

Relationship between Obesity and Hypercholesterolemia

Salwa Muftah Eljamay

Corresponding author: Salwa Muftah Eljamay, Department of public Health,
Faculty of Medical Technology, Derna City , Libya

Abstract

The aim of this study was to evaluate the association between serum cholesterol level and body Obesity in Derna City, and to investigate the trend of the prevalence of obesity in Derna and its relationship with hypercholesterolemia. The study was a cross-sectional study carried out on the 66 (40 males and 26 females) weight between 65 – 135 kg, which were selected using multistage cluster sampling method. Plasma cholesterol was measured in the morning after a 12-hour fasting and was determined by auto-analyzer. Hypercholesterolemia (HC) was defined by a total plasma cholesterol level over 200 mg/dl. That the percent of males was 40(60.6%), and the percent of female was 26(39.4%), Ranges weights of the people who took them samples were, from 55kg to 135 kg, the percent of less weight was (7.6%) . The weights that were above normal weight rate was from 86kg to 135kg by (28.79%), The percent of cholesterol levels ranged between 90mg\dl to 350mg\dl, The percentage of people who increased their cholesterol were 7(10.6%), the percent and the type of Nutrition, that was, fat, vegetable, fruits, and carbohydrate. The highest proportion of fat by 31(47.0 %), and less percentage of fruit by,8 (12.1%), The rate of Heart disease in the people and there percent were, 13 (19.7 %), the people did not have heart disease were 53(80.3%), and the proportion of smokers from non-smokers were, smokers 17(25.8 %), non smoking 49(74.2 %). I note that the Mean and Std. deviation of the weight was 3.0 (Std, 1.478), and the quality of nutrition was 2.11(Std .1.229), smoking was1.74, (Std. 0.441), and heart disease1.80 (Std.0, 401).

Keywords: Cholesterol, Obesity, Hypercholesterolemia, Nutrition, Carbohydrate.

INTRODUCTION

Hypercholesterolemia, or high cholesterol, occurs when there is too much cholesterol in the body. Cholesterol is a soft, waxy, fat-like substance that is a natural component of all the cells of the body. Your body makes all the cholesterol it needs. Any added cholesterol, which comes from the foods you

eat, can cause harm. High cholesterol raises your risk for heart disease, heart attack, and stroke. When there is too much cholesterol circulating in the blood, it can create sticky deposits (called plaque) along the artery walls.

Plaque can eventually narrow or block the flow of blood to the brain, heart, and other organs. Blood cells that get caught on the plaque form clots, which can break loose and completely block blood flow through an artery, causing heart attack or stroke.⁽³⁶⁾

The normal range for total blood cholesterol is between 140 and 200 mg per decilitre (mg/dL) of blood (usually just expressed as a number). However, the total number doesn't tell the whole story: There are two types of cholesterol -- HDL (high density lipoproteins, or "good" cholesterol) and LDL (low density lipoproteins, or "bad" cholesterol). The amount of HDL relative to LDL is considered a more important indicator of your heart disease risk. There is a third kind of fatty material called triglycerides found in the blood. They also play a role (generally as triglyceride levels rise, "good" HDL cholesterol falls). In fact, there is a subset of physicians who believe that triglycerides are the only fats in the body that increase heart disease risk. When you have high cholesterol, it usually means you have high levels of LDL cholesterol, normal or low levels of HDL cholesterol, and normal or high levels of triglycerides. While heredity may be a factor for some people, the main culprits are lack of exercise and diets high in saturated fat. High cholesterol can be prevented, sometimes with lifestyle changes (diet and exercise) alone. If these do not work, your doctor may recommend medications to lower your cholesterol levels.⁽³⁶⁾ There usually are not any symptoms of high cholesterol, especially in early stages. The only way to tell if your cholesterol is high is through a blood test.⁽³⁶⁾ In some cases, high cholesterol levels may be inherited -- your liver may make too much cholesterol, or your body may not remove LDL from your blood as efficiently as normal. High cholesterol and elevated triglycerides can also be associated with other diseases, such as diabetes. But most often high cholesterol is caused by eating foods high in saturated fat and not getting enough exercise. High cholesterol is more common in people who are overweight or obese, a condition that affects almost half of U.S. adults.⁽³⁶⁾

Obesity is described by the world health organization (WHO) as: disease in which excess body fat has accumulated to such an extent that health may be adversely affected.⁽²⁾ WHO also says: obesity is a complex condition, one- with serious social and psychological dimensions, that affects virtually all age and socioeconomic groups and threatens to overwhelm both developed and developed countries.^{(3) (17)} This study aimed to to evaluate the association between serum cholesterol level and body Obesity in Derna City, and to investigate the trend of the prevalence of obesity in Derna and its relationship with hypercholesterolemia.

