

Effect of Two Types of Diet on Cholecystokinin (CCK) Level in Three Groups of Males



Nour Shakir Rezaieg

General Directorate of Education in Anbar, Gifted Guardianship Committee, Ministry of Education in Iraq, Anbar, Iraq

ARTICLE INFO

Received: 9 / 9 / 2021
Accepted: 18 / 11 / 2021
Available online: 21 / 12 / 2021

DOI: 10.37652/juaps.2022.172446

Keywords:

CCK,
Healthy diet,
Unrestricted diet,
Males.

Copyright©Authors, 2021, College of Sciences, University of Anbar. This is an open-access article under the CC BY 4.0 license (<http://creativecommons.org/licenses/by/4.0/>).



ABSTRACT

In response to a meal, the signals of satiety suppress the signals of hunger (meaning to finish the meal). These signals originate in the pancreas and gastrointestinal tract, transmitting information from the periphery to the brain (by the vagus nerve or the circulation). The study aimed to estimate whether the serum level of Cholecystokinin (CCK) in three male groups is influenced by their type of food. The current study included Sixty volunteers of adult males (normal-weight group $n=20$, overweight group $n=20$, and obese I group $n=20$) (21- 24 years). The blood samples were taken from subjects in the afternoon after (30 minutes–2 hours) from lunch was consumed, during March 2021 till June 2021. ELIZA kit was used to assay the serum concentration of the Cholecystokinin hormone. The anthropometric measurements were done, such as body weight and height, to calculate body mass index (BMI) by special formula, and the subjects were assorted depending on WHO body mass index (BMI) classification. Cholecystokinin showed a significant decrease ($p<0.05$) in obese I (311.201 ± 21.542) and overweight (353.494 ± 43.915) as compared with the normal weight group (646.002 ± 46.344). A significant negative correlation was noticed between the hormone and body weight. Eating palatable food leads to uncontrolled ingesting behaviors due to the shift from homeostatic to hedonic regulatory mechanisms of food intake. These changes occur primarily in individuals with obesity and thus lead to an irregularity in the secretion of anorexigenic hormones.

1. Introduction

Obesity is caused by an excess of calorie intake in comparison to energy expenditure, not only that, but it can happen for some reasons including a high-calorie diet, a lack of physical activity, socioeconomic position, and genetic changes [1]. Obesity leads to an increase in associated diseases such as cardiovascular disease, type2 diabetes, numerous tumors, and psychiatric disorders. In this regard, a bidirectional communication system known as the gut brain axis plays an important role [2]. The Gut-brain axis is two-way communication between the gastrointestinal tract (GIT) and the central neurological system (CNS). Based on peptides expressed peripherally and/or centrally, both systems constantly share information about nutrient intake [3].

The gastrointestinal tract (GIT) is considered a main sensory organ, which reacts to a variety of stimuli, including mechanical, nutritional, microbiota metabolites, pathogens, and toxins, and orchestrates a response that is important in order to maintain body homeostasis [4]. Following a meal, nutrients are transport from the stomach into the duodenum and jejunum leads to produce chemical and mechanical stimuli that the body can discover them. Enteroendocrine cells (EECs), which are specialized chemosensory cells that line the intestinal epithelium, are among the first sentinels to detect the presence of nutrients [5].

The hypothalamus and the brainstem are central structures in the central nervous system that regulate food intake. The vagus nerve, which connects the gut to the hindbrain, plays an important role in the gut brain and brain-gut relationship [6]. Cholecystokinin (CCK), Glucagon-like peptide (GLP-1), and Peptide YY (PYY) are food intake-regulating hormones that stimulate vagal afferent fibers that express respective receptors and project to the nucleus of the solitary tract (NTS), whence these signals are conveyed to the hypothalamus [7]. In

*Corresponding author at: General Directorate of Education in Anbar, Gifted Guardianship Committee, Ministry of Education in Iraq, Anbar, Iraq Tel.:+964 7806682292;E-mail address: nourshakir123@gmail.com

hypothalamus, each of paraventricular nucleus (PVN) and arcuate nucleus (ARC) are important for energy balance. When it comes to the motor and secretory activity, the stomach has a circadian rhythm that can lead to obesity if it is disrupted [8].

