World Nutrition Journal |eISSN 2580-7013

ORIGINAL PAPER

The Effect of a Low-Fat Diet and a Low-Carbohydrate Diet with Aerobic Exercise on Lipid Profile Changes in Adult Women

Ni Made Dewantari,[1] I Wayan Ambartana,[1] I Putu Suiraoka,[1] G.A Dewi Kusumayanti,[1] D.P Sukraniti,[1] I Gede Iswara Pranidhana Putra[2]

1. *Nutrition Department, Health Polytechnic, Ministry of Health Denpasar, Bali, Indonesia*
2. *Ikatan Apoteker Indonesia (IAI), Bali, Indonesia*

Received 4 March 2019,
Accepted 19 August 2019

Link to DOI:
10.25220/WNJ.V03.i2.0007

Journal Website:
www.worldnutrijournal.org

Abstract

Background Lifestyle changes become the foundation in primary and secondary prevention of lipid and lipoprotein disorders. The aim of the study was to know the effectiveness of low fat diet and low carbohydrate diet with aerobic exercise toward lipid profile change.
Methods This experimental research was done with pre test-post test control group design. The sample of adult women in the city of Denpasar as many as 33 people, aged 30-50 years, BMI 25-30 kg/m2, allocated to 3 groups. A low-fat diet was applied to Group 1, a low-carbohydrate diet to group 2 and group 3 as controls. Before and after the intervention, blood lipid profile was measured. Changes in blood lipid profile before and after intervention were analyzed by paired t-test. The difference in mean blood lipid profile in all three groups was analyzed by One Way ANOVA test.
Results Low-fat diet and low-carbohydrate diet can lower total cholesterol and low density lipoprotein-cholesterol (LDL-C) significantly ($p < 0.05$). The average decrease in total cholesterol with low fat diet was 16.82 mg/dL and low carbohydrate diet 14.64 mg/dL. The LDL-C decrease was 13.36 mg/dL in low fat diet and 7.45 mg/dL in low-carbohydrate diet group. There was no significant difference in lipid profile changes between low fat compared to low carbohydrate diet ($p > 0.05$).
Conclusion Low-fat diet is as effective as a low-carbohydrate diet to improve lipid profile.

Keywords low fat diet, low carbohydrate diet, aerobic exercise, lipid profile

Introduction

Lifestyle changes, namely changes in dietary and physical activity patterns play an important role in lipid profile changes and reduce risk factors for cardiovascular disease. Recommended lifestyle changes for those who have high cholesterol levels include low-fat saturated and low trans-fatty acids diet, exercising regularly and maintaining a healthy weight.[1]

Manipulating the dietary macronutrient content contributes to the beneficial effects of improving the lipid profile even without changes in total calorie intake. Low-fat diet recommendations to reduce cardiovascular diseases (CVD) risk factors, there is still much debate and attention recently to foods that are low in carbohydrates rather than low in fat, it remains to be explained the beneficial effects of each type of diet when providing recommendations for CVD prevention.[2]

Corresponding author:
I Putu Suiraoka
Nutrition Department, Health Polytechnic of Denpasar, Bali.
Email: suiraoka@gmail.com

Given the complexity of individual lifestyle choices, observed research results emphasize the challenge of accurately assessing the impact of lifestyle changes, including diet-based intervention or physical activity, on lipid profiles and cardiovascular risk.[1]

Therefore, this study was conducted with aim to determine the effectiveness of low-fat diet and low-carbohydrate diet with aerobic exercise in improving lipid profile in obese women.