Material and Methods

The research was a cross-sectional study carried out on the 66 (40 males and 26 females) weight between 65 – 135 kg, our study by our data which collected from different area in Derna City, the time of sample collection was in July 2012 to may 2013, that were selected using multistage cluster sampling method.

Plasma cholesterol was measured in the morning after a 12-hour fasting and was determined by auto-analyzer. Hypercholesterolemia (HC) was determined by a total plasma cholesterol level over 200 mg/dl. *In this study, we use the following diagnostic kits: LDL CHOLESTEROL Liquicolor, Human csellachaft fur Biochemica und Diagnostica mbH (Max-Planck-ring 21 . 65205 wiesbaden. Germany). The assay combines two steps :in the 1st step chylomicrons, VLDL and HDL cholesterol are specifically removed by enzymatic reactions.*

In the 2nd step remaining LDL- cholesterol is determined by well established enzymatic reactions , also employing specific surfactants for LDL.

HDL-CHOL

HDL-CHOLESTOL PRECIPITATION REAGENT

Analyticon Biotechnologies AG

Am Mnhlenberg 10,35104 Lichtenfels/ Germany.

Test principle

The chylomicrons ,VLDL(very low density lipoproteins) and LDL(low density lipoproteins)are precipitated by addition phosphotungstec acid and magnesium chloride.After centrifugation thhe supernatant fluid containsthe HDL(High density lipoproteins) –fraction, their cholesterol content is determined enzymatically.

Specimen:

Serum was collected using standard sampling tubes serum, heparin- or EDTA-plasma without use citrat-, oxalate-or fluid stability. The samples were kept for 7 days at +2 c- +8c 3 months at- 20c. Fasting and non fasting samples can be used. EDTAplasma causes decreases results. Samples containing precipitate were centrifuged before performing the assay

Preparation and stability:

- Precipitant for macro assays. Use contents undiluted.
- Precipitant for semi macro assays:
- Dilute 4 parts precipitating reagent with 1 parts of redistilled water(e.g. 80ml+20ml)

The HDL reagent is stable up to the expiry date when stored at +15 to +25°.

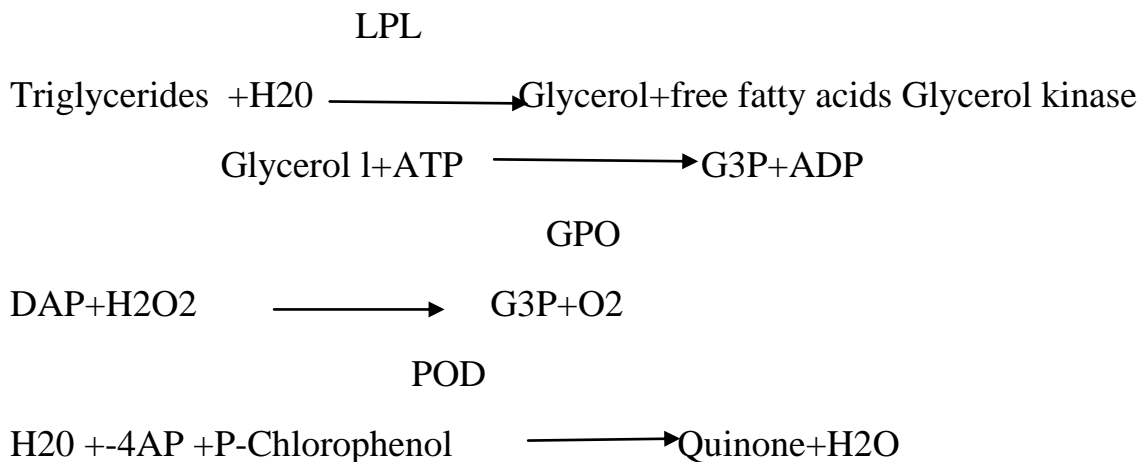
3.3 Triglycerides

GPO-POD. Enzymatic colorimetric

We use kit of SPINERACT, S.A.U. Ctra .Santa Coloma, 7E-17176 SANT ESTEVE DE BAS (GI) SPAIN.