Food high in fat and sugar enhances food intake, indicating that the activity and expression of appetite-controlling signals will be balanced in favor of longer eating, activating the reward system and therefore influencing ingestive behavior. The behavior resulted via activating the reward system is to “get back for more” [9]. As a result, easy access to delicious food may lead to overeating, which is characterized via meal prolonging due to the overriding of the usually generated sensation of satiety, resulting in a gradual shift in the set point for energy balance and body weight. In the case of a healthy diet, reaching satiety is in an organized manner [10]. Figure 1 shows the effects of healthy and unhealthy diets on the expression of satiety peptides and brain response.

Cholecystokinin (CCK) is a peptide that reduces food intake. It is produced by intestinal cells in response to nutrient intake, particularly long-chain fatty acids reaching the duodenum and jejunum [11]. CCK release stimulates various parts of the CNS, including the brainstem, pons, hypothalamus, and motor cortex, causing the inhibition of food intake to be blocked [12].

There are no local studies that address the influence of food type on anorexigenic hormones in some individuals with gaining weight, to our knowledge, so this study was conducted. The goal of this study was to investigate how the type of diet affected the level of CCK hormone.

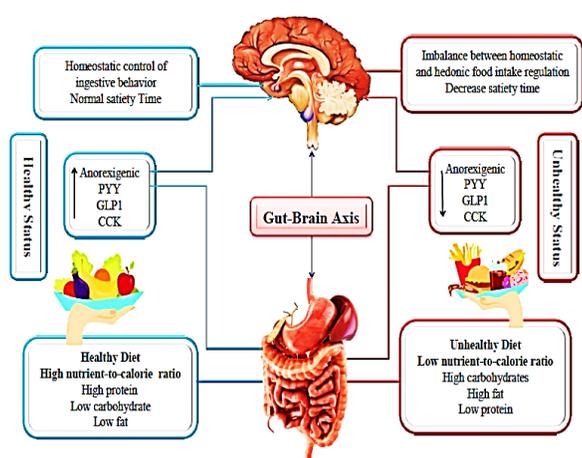


Fig 1: Proposed schematic diagram that connects the gut hormones changes. Left: Healthy diet leads to changes in hormone levels that lead to central nervous system response to inhibit eating. Right: Unrestricted Diet leads to changes in hormone levels leads to central nervous system response to more eating. Arrows show the respective change (↑ increase, ↓ decrease) (Designed by me).

1. Methods and Procedures

2.1. Participants

The study was conducted in Anbar governorate, Iraq at Maternity and Children Teaching Hospital in Ramadi city, from March 2021 to June 2021. Study samples included 60 adults’ males who were close to the ages from 21 - 24 years. Subjects in this study were classified according to BMI as (normal-weight group n=20, overweight group n=20 and obese I group n=20). The males participating in the study did not have any gastrointestinal disease or symptoms or any other illnesses, or take any medication known to affect gastrointestinal motility or appetite.

2.2. Data Collection

The cross-sectional comparative study used data collected via a questionnaire including: age, length, weight, dietary, and lifestyle practices. Participants mentioned a diet diary through 21 before the study day to ascertain that their habitual energy and fat intake had not changed.

2.3. Protocol

On the day of the study, each group of subjects was given a different meal with different calories, and with different percentages of fat, carbohydrates and protein. Lunch meal is designed to match the meal each person in the three groups eats like a daily basis.

The first group was given a healthy lunch meal. At the same time, the second and third groups were given an unrestricted lunch meal. A detailed description of the two menus is given in Tables 1 and 2.