Materials And Methods

This was an experimental study with randomized pre-test and post-control group design.[3] The study was conducted in Denpasar City, targeting adult women aged 30-50 years old and body mass index (BMI) of 25-30 kg/m^2. The sample size was calculated using the Pocock formula. The result was 11 subjects. The study used three groups of observation, therefore it required 33 subjects. Group 1 was given low-fat dietary intervention and aerobic exercise; group 2 was given a low-carb dietary intervention and aerobic exercise; group 3 acted as control (no diet nor aerobic exercise).[4]

The population of this study was PKK (Indonesian family welfare programme) members in Kesiman Kertalangu Village, East Denpasar District, Denpasar City, while the sample was part of the population with the following inclusion criteria: 1) willing to become the research subject until completion of the study; 2) healthy based on doctor's examination; 3) age 30-50 years old; 4) body mass index (BMI) 25-30 kg/m^2; 5) did not have a history of obesity; 6) not currently attending a regular physical training program. Subjects who have history of bone injury is excluded. Drop out criteria: suffering from illness or injury during training and did not attend training three times in a row.

The diet applied was a low energy diet i.e energy intake minus 500 kcal from normal needs, with different compositions. Low-fat diet is a low energy diet with 10-15% protein composition, <20% fat and >65% carbohydrates from total energy. On the other hand, low-carbohydrate diet was 10-15% of protein, >30% fat and <55% carbohydrates of total energy. The application of low-fat and low-carbohydrate diets by subjects was done daily for six weeks. Monitoring the implementation of dietary measurement of food intake was done with the food recall method and nutrition counselling three times a week during the study period. Aerobic exercise was moderate in intensity, with 3 times a week frequency and 60 minutes duration. Exercise was held for 6 weeks guided by gym instructors.

Before and after the intervention, lipid profile was taken (total cholesterol, triglycerides, high density lipoprotein-cholesterol (HDL-C), low density lipoprotein-cholesterol (LDL-C)). Lipid profile changes before and after intervention in each group were analyzed by Paired t-test. Differences in lipid profile changes in the three groups were analyzed by One Way ANOVA Test. Finally, to find out which interventions improved the lipid profile Least Significant Different (LSD) test was used.

Results

The participants recruited in this study were more than 11 people. But 2 people dropped out because they were not present several times at the intervention and 1 person was not measured at the time of the final blood lipid profile level test of the study.

Characteristic of research subjects

Baseline characteristics of study subjects before intervention are shown in Table 1. Comparison of data before intervention between groups 1, 2 and 3

Table 1. Baseline characteristics of the subjects

Characteristics	Group 1	Group 2	Group 3
Age (years)	42.27±5.90	43.82±3.76	39.64±7.57
Cholesterol level (mg/dL)	211.45±41.04	211.91±49.66	200.45±27.60
Triglycerides (mg/dL)	109.09±42.67	150.27±135.58	97.82±49.39
HDL-C (mg/dL)	52.36±9.69	54.64±10.92	66.73±12.51
LDL-C (mg/dL)	138.91±37.23	127.18±30.70	114.10±23.18

were tested with One Way ANOVA at α = 0.05 showing p values for age, total cholesterol, triglyceride, HDL-C and LDL-C greater than 0.05 (p>0.05) which means not significantly different. Thus the condition of the subjects between groups 1, 2 and 3 before the intervention was similar.

The result of normality test with Kolmogorov-Smirnov Test at α=0.05 to the data obtained before intervention showed the p value greater than 0.05 (p>0.05). This means that the distribution of samples from all groups are normal.

Diet application

The average energy recommended in low-fat diet group was 1626.93 kcal, while average energy consumed was 1656.2 kcal. Average percentage of protein intake was 12.08% of total energy, as recommended (10-15% total energy). The average of carbohydrate intake was 66.95%, as recommended (>65% total energy), while fat intake was 20.82% total energy nearly similar to recommended (<20% of total energy).

In low carbohydrate diet intervention group, the recommended average energy was 1592.41 kcal and subjects averagely consumed 1667.80 kcal. The average percentage of protein intake was 14.31% of total energy, as recommended (10-15% total energy); fat intake 32.69% of total energy, as recommended (>30% total energy); and carbohydrate intake 53.26%, as recommended (<65% total energy).

In control group, the average of energy requirement is 2139.34 kcal. Subjects in this group consumed 2185.50 kcal. Average percentage of protein intake was 15.33% total energy, as recommended (10-15% total energy); carbohydrate intake 62.67% as recommended (55-65% total energy) and fat intake 21.67% total energy as recommended (20-25% total energy).