Principle of the method

Sample triglycerides incubated with action -3-phosphate (G3P) is then converted by glycerol phosphate dehydrogenase (GPO) to dihydroxyacetone phosphate (DAP) and hydrogen peroxide (H₂O₂) in the last reaction, hydrogen peroxide (H₂O₂) react with 4-aminophenazone (4-AP) and P-chlorophenol in presence of peroxidase (POD) to give a red colored dye.



The intensity of the color formed is proportional to the triglycerides concentration in the sample.

Statistical analysis

A computer program was used for data analysis. SPSS version 18 was used and the descriptive data was given as a mean ± standard deviation (SD).

Results

Data were collected from different area in Derna City, the period of sample collection was in July 2012 to may 2013, and the total numbers of persons were 66 persons (40 males and 26 females). The percent of males was (60.6%), and the percent of female was (39.4%) as shown in table (1), graph (1).

Table: (1) percent male and female

	Frequency	Percent%
Valid male	40	60.6
female	26	39.4
Total	66	100.0

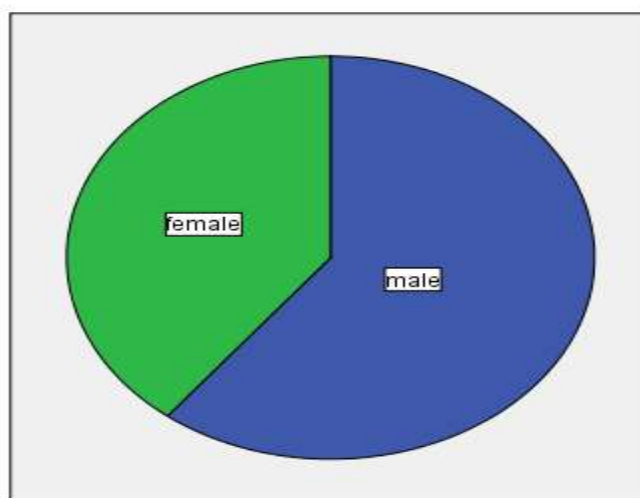


Figure: (1) percent males and females.

The weights of the cases used in this work arranged from 55kg to 135 k. The percent of less weight was (7.6%),as shown in Table (2). While, the weights that are above normal weight varied from 86 to 135 kg (28.79%), as shown in Table (3) and Graph (2).

Table (2) : Frequency and Percentage of Cases Weight

Weight	Frequency	Percent %
Valid 55-65	5	7.6
66-75	27	40.9
76-85	15	22.7
86-95	8	12.1
96-105	7	10.6
106-115	2	3.0
116-125	1	1.5
126-135	1	1.5
Total	66	100.0

Table (3) : the percent of over Wright

Weight	Frequency	Percent %
86-95	8	28.79
96-105	7	
106-115	2	
116-125	1	
126-135	1	
Total	19	

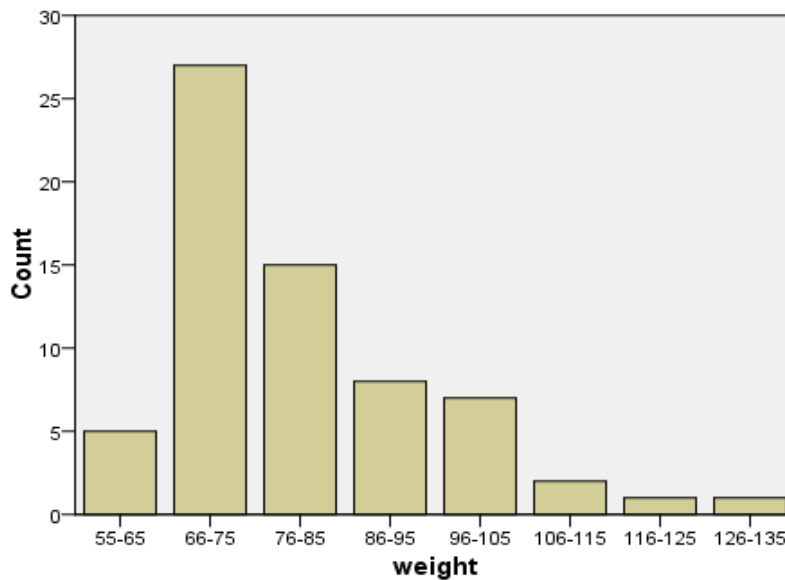


Figure (2) : Ranges Weights of the Cases and their Percentage.

The percent of cholesterol levels ranged between 90mg\dl to 350mg\dl, as shown in table (4), and graph (8).

