese males improved after the adoption of the healthy lifestyle for 4 weeks.

Most individuals are at risk to overweight and obesity because of unhealthy lifestyle changes, such as unhealthy meal choices, excessive snacking, lack of understanding of healthy food options, and low intake of vegetables and fruits. Other factors include increased use of electronic devices and lack of physical activity [19].

Young people, especially males, are more willing and motivated to lose weight to improve their social image and confidence.

Table 3 shows decreases in fat percentages, WC, and BMI in obese and overweight males relative to the results in Table 2. These decreases are caused by diet and exercise performed continuously over time and reliance on fat stored in adipose tissues to meet the body’s energy needs [20].

Physical activity decreased the risk of abdominal obesity, consistent with the results of a previous study [20], which reported that high physical activity decreased the risk of abdominal obesity (WC) by 61%.

Another study comparing obese individuals who regularly exercised and those who infrequently exercised showed decrease in visceral, adipose, and subcutaneous tissues [19].

Table 4.5 shows that leptin concentration is significantly higher in people who suffer from obesity and overweight than in normal-weight people. Overweight and obese

people show increased leptin levels, which result in leptin resistance, weight gain, and fat accumulation in the body. Leptin concentration considerable increases in some parts of the body [21].

High serum leptin concentrations have been linked to weight gain caused by the consumption of unhealthy food rich in calories. Under normal physiological conditions, leptin stops hunger by stimulating anorexigenic nerve cells and plays an important role in the regulation of sleep–wake cycle, immune processes, and sexual behavior and function [22].

Leptin is the protein encoded by fat cell–specific ob genes, playing an essential role in the regulation of body weight. This function is mainly accomplished by reducing food intake, inhibiting the secretion of neuropeptide Y, and increasing energy expenditure. In fact, serum leptin concentration increases in obese and overweight people and clinical conditions related to increased body fat, including adult GH deficiency, Cushing’s syndrome, and anorexia nervosa [23].

Meanwhile, GH plays a major role in the regulation of body composition through lipolysis and nitrogen sparing. This role was demonstrated in GH-deficient patients and obese individuals who received GH [24].

Tables 4 and 5 show low testosterone concentrations in overweight and obese males, consistent with the results of Fernández-García et al. [25].

Testosterone concentration is linked inversely to BMI level in males. In this study, testosterone concentrations decreased in overweight and obese males.

The correlation between androgen level and obesity in males and females are attributed to imbalance in metabolism ad sex hormones, variation in BMI, and variation in androgen concentration in individuals with infertility and endocrine disorders [26].

Obesity in the modern society is associated with factors that promote cortisol production, such as chronic stress, sleep deprivation, and consumption of food with a high glycemic indices [27].

The results of the present study showed significant increase in cortisol concentration in overweight and obese males with high BMI, fat percentage, and WC. These results are consistent with those of a pervious study [28], which showed that 10 kg/m<sup>2</sup> increase in BMI

might increase cortisol level 2.5-fold in subcutaneous adipose tissues.

Obesity in itself is a state of functional (relative) hypsomatotropism. In obesity, spontaneous and stimulated GH secretion decrease, whereas GH clearance increases, and weight loss induced by GH secretion is reversed [29]. Table 7 indicates similar results.

GH has a remarkable metabolic effect, and its secretion is greatly reduced in obese people [30]. However, hormonal concentration increased with decreasing body weight (Table 7).

Moreover, decreasing the frequency of meals to less than three times and having no snacks between main meals increase the risk of obesity. This effects may be attributed to the fact that the amount of calories consumed exceeds energy expenditure after starvation. Thus, the obesity and overweight are the direct results of this imbalance between energy consumption and the number of calories consumed. This finding is in agreement with that of a previous study [28].

## Conclusions

Healthy eating and daily physical activity are associated with low risk of obesity, and the risk of the overweight and obesity can be prevented through simple changes in behavior.

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## Conflict of Interest

The author declares that there is no conflict of interest

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## تأثير التغذية الصحية والنشاط البدني على الذكور الذين يعانون من زيادة الوزن والسمنة وعلاقته بمستويات بعض الهرمونات

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### الخلاصة:

هدفت الدراسة إلى مقارنة فعالية تدخلات نمط الحياة الصحي (النظام الغذائي الصحي وممارسة الرياضة) في تقليل خطر زيادة الوزن. كانت الدراسة عبارة عن تجربة خاضعة للرقابة أجريت من عام ٢٠٢٣ إلى ٢٠٢٤، حيث تم اختيار ثلاث مجموعات من الذكور (ذكور ذوي وزن طبيعي، وذكور يعانون من زيادة الوزن، وذكور يعانون من السمنة من النوع الأول). تم معرفة نمط حياتهم اليومي. تم تصميم نمط حياة صحي لهم لمنع مخاطر زيادة الوزن والاضطرابات الهرمونية المرتبطة بها. أجريت الدراسة في مستشفى الولادة والأطفال التعليمي في مدينة الرمادي / العراق. شملت الدراسة ٩٠ ذكرًا: ٦٠ ذكرًا بمؤشر كتلة الجسم أكثر من ٢٥، بينما ٣٠ ذكرًا بمؤشر كتلة الجسم أقل من ٢٥. تم تطبيق نمط الحياة الصحي على المشاركين الذين يعانون من زيادة الوزن والسمنة لمدة أربعة أسابيع. تم قياس القياسات الأنثروبومترية التي شملت مؤشر كتلة الجسم ومحيط الخصر ونسبة الدهون بواسطة صيغة خاصة. تم قياس تركيز اللبتين والتستوستيرون والكورتيزول وهرمون النمو في المصل لجميع الأفراد المشاركين في الدراسة. كان هناك زيادة كبيرة في مؤشر كتلة الجسم ومحيط الخصر ونسبة الدهون وتركيز هرمون الكورتيزول واللبتين، بينما كان هناك انخفاض كبير في تركيز هرمون التستوستيرون وهرمون النمو لدى الذكور الذين يعانون من زيادة الوزن والسمنة مقارنة بالذكور ذوي الوزن الطبيعي قبل تطبيق نمط الحياة الصحي. بينما كان هناك انخفاض في مؤشر كتلة الجسم والدهون ومحيط الخصر واللبتين وتركيز الكورتيزول وزيادة في تركيز هرمون التستوستيرون وهرمون النمو، كما زادت تركيزات هرمون النمو بعد ٦٠ دقيقة وبعد ٩٠ دقيقة من التحفيز بالكلونيدين (GH3) لدى الذكور الذين يعانون من زيادة الوزن والسمنة بشكل كبير مقارنة بنتائجهم قبل تطبيق نمط الحياة الصحي. كان التدخل المشترك بين الأكل الصحي والنشاط البدني قادرًا على الحد من زيادة الوزن وتحسين النتائج الهرمونية بشكل أكثر إيجابية. وبالتالي، فإن تغييرات نمط الحياة تعمل على تحسين الصحة العامة.

**الكلمات المفتاحية:** نمط حياة صحي؛ اللبتين؛ الكورتيزول؛ التستوستيرون؛ هرمون النمو؛ الصحة العامة.