Effect on total cholesterol

The result of t-paired test in Table 2 shows low fat and low carbohydrate diet can significantly decrease total cholesterol (p <0.05). The mean decrease of total cholesterol in low fat diet was 16.82 ± 12.94 mg / dL and on low carbohydrate diet 14.64 ± 14.78 mg/dL.

ANOVA test results showed there was a significant difference of total cholesterol decrease between the three groups (p<0.05). To find out which intervention had greater effect in reducing total cholesterol, further analyzed by LSD test at α=0.05 was done. The test results showed that there was a significant difference of total cholesterol decrease between low fat diet compared to control, with 17.64 mg/dL different value (p<0.05). Similarly there was a significant difference in total cholesterol reduction between low carbohydrate diets compared to controls with different values of 15.46 mg/dL (p<0.05). However, there was no significant difference in total cholesterol reduction between low-fat diet compared to low-carbohydrate diet (p=0.67). Thus low-fat diet is as effective as low-carbohydrate diet to lower total cholesterol.

Table 2. Mean of total cholesterol distribution before and after intervention

Group	Before (mg/dL)	After (mg/dL)	Difference (mg/dL)	p
1	211.45±41.04	194.64±41.97	16.82±12.94	0.00
2	211.91±49.66	197.27±39.00	14.64±14.78	0.01
3	200.45±27.59	201.27±27.10	-0.82±1.87	0.67

Effect on triglyceride

The result of t-paired test in Table 3 showed no significant difference between triglyceride decrease in low fat and low carbohydrate diet group (p>0.05). ANOVA test results also showed no significant difference mean of triglyceride decrease between the three groups (p=0.591)

Effect on HDL-C levels

The paired t-test results in Table 4 showed no significant difference in HDL-C before and after intervention in all groups. ANOVA test results also showed no significant difference in HDL-C changes between the three groups (p>0.05).

Table 3. Mean of triglyceride levels before and after intervention

Group	Before (mg/dL)	After (mg/dL)	Difference (mg/dL)	p
1	109.09±42.67	95.00±25.94	14.09±43.35	0.31
2	150.27±35.58	123.27±63.85	27.00±77.53	0.28
3	97.82±49.39	94.45±41.02	3.36±27.08	0.70

Table 4.Mean of HDL-C levels before and after intervention

Group	Before (mg/dL)	After (mg/dL)	Different (mg/dL)	p
1	52.36±9.69	50.09±7.85	2.27±5.24	0.18
2	54.64±10.92	52.73±13.46	1.91±9.66	0.53
3	66.73±12.51	64.55±12.64	2.18±6.27	0.28

Effect on LDL-C levels

The result of paired t-test in Table 5 shows there is significant difference of LDL-C decrease in low-fat diet (13.36±14.77 mg/dL). ANOVA test results showed there was a difference of LDL-C decrease between the three groups ($p<0.05$). LSD test results showed there was a difference of LDL-C decrease between low fat diet compared to control, the difference was 17.091 mg/dL ($p<0.05$). However, there was no significant difference in LDL-C reduction between low-fat diets compared to low-carb diets, a difference of 5.909 mg / dL ($p>0.05$).

Table 5. Mean of LDL-C levels before and after intervention

Group	Before (mg/dL)	After (mg/dL)	Difference (mg/dL)	p
1	138.91±37.23	125.55±40.69	13.36±14.77	0.01
2	127.18±30.70	119.73±33.97	7.46±5.12	0.18
3	114.00±23.18	117.73±23.19	-3.73±7.58	0.13

Discussion

Effect of intervention on total cholesterol level decrease

Low-fat dietary interventions as well as low-carbohydrate diets with aerobic exercise can significantly reduce total cholesterol ($p<0.05$). The mean decrease of total cholesterol with low fat diet was 16.82±12.94 mg/dL greater than low carbohydrate diet: 14.64±14.78 mg/dL, even though it was not significantly different statistically ($p>0.05$). This result is in line with the findings of Tian Hu[5] which suggests that low-carbohydrate diets are as effective as low-fat diets to improve metabolic risk factors.