Table (4) : The percent of cholesterol levels

Cholesterol mg\dl	Frequency	Percent %
Valid <100	21	31.8
100-150	30	45.5
156-200	8	12.1
206-250	3	4.5
256-300	4	6.1
Total	66	100.0

The percentage of people who increased their cholesterol were 7 (10.6%) as shown in Table (5).

Table (5) : The percentage of People with High Cholesterol

Cholesterol mg\dl	Count	Percent %
206-250	3	10 .6
256-300	4	
Total	7	
Total	66	100.0%

Table (6), showed the percent and the type of nutrition including, fat, vegetable, fruits, and carbohydrate. The highest proportion was fat 31(47.0 %) , and lowest percentage was fruit 8 (12.1%), as shown in figure (3).

Table (6): Percentage and Type of Nutrition

Type of Nutrition	Frequency	Percent %
Valid fat	31	47.0
vegetable	12	18.2
fruits	8	12.1
carbohydrates	15	22.7
Total	66	100.0

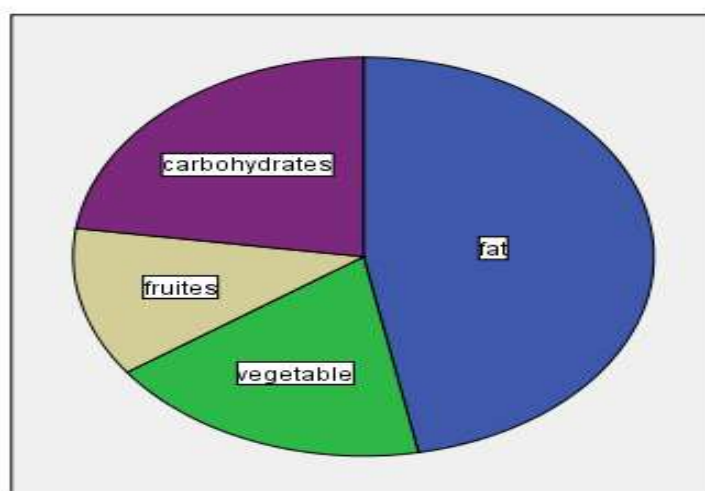


Figure (3): Percentage and Type of Nutrition.

The rate and percentage of heart disease were, 13 (19.7 %), while the rate and percentage of people who did not have heart disease were 53(80.3%) as shown in table (7) and graph (4).

Table (7): The rate of Heart disease.

	Frequency	Percent %
Valid yes heart disease	13	19.7
No heart disease	53	80.3
Total	66	100.0

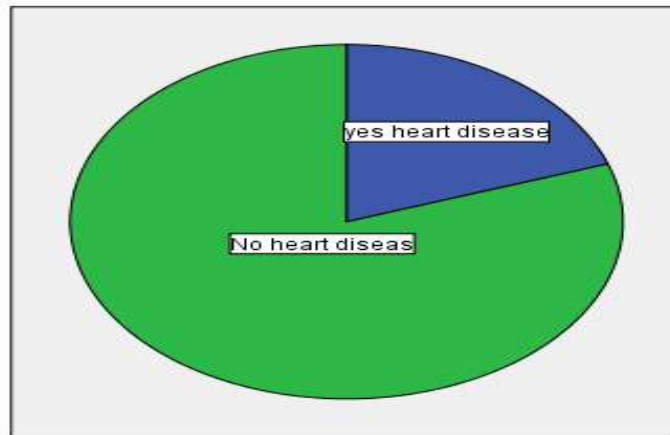


Figure (4) : The rate of Heart disease

And the proportion of smokers from non-smokers were, smokers 17(25.8 %), non smokers 49(74.2 %), as shown in table (8), and figure (5).

Table (8) : The proportion of smokers from non-smokers

	Frequency	Percent
Valid yes smoking	17	25.8
Not smoking	49	74.2
Total	66	100.0

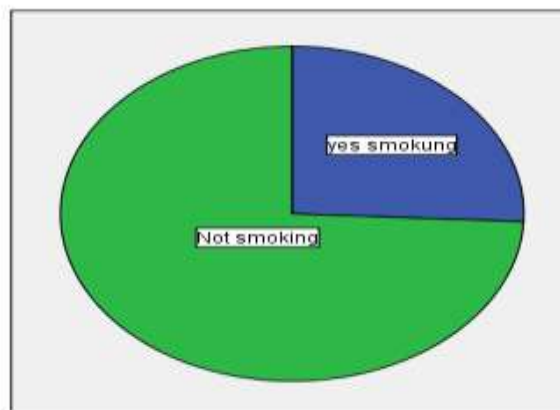


Figure (5) : The percentage of Smokers and Non-Smokers

Relationship between Obesity and Hypercholesterolemia

We note that the Mean and Std. deviation of the weight was 3.0 (Std, 1.478) , and the quality of nutrition was 2.11(Std .1.229), smoking was 1.74, (Std. 0.441), and heart disease 1.80(Std.0,401), as shown in table (9).