Each meal was consumed under medical supervision. Each person had consumed their meal at 1:00 pm. After 30 to 90 minutes of meal intake, blood samples were collected from each subject to measure serum CCK level.

Table 1: Nutrition facts of healthy lunch meal for normal-weight men.

Low-fat meal	Proteins (g)	Fat (g)	Carbohydrates (g)	Energy (kcal)
Raw Low Fat Beef)150g(35.7	10.5	0	228
Olive oil 7 g	-	6.99	-	63
Medium slice of brown bread (15g)	4	1.00	14	70
Salad (200g) (Tomato+ Lettuce)	1.2	0.2	5.1	23
A cup of coffee	0.3	-	-	1
Total	41.2	18.69	19.1	385

Table 2: Nutrition facts of unrestricted lunch meal for overweight and obese class I men.

High-fat meal	Proteins (g)	Fat(g)	Carbohydrates (g)	Energy (kcal)
Raw High Fat Beef)200g(34.0	39.0	0	508
Ghee 15 g	-	14.00	-	130
French fries (70g)	2.44	9.84	24.96	192
2 Medium slice of white bread (28g)	4	2	30	140
Coca-Cola (470ml)	-	-	52	187
Slice Chocolate cake(100g)	5	15	53	371
Total Energy (kcal)	45.44	79	159.96	1.528

3.Methods

3.1.Measurement of BMI

The body weight of each individual dressed in light clothing without shoes using a carefully calibrated electrical balance, the height of each individual was measured using vertical measuring rod. BMI was calculated as weight (kg) divided by squared height (m²). The BMI was estimated with below formula, according to the World Health Organization classification (Table 2).

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

Table 3: WHO body mass index (BMI) Classification [13].

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

3.2. Determination of CCK hormone

The samples were collected and allowed to coagulate for serum separation using a centrifuge (4000 rpm) for 5 minutes. The sera were stored at -20°C until the assay was done. Cholecystikinin (CCK) level was measured by Enzyme Linked Immune Sorbent Assay kit of (Phoenix Pharmaceuticals, Belmont, CA) (intra-assay coefficient of variation <5% and interassay coefficient of variation <15%). The standard curve of CCK determination is shown in Figure 2:

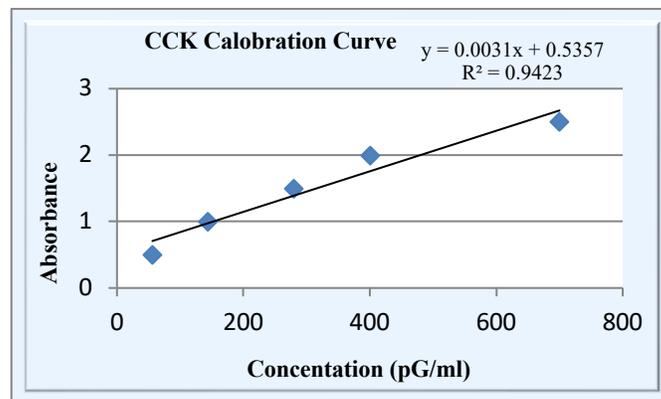


Fig 2: Representation Standard curve of CCK hormone.

3.3.Data Analysis

The data was analyzed using SPSS (version 18.0), and the results were presented as mean ± SD. A t-test and a nova were used to estimate statistical parameters for differences between the subjects tested. $p < 0.05$

4.Results

The results in Table 4 shows that there was no significant difference in age between normal-weight, overweight and obese groups. While BMI in the overweight and obese I group was significantly higher in comparison with the normal weight group. While BMI in obese I group was significantly higher than the overweight group.

Table 4: Mean and SD of BMI and Age in all study group.