Cholesterol reduction is caused by increased cholesterol metabolism during diet. In addition there is also a breakdown of triglyceride deposits in adipose tissue. Deposits come from the breakdown of cholesterol in the plasma which is then used as energy. This breakdown is catalyzed by the hormone sensitive lipase (HSL) enzyme present in the adipose tissue. This enzyme is affected by adrenaline. During diet and physical exercise there will be an increase in adrenaline which means there is also an increase in the activity of these enzymes.[6] The type of fat that affects the most increase in cholesterol is saturated fat, while consumption of monounsaturated fats can lower cholesterol levels.[7]

Various hypotheses suggest that physical activity can improve body composition, increase the capacity of mobilization and fat oxidation, control food intake by controlling appetite and high-fat food intake, increasing thermogenesis response, increasing insulin sensitivity and improving blood lipid profile.[8] Total cholesterol levels can be decreased by doing aerobic exercise regularly.[9] Exercise not only has a positive effect on individuals with dyslipidemia, but also can help to improve lipid profile.[10]

Effect of intervention on changes in triglyceride

The average reduction of triglycerides in the low-carbohydrate diet of 27.00 mg/dL is relatively

greater than the low-fat diet of 14.09 ml/dL. This result is in accordance with William S et al.[11] research shows low-carbohydrate diets have a greater decrease in serum triglyceride than a low-fat diet. However, the result of t-paired test showed no significant difference of triglyceride decrease with low fat diet and low carbohydrate diet ($p>0.05$). This may be because the subjects did not adhere to fasting before blood-taking, diet and exercise intervention programs have not managed to control blood triglyceride levels because the intervention was given only 6 weeks. Blood triglyceride levels are strongly influenced by dietary intake consumed by a person and will increase within hours of eating. Similar to this study, previous studies also did not gain significant differences between blood triglycerides before and after diet and exercise interventions.[1]

Effect of intervention on changes in HDL-C

There was no significant difference in HDL-C before and after low-fat dietary interventions as well as low-carbohydrate diets ($p>0.05$). This may occur because the intervention has not managed to control blood levels of HDL because the intervention is given only 6 weeks, so it has not improved physical fitness. According to Cooper,[12] several studies have proven that achieving a high level of fitness with aerobic exercise activities can benefit one of them is improved lipid profile, such as increased HDL-C and lower total cholesterol ratio with HDL-C. The more fit a person aerobically, the more likely that person's HDL-C becomes higher.

In line with the study of Saritas et al.[13] showing a short-term aerobic exercise program (8 weeks) undertaken without diet in active young adolescent males is not enough to make a beneficial effect on blood lipid profiles. In contrast to research results of Augusto et al.[14] showed that after physical exercise intervention, there was an increase in lipid profile (HDL-C) in the experimental group ($p<0.05$).

Effect of intervention on decreased in LDL-C

A low-fat diet significantly decreased LDL-C ($p<0.05$), with a mean reduction of 13.36 ± 14.77 mg / dL. A decrease in LDL-C is achieved when the saturated fat intake is lowered.[15] Regular exercise can also decrease plasma LDL-C, increase HDL-C. Triacylglycerol levels are also reduced, most likely due to increased insulin sensitivity that increases lipoprotein lipase expression.[16] Low-fat and low-carbohydrate diets show a comparable effect on insulin resistance.[17]

While the mean lowering of LDL-C with low carbohydrate diet 7.46 mg/dL, but not statistically significant ($p>0.05$). In line with the William et al [11] study, LDL-C changes did not differ statistically (1.6 mg / dL) with low-carb diets.

Conclusion

Low-fat and low-carb diets, each with aerobic exercise performed for six weeks, can significantly lower total cholesterol and LDL-C ($p<0.05$) and may decrease triglycerides but not statistically significant ($p>0.05$). There was no significant difference in lipid profile changes between low-fat diets compared to low-carbohydrate diets ($p>0.05$). Thus a low-fat diet is as effective as a low-carb diet to improve lipid profile.