Table (9) : The Mean and Std. Deviation of the Weight, Quality of Nutrition, Smoking, and Heart Disease

	No	Mean	Std. Deviation
weight	66	3.00	1.478
Heart disease history	66	1.80	.401
Nutrition type	66	2.11	1.229
Smoking	66	1.74	.441

Discussion

This study finding indicates that samples collected from different areas in Derna City, the period of sample collection was in July 2012 to may 2013, and the total number of persons were 66 person. That the percent of males was 40(60.6%), and the percent of female was 26(39.4%), ranges weights of the people who took them samples were, from 55kg to 135 kg, the percent of less weight was (7.6%) . weights that are above normal weight rate were from 86kg to 135kg by (28.79%), The percent of cholesterol levels ranged between 90 mg\dl to 350mg\dl, The percentage of people who increased their cholesterol were 7(10.6%), the percent and the type of Nutrition, that was, fat, vegetable, fruits, and carbohydrate. The highest proportion of fat by 31(47.0 %) , and less percentage of fruit by,8 (12.1%).

The rate of heart disease in the people and there percent were, 13 (19.7 %),the people didn't have heart disease were 53(80.3%), and the proportion of smokers from non-smokers were, smokers 17(25.8 %), non smoking 49(74.2 %). We note that the Mean and Std. deviation of the weight was 3.0 (Std, 1.478), and the quality of nutrition was 2.11(Std .1.229), smoking was 1.74, (Std. 0.441), and heart disease 1.80 (Std.0, 401).

From all of this data shows that the type of nutrition is the most important factor in increasing the proportion of cholesterol, followed by smoking, family genetic history of the person.

According to the study of "Obesity and dyslipidemia" by Repas T, researchers wrote in abstract that Dyslipidemia is frequently found in association with obesity.⁽³⁷⁾ Obesity-related dyslipidemia is characterized by elevated triglycerides, elevated VLDL, increased apo-B, decreased HDL cholesterol and increased small dense LDL particles. This combination of lipid abnormalities is particularly atherogenic and, along with related comorbidities, explains the increased cardiovascular risk seen in obesity. Weight loss, through diet, medication and/or surgery all result in beneficial effects upon serum lipids.

Dietary modification and lifestyle change are essential components in the management of obesity-related dyslipidemia. Many patients, however, require pharmacotherapy to achieve lipid goals”⁽³⁷⁾ Another previous study “Prevalences of overweight, obesity, hyperglycemia, hypertension and dyslipidaemia in the Gulf: systematic review” by Alhyas L, McKay A, Balasanthiran A, Majeed A found that there are high prevalences of risk factors for diabetes and diabetic complications in the GCC region, indicative that their current management is suboptimal. Enhanced management will be critical if escalation of diabetes-related problems is to be averted as industrialization, urbanization and changing population demographics continue.⁽³⁷⁾

In the abstract of “The relative risks of hyperglycemia, obesity and dyslipidaemia in the relatives of patients with Type II diabetes mellitus” by Shaw JT, Purdie DM, Neil HA, Levy JC, Turner RC, researchers found that the relatives were significantly more obese, had higher fasting plasma insulin concentrations and had lower HDL-cholesterol concentrations.⁽³⁷⁾

In conclusion, there is a strong familial aggregation of hyperglycemia and obesity in the relatives of subjects with Type II diabetes and these subjects have higher fasting plasma insulin concentrations and lower HDL-cholesterol than the general population. These data indicate the particular relevance of screening the first degree relatives of subjects with Type II diabetes, as intervention strategies which aim to improve the metabolic profile are indicated for a large proportion of these subjects.⁽³⁷⁾ While, in the abstract of Obesity and risk of hypercholesterolemia in Iranian northern adults to Veghari *et al* , Vol 9, No 1 (2013) , Mean of age was 44.2 ± 11.5 years (44.3 ± 11.5 in men and 44.1 ± 11.2 in women) and plasma total cholesterol level was 203.1 ± 41.8 mg/dl.