Parameters	First Group (Normal Weight)		Second Group (Over Weight)		Third Group (Obesity class I)	
	Mean	S.D	Mean	S.D	Mean	S.D
BMI kg/m2	24.07	3.56	28.10	2.97	31.56	3.49
Age	22.13	8.13	23.34	1.63	21.45	2.20

The results in Table 5 show that the CCK level was significantly lower in both the overweight and obese I group; respectively, compared to the normal weight group.

Table 5: Mean and SD of CCK hormone in all study group.

Parameter	Group	N	Mean ± S.D	95% confidence interval for mean		Sig. Value
				Lower bound	Upper bound	
CCK (PG/ml)	First Group	30	646.002 ± 46.344	631.912	660.092	.000**
	Second Group	30	353.494 ± 43.915	340.142	366.845	
	Third Group	30	311.201 ± 21.542	241.720	354.871	

* $p < 0.05$

5. Discussion

The current study has evaluated the effects of unrestricted diet on the CCK levels in overweight and obese I men compared with the effects of a healthy diet on CCK levels in normal-weight men. Consumption of an unrestricted diet (high calories diet) was associated with a decreased concentration of CCK, suggesting that exposure to this diet changes CCK secretion. Also, CCK signaling is blunted under obese conditions, possibly due to reduced excitability of the vagus nerve [14].

Overweight and obesity were associated with increased calories with participants in this study. This agrees with a study in Europe that found that the diet characterized by irregular calorie consumption is associated with weight gain [15].

The current study results agree with the study by Lasschuijt and his colleagues have reported that overweight and obese men show an attenuated CCK response to unrestricted intake meals compared with normal-weight men [16].

Taste-signaling mechanisms specified in the oral cavity have an important role in detecting the taste; stimulation of taste receptors triggers regulatory circuits, which are essential in controlling eating behavior and regulating energy homeostasis [17].

In the gut, nutrient detection is controlled mainly by enteroendocrine cells; upon sensing nutrients, a cascade of physiological phenomena is activated, including secretion of CCK for inhibition of gastric emptying and reduction in food intake, as shown in the results of the current study, but with different levels of CCK hormone depending on the type of meal [18] [19].

Food is an essential component for living a long and healthy life. The human need for food stems from the requirement to provide the body with the energy it requires to perform important functions such as heartbeat, breathing, digestion, and so on [20]. Obesity and many disorders connected with it, such as heart disease and cancer, are caused by an excessive increase in calories consumed by the person [21].

In the current study, men with a high BMI reported their cravings to eat large amounts of calorie-rich, unrestricted foods, as shown in Table 2, because of the greater responsiveness of brain reward regions [22] [23].

Very appealing foods are more appreciated, preferred, and found to be more flavorful. Foods high in sugar and sweet flavor, highly processed foods high in saturated fats or high carbohydrate forming savory tastes, and combinations of food categories cooked in ways that improve the taste and value of such foods are examples of these [24].

As indicated in their lunch meal, as shown in Table 1, the first set of our study (Normal-weight men) participants were concerned about reducing energy intake by adopting healthy lifestyles and avoiding foods high in sugar, salt, or fat to prevent obesity and other diseases. These results are in agreement with a study by Mohammadbeigi and his team [25]. Unrestricted food has an effect on regular appetite regulation, which means it decreases the response to fullness signals and

activates the reward system. This explains the rising obesity problem [26] [27].

6. Conclusion

We conclude that the ingestion of the healthy meal lead to stimulation of gut hormone release CCK have a decelerating effect on gastric emptying, conversely, when ingestion of unrestricted meal.

7. Limitations

In this study, we studied effects of type of diet on CCK levels in three groups. In future studies, the type of food should be more specific and number of samples more.