Ethical Clearance

Ethical clearance no: 1462/UN.14.2/Litbang/2016, obtained from University Udayana Committee.

Conflict of interest

All authors declare that there is no conflict of interest within this research and publication including the financial agency

Open Access

Reference

1. Wong PC, Chia MY, Tsou IY, Wansaicheong GK, Tan B, Wang JC, et al. Effects of a 12-week exercise training

programme on aerobic fitness, body composition, blood lipids and C-reactive protein in adolescents with obesity. Annals of the Academy of Medicine. Singapore: Annals of the Academy of Medicine; 2008. [Google Scholar]
2. Daoud E, Scheede-Bergdahl C, Bergdahl A. Effects of dietary macronutrients on plasma lipid levels and the consequence for cardiovascular disease. Journal of Cardiovascular Development and Disease 2014 Oct;1(3):201-13. [Google Scholar]
3. Campbell DT. Experimental and quasi-experimental designs for research on teaching. Handbook of research on teaching 1963;5:171-246. [Google Scholar]
4. Pocock S. Clinical Trials, A Practical Approach. New York: A Willey Medical Publication; 2008. [Google Scholar]
5. Hu T, Mills KT, Yao L, Demanelis K, Eloustaz M, Ws YJ, et al. Effects of low-carbohydrate diets versus low-fat diets on metabolic risk factors: a meta-analysis of randomized controlled clinical trials. American journal of epidemiology 2012 Oct;176(suppl_7). [Google Scholar]
6. Rf ZJ. Physical activity and fitness in the prevention of coronary heart disease and associated risk factors. American Journal of Lifestyle Medicine 2007;1(1):29-33. [Google Scholar]
7. Muchtadi D. Pangan Dan Kesehatan Jantung. Bandung: Alfa Beta; 2013. [Google Scholar]
8. Egger A, Kreis R, Allemann S, Stettler C, Diem P, Buehler T, et al. The Effect of Aerobic Exercise on Intrahepatocellular and Intramyocellular Lipids in Healthy Subjects. PLoS One 2013;8(8):1. [Google Scholar]
9. Stangl V, Baumann G, Stangl K. Coronary atherogenic risk factors in women. Eur Heart J 2002;23(22):1738. [Google Scholar]
10. Wang Y, Xu D. Effects of aerobic exercise on lipids and lipoproteins. Lipids in health and disease 2017;16(1):132. [Google Scholar]
11. William S. Yancy Jr., MD, MHS; Maren K. Olsen, PhD; John R. Guyton, MD; Ronna P. Bakst, RD; and Eric C. Westman, MD M. A Low-Carbohydrate , Ketogenic Diet versus a Low-Fat Diet To Treat Obesity and Hyperlipidemia. Ann Intern Med 2004;140:769. [Google Scholar]
12. Sharkey BJ. Kebugaran & Kesehatan. Jakarta: PT Rajagrafindo Persada; 2011. [Google Scholar]
13. Saritas N. Effect of endurance exercise training on blood lipids in young men. African J Pharm Pharmacol 2012;6(3):216. [Google Scholar]
14. Silva DA, Petroski EL, Pelegrini A. Effects of aerobic exercise on the body composition and lipid profile of overweight adolescents. Revista Brasileira de Ciências do Esporte 2014;36(2):295-309. [Google Scholar]
15. Enas E a, , Senthilkumar a, , Chennikkara H, Bjurlin M a . Prudent diet and preventive nutrition from pediatrics to geriatrics: current knowledge and practical recommendations. Indian Heart J 2003;55(4):310. [Google Scholar]
16. Pa, K.d. (Mayer) . Sintesis, Transpor, dan Ekskresi Kolesterol, dalam Biokima Harper. 29th ed. Jakarta: EGC; 2012. [Google Scholar]
17. Bradley U, Spence M, Courtney CH, Mckinley MC, Ennis CN, Mccance DR, et al. . 2009;58(December):2741. [Google Scholar]