The HC was detected in 49.1% with higher rate in women (57.0%) than men (44.7%). In men at age 25-35 years, the odds ratio was 3.42 (1.60-7.29) in obese group and 1.90 (1.03-3.50) in overweight group compared to normal weight. In women, at age 35-45 years, the risk of HC in obese group was 3.01 (1.58-5.73) and in overweight group it was 2.06 (1.58-5.73), while in men aged 35-45 years the relative risk was 4.03 (2.22-7.34) in overweight and 3.58 (1.77-7.25) in obese group. In women after age 45 years, higher BMI was not a risk factor for HC. There was a positive association between BMI and serum cholesterol level. In early middle age, obese individuals were at risk of HC more than overweight subjects. In men, after age 35 years, the risk of HC increased in overweight group while in women there was no statistically significant association between BMI and HC⁽³⁸⁾.

Recommendations

Treatment of high cholesterol is important and there are two ways to reduce it. The first is with lifestyle changes, which include changing diet, managing your

weight and exercising. The second is to combine lifestyle changes with cholesterol-lowering medicines.

Also self-help is recommended by eating healthy foods to reduce high cholesterol levels. The diet should be low in saturated fats in particular, and low in fat overall. Biscuits, cakes, pastries, red meat, hard cheese and butter all tend to be high in saturated fats, so it's good to cut down on these foods. Some foods such as eggs, prawns and offal (for example, liver and kidneys) contain cholesterol. This type of cholesterol is known as dietary cholesterol and it has a much lower effect on blood cholesterol than saturated fat in your diet.

It's also important to eat plenty of fiber, especially soluble fiber, which helps to lower cholesterol. There is soluble fiber in fruits and vegetables, beans and oats. Aim to eat at least five portions of fruit and vegetables each day. Eating foods containing substances called plant sterols, contained in some yoghurt or spreads, may help to lower high cholesterol, but they are not a substitute for a healthy diet.

People who overweight should lose excess weight and stop smoking to reduce your LDL levels and increase HDL levels. Also, obese people should increasing their physical activity to enhance healthy body and decrease LDL.

Conclusion

Hypercholesterolemia (HC) was described by a total plasma cholesterol level over 200 mg/dl. The percent of males was 40(60.6%), and the percent of female was 26(39.4%). Ranges weights of the people who took them samples were, from 55kg to 135 kg, the percent of less weight was (7.6%) . The weights that were above normal weight rate was from 86kg to 135kg by (28.79%), The percent of cholesterol levels ranged between 90mg\dl to 350mg\dl, The percentage of people who increased their cholesterol were 7(10.6%), the percent and the type of Nutrition, that was, fat, vegetable, fruits, and carbohydrate. The highest proportion of fat by 31(47.0 %) , and less percentage of fruit by, 8 (12.1%). People can prevent high cholesterol by keeping to a healthy weight and eating a diet that is low in saturated fat including at least two portions of fish per week in diet, of which at least one should be an oily fish such as mackerel or salmon. Also regular exercise, avoid smoking and limits of alcohol are essential for healthy body.

References

1. Durrington, P (2003). "Dyslipidaemia". *The Lancet* 362 (9385): 717–31. doi:10.1016/S0140-6736(03)14234-1.
2. Melissa C, Jerry R. B . (2012). 1996-2013 Medicine Net, Source quiz on Medicine Net.