8. References

- [1] L. D. Ruiz, M. L. Zuelch, S. M. Dimitratos, and R. E. Scherr. (2020) "Adolescent obesity: Diet quality, psychosocial health, and cardiometabolic risk factors," *Nutrients*.
- [2] Ş. Akkartal and C. Gezer, "Is Nutrition Knowledge Related to Diet Quality and Obesity. (2020)" *Ecol. Food Nutr.*
- [3] S. Mörkl, M. I. Butler, A. Holl, J. F. Cryan, and T. G. Dinan. (2020) "Probiotics and the Microbiota-Gut-Brain Axis: Focus on Psychiatry," *Current Nutrition Reports*.
- [4] E. M. Flores, A. T. Nguyen, M. A. Odem, G. T. Eisenhoffer, and A. M. Krachler. (2020) "The zebrafish as a model for gastrointestinal tract-microbe interactions," *Cellular Microbiology*.
- [5] Y. Yu, W. Yang, Y. Li, and Y. Cong. (2020) "Enteroendocrine Cells: Sensing Gut Microbiota and Regulating Inflammatory Bowel Diseases," *Inflamm. Bowel Dis.*
- [6] T. M. Le *et al.* (2020) "The interrelationship of body mass index with gray matter volume and resting-state functional connectivity of the hypothalamus," *Int. J. Obes.*
- [7] E. S. Bliss and E. Whiteside, "The gut-brain axis, the human gut microbiota and their integration in the development of obesity. (2018)" *Frontiers in Physiology*.
- [8] S. Yousefvand and F. Hamidi. (2020) "Role of Paraventricular Nucleus in Regulation of Feeding Behaviour and the Design of Intranuclear Neuronal Pathway Communications," *International Journal of Peptide Research and Therapeutics*.
- [9] J. R. Dalenberg *et al.* (2020) "Short-Term Consumption of Sucralose with, but Not without, Carbohydrate Impairs Neural and Metabolic Sensitivity to Sugar in Humans," *Cell Metab.*
- [10] A. N. Gearhardt and J. Hebebrand. (2021) "The concept of 'food addiction' helps inform the understanding of overeating and obesity: Debate Consensus," *American Journal of Clinical Nutrition*.
- [11] J. A. Williams. (2019) "Cholecystokinin (CCK) regulation of pancreatic acinar cells: Physiological actions and signal transduction mechanisms," *Compr.*

- Physiol.*
- [12] P. D. Whissell *et al.* (2019) "Selective activation of cholecystokinin-expressing GABA (CCK-GABA) neurons enhances memory and cognition," *eNeuro*.
- [13] Q. Yang *et al.* (2018) "Living High-Training Low improved weight loss and glucagon-like peptide-1 level in a 4-week weight loss program in adolescents with obesity," *Med. (United States)*.
- [14] E. Tsuda *et al.* (2021) "Content knowledge acquisition in physical education: Evidence from knowing and performing by majors and Nonmajors," *J. Teach. Phys. Educ.*
- [15] A. Astrup. (2018) "Personalized dietary management of obesity based on simple biomarkers," *Obes. Facts*.
- [16] M. P. Lasschuijt, K. de Graaf, and M. Mars. (2021) "Effects of oro-sensory exposure on satiation and underlying neurophysiological mechanisms—what do we know so far," *Nutrients*.
- [17] E. T. Rolls (2020) "The texture and taste of food in the brain," *Journal of Texture Studies*.
- [18] T. Banerjee, V. Chattaraman, H. Zou, and G. Deshpande (2020) "A neurobehavioral study on the efficacy of price interventions in promoting healthy food choices among low socioeconomic families," *Sci. Rep.*
- [19] N. V. Di Patrizio. (2021) "Endocannabinoids and the gut-brain control of food intake and obesity," *Nutrients*.
- [20] L. M. Mongioi *et al.* (2020) "Effectiveness of a very low calorie ketogenic diet on testicular function in overweight/obese men," *Nutrients*.
- [21] E. Carbonneau *et al.* (2021) "Liking for foods high in salt and fat is associated with a lower diet quality but liking for foods high in sugar is not – Results from the PREDISE study," *Food Qual. Prefer.*
- [22] W. L. Yap, C. M. Ng, and S. Kaur (2019) "Poor Diet Quality among Overweight/Obese (OW/OB) young adults in Klang valley, Malaysia: A case-control study," *Pertanika J. Soc. Sci. Humanit.*
- [23] L. S. Chow *et al.* (2020) "Time-Restricted Eating Effects on Body Composition and Metabolic Measures in Humans who are Overweight: A Feasibility Study," *Obesity*.
- [24] J. Ueda, C. Spence, and K. Okajima. (2020) "Effects of varying the standard deviation of the luminance on the appearance of food, flavour expectations, and taste/flavour perception," *Sci. Rep.*
- [25] A. Mohammadbeigi *et al.* (2018) "Fast food consumption and overweight/obesity prevalence in students and its association with general and abdominal obesity," *J. Prev. Med. Hyg.*
- [26] H. Ao, J. Li, O. Li, M. Su, and X. Gao (2020) "Fructose vs glucose decreased liking/wanting and subsequent intake of high-energy foods in young women," *Nutr. Res.*
- [27] D. Handayani *et al.* (2020) "Plasma Glucagon-Like Peptide-1 and Cholecystokinin Responses to Fast Food in Healthy-Weight and Obese Men," *J. Kedok. Brawijaya*.