3. Biggerstaff KD, Wooten JS, 2004, "Understanding lipoproteins as transporters of cholesterol and other lipids". *Adv Physiol Educ* 28 (1–4): 105–110. doi:10.1152/advan.00048
4. Carmena R, Duriez P, Fruchart JC (2004), "Atherogenic lipoprotein particles in atherosclerosis". *Circulation* 109 (23 Suppl 1): III2–III7. doi:10.1161/01.CIR.0000131511.50734.44.
5. Kontush A, Chapman MJ, (2006). "Antiatherogenic small, dense HDL--guardian angel of the arterial wall?". *Nat Clin Pract Cardiovasc Med* 3 (3): 144–153. doi:10.1038/ncpcardio0500.
6. Hooper L, Summerbell CD, Thompson R, *et al.* (2012). "Reduced or modified dietary fat for preventing cardiovascular disease". In Hooper, Lee. *Cochrane Database Syst Rev* 5: CD002137. doi:10.1002/14651858.CD002137.pub3. PMID 22592684.
7. Ito MK, McGowan MP, Moriarty PM, (2011), "Management of familial hypercholesterolemias in adult patients: recommendations from the National Lipid Association Expert Panel on Familial Hypercholesterolemia". *J Clin Lipidol* 5 (3 Suppl): S38–45. doi:10.1016/j.jacl.2011.04.001. .
8. Bhatnagar D, Soran H, Durrington PN, (2008), "Hypercholesterolaemia and its management". *BMJ* 337: a993. doi:10.1136/bmj.a993.
9. Finn AV, Nakano M, Narula J, Kolodgie FD, Virmani R (2010). "Concept of vulnerable/unstable plaque". *Arterioscler. Thromb. Vasc. Biol.* 30 (7): 1282–1292. doi:10.1161/ATVBAHA.108.179739. Grundy, SM; Balady, GJ; Criqui, MH; Fletcher, G; Greenland, P; Hiratzka, LF; Houston-Miller, N; Kris-Etherton, P (1998). "Primary prevention of coronary heart disease: guidance from Framingham: a statement for healthcare professionals from the AHA Task Force on Risk Reduction. American Heart Association". *Circulation* 97(18): 1876–1887. doi:10.1161/01.CIR.97.18.1876. |displayauthors= suggested (help)
10. Shields, C; Shields, J, (2008). *Eyelid, conjunctival, and orbital tumors: atlas and textbook*. Hagerstown, Maryland: Lippincott Williams & Wilkins. ISBN 0-7817-7578-7.
11. Zech LA Jr, Hoeg JM, (2008), "Correlating corneal arcus with atherosclerosis in familial hypercholesterolemia". *Lipids Health Dis* 7: 7. doi:10.1186/1476-511X-7-7. PMC 2279133.
12. James, WD; Berger, TG (2006). *Andrews' Diseases of the Skin: Clinical Dermatology*. Saunders Elsevier. pp. 530–2. ISBN 0-7216-2921-0.
13. Rapini, RP; Bologna, JL; Jorizzo, JL, (2007). *Dermatology: 2-Volume Set*. St. Louis, Missouri: Mosby. pp. 1415–6. ISBN 1-4160-2999-0.
14. Key topics in public health (ELSEVIER Churchill An imprint of Elsevier limited, © 2005, Elsevier limited. All rights reserved
15. Howell WH, McNamara DJ, Tosca MA, Smith BT, Gaines JA (1997). "Plasma lipid and lipoprotein responses to dietary fat and cholesterol: a meta-analysis". *Am. J. Clin. Nutr.* 65 (6): 1747–64.

16. AH (1990). "Intestinal cholesterol metabolism". *Ann. Med.* 22 (1): 49–52. doi:10.3109/07853899009147241.
17. Stryer, Lubert; Berg, Jeremy Mark; Tymoczko, John L. (2007). *Biochemistry*. San Francisco: W.H. Freeman. ISBN 0-7167-8724-5.
18. Sacks FM, Katan M, (2002), "Randomized clinical trials on the effects of dietary fat and carbohydrate on plasma lipoproteins and cardiovascular disease". *Am. J. Med.* 113 Suppl 9B: 13S–24S.
19. Schaefer, EJ; Gleason, JA; Dansinger, ML (2009). "Dietary fructose and glucose differentially affect lipid and glucose homeostasis". *The Journal of nutrition* 139 (6):1257S 1262S. doi:10.3945/jn.108.098186. PMC 2682989.
20. Consumer Reports. (2013). Drug Effectiveness Review Project : "Evaluating statin drugs to treat High Cholesterol and Heart Disease: Comparing Effectiveness, Safety, and Price".
21. Grundy, SM; Balady, GJ; Criqui, MH; Fletcher, G; Greenland, P; Hiratzka, LF; Houston-Miller, N; Kris-Etherton, P (1998). "Primary prevention of coronary heart disease: guidance from Framingham: a statement for healthcare professionals from the AHA Task Force on Risk Reduction. American Heart Association". *Circulation* 97(18): 1876–87. doi:10.1161/01.CIR.97.18.1876. |displayauthors= suggested (help)
22. Reiner Z, Catapano AL, De Backer G, *et al.* (2011). "ESC/EAS Guidelines for the management of dyslipidaemias: the Task Force for the management of dyslipidaemias of the European Society of Cardiology (ESC) and the European Atherosclerosis Society (EAS)". *Eur. Heart J.* 32 (14): 1769–818. doi:10.1093/eurheartj/ehr158.
23. Pignone, M, (2005). "Primary prevention: dyslipidaemia". *Clin Evid* (14): 142–50. Retrieved 2010-11-04.
24. Gami, A (2006). "Secondary prevention of ischaemic cardiac events". *Clin Evid* (15): 195–228. PMID 16973010. Retrieved 2010-11-04.
25. Tang JL, Armitage JM, Lancaster T, Silagy CA, Fowler GH, Neil HA (1998). "Systematic review of dietary intervention trials to lower blood total cholesterol in free-living subjects". *BMJ* 316 (7139): 1213–20. doi:10.1136/bmj.316.7139.1213. PMC 28525. PMID 9552999. Retrieved 2010-11-04.
26. National Institute for Health and Clinical Excellence. *Clinical guideline 67: Lipid modification*. London, 2008.
27. Snow V, Aronson M, Hornbake E, Mottur-Pilson C, Weiss K (2004). "Lipid control in the management of type 2 diabetes mellitus: a clinical practice guideline from the American College of Physicians". *Ann Intern Med* 140 (8):6449. doi:10.1059/00034819140820040420000012. 2010-11-04.
28. Vijan, S; Hayward, RA; American College of Physicians (2004). "Pharmacologic lipid-lowering therapy in type 2 diabetes mellitus: background paper for the American College of Physicians". *Ann Intern*

- Med 140 (8):650–8.doi:10.1059/0003-4819-140-8-200404200-00013.
Retrieved 2010-11-04.
29. Grundy SM, Cleeman JI, Merz CN, Brewer HB, Clark LT, Hunninghake DB, Pasternak RC, Smith SC, Stone NJ (2004). "Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III Guidelines". *JAmCollCardiol* 44 (3):72032.doi:10.1016/j.jacc.2004.07.001.
 30. Hayward, RA; Hofer, TP; Vijan, S (2006). "Narrative review: lack of evidence for recommended low-density lipoprotein treatment targets: a solvable problem". *Ann Intern Med* 145(7): 520–30. doi:10. 7326/0003-4819-145-7-200610030-00010.
 31. Nazir Ahmed, Waqas Anwar*, Huma Waqas Department of Medicine, *Department of Dermatology, Frontier Medical College, Abbottabad, Department of Paediatrics, Women Medical College, Abbottabad, Pakistan, *J Ayub Med Coll Abbottabad* 2009;21(4) OBESITY, HYPERLIPIDEMIA, AND HYPERURAECEMIA IN YOUNG AND OLD HYPERTENSIVE PATIENTS
 32. Andrew M Tershakovec, Abbas F Jawad, Nicole O Stouffer, Abdalla Elkasabany, Sathanur R Srinivasan, and Gerald S Berenson, *Am J Clin Nutr* 2002;76:730–5. Printed in USA. © 2002 American Society for Clinical Nutrition, Persistent hypercholesterolemia is associated with the development of obesity among girls: the Bogalusa Heart Study 1–3.
 33. *Journal Eur Heart J.* (2013). [Epub ahead of print] Affiliation Department of Clinical Biochemistry, Herlev Hospital, Copenhagen University Hospital, University of Copenhagen, DK-2730 Herlev, Copenhagen, Denmark. Familial hypercholesterolaemia is underdiagnosed and undertreated in the general population: guidance for clinicians to prevent coronary heart disease: Consensus Statement of the European Atherosclerosis Society.
 34. Pećin I, Sućur N, Reiner Z. *Journal Lijec Vjesn.* (2013). Familial hypercholesterolemia - do we think enough about this severe disease?]. Article in Croatian, 135(5-6):145-9.
 35. Guidance for clinicians to prevent coronary heart disease. (2013). Consensus Statement of the European Atherosclerosis Society. *Eur Heart J.*
 36. Pećin I, Sućur N, Reiner Z. (2013). *Journal Lijec Vjesn.*;135(5-6):145-9. do we think enough about this severe disease.
 37. Ahmed W, Whittall R, Riaz M, Ajmal M, Sadeque A, Ayub H, Qamar R, Humphries SE. (2013). The genetic spectrum of familial hypercholesterolemia in Pakistan. *Journal Clin Chim Acta*: 5;421:219-25. doi: 10.1016/j.cca.2013.03.017.
 38. Hypercholesterolemia | University of Maryland Medical Center. (2018). <http://umm.edu/health/medical/altmed/condition/hypercholesterolemia#ixzz2i6EQuZd1>.

39. kylenorton, (2011). Obesity and Hyperlipidemia (High Levels of Cholesterol and Triglycerides).
40. Gholamreza V, Mehdi S, Hamidraza J, Samieh B, Pooneh, Abdolhamid A, Ebrahim T, Abbas M. (2013). Obesity and risk of hypercholesterolemia in Iranian northern adults, Vol 9, No 1.