تأثير نوعين من النظام الغذائي على مستوى الكوليبيستوكينين (CCK) في ثلاث مجموعات من الذكور

نور شاكر رزيح

المديرية العامة للتربية في الانبار، هيئة رعاية الموهوبين، وزارة التربية والتعليم في العراق، الانبار، العراق

nourshakir123@gmail.com

الخلاصة:

استجابةً للوجبة، تقوم إشارات الشبع بقمع إشارات الجوع (بمعنى إنهاء الوجبة)، وتنشأ هذه الإشارات في البنكرياس والجهاز الهضمي، ثم تنتقل هذه المعلومات من المحيط إلى الدماغ (عن طريق العصب المبهم أو الدورة الدموية). هدفت الدراسة إلى تقدير ما إذا كان مستوى مصل دم الكوليبيستوكينين (CCK) في ثلاث مجموعات من الذكور البالغين يتأثر بنوع طعامهم. شملت الدراسة الحالية ستين ذكراً بالغاً مقسمين بالتساوي على ثلاثة مجموعات (مجموعة الوزن الطبيعي 20، مجموعة الوزن الزائد 20 ومجموعة الأشخاص المصابين بالسمنة 20) تتراوح أعمارهم ما بين (21 إلى 24 سنة). وقد تم أخذ عينات الدم من الأشخاص في فترة ما بعد الظهر بعد تناول وجبة الغداء لفترة من (30 دقيقة إلى ساعتان)، من مارس 2021 إلى يونيو 2021. وقد استخدمت مجموعة ELIZA لفحص تركيز هرمون الكوليبيستوكينين في الدم، وتم اخذ قياسات الجسم البشري مثل؛ وزن الجسم والطول لحساب مؤشر كتلة الجسم وتم تصنيف الذكور اعتماداً على مؤشر كتلة الجسم لمنظمة الصحة العالمية. أظهر كوليبيستوكينين انخفاضاً معنوياً ($p > 0.05$) في مجموعة السمنة (21.542 ± 311.201) وزيادة الوزن (43.915 ± 353.494) مقارنة بمجموعة الوزن الطبيعي (46.344 ± 646.002)، كما لوحظ وجود علاقة سلبية معنوية بين هرمون الكوليبيستوكينين مع وزن الجسم. يؤدي تناول الطعام المستساغ إلى سلوكيات ابتلاع غير منضبطة، وذلك بسبب التحول من آليات التنظيم المتوازنة إلى اللذة في تناول الطعام. تحدث هذه التغييرات في المقام الأول لدى الأفراد المصابين بالسمنة، وبالتالي تؤدي إلى عدم انتظام في إفراز هرمونات فقدان الشهية.