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Anthropometric-Parameters and Total-Cholesterol to HDL-Cholesterol Ratio are Better in Long-Distance Cyclists

Mahalul Azam[1,2]✉, Sri Ratna Rahayu[1], Arulita Ika Fibriana[1], Hardhono Susanto[3], Martha Irene Kartasurya[4], Udin Bahrudin[5]

[1]Public Health Department, Sport Sciences Faculty, Universitas Negeri Semarang
[2]Doctoral Program in Medicine and Health Sciences, Faculty of Medicine, Universitas Diponegoro
[3]Department of Anatomy, Faculty of Medicine, Universitas Diponegoro
4Public Health Nutrition Department, Faculty of Public Health, Universitas Diponegoro
5Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Diponegoro

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Abstract

Total-Cholesterol (TC) to HDL-Cholesterol (HDL-C) ratio in athletes is well-known to be better than sedentary people. However, information about comparison of TC/HDL-C in different groups of cyclists based on cycling touring characteristics and anthropometry parameters is lacking. This study aimed to compare TC/HDL-C ratio between groups based on the type of tour in cyclists population. Eighty-eight participants were recruited in this cross-sectional study. Mean differences of parameters between groups was analyzed by One-Way Anova and independent t-test, whereas multivariate analyses was conducted by binary logistic-regression. P value <0.05 was considered statistically significant. TC/HDL-C ratio in all groups were less than 4.5. There is no differences of TC-levels (NC240K: 216.6±55.04, TdB140K: 208.1±27.13, TdB100K: 203.1±31.95; p=0.427). But there is significantly different level of HDL-C (NC240K: 68.9±19.09, TdB140K: 52.1±13.9, TdB100K: 53.6±12.45; p=0.0001) and TC/HDL-C ratio (NC240K: 3.3±1.12, TdB140K: 4.2±1.07, TdB100K: 4.0±1.06; p=0.007). Between TC/HDL ratio groups (≥4 or <4), there were differences of weight, BMI, waist-circumference, hip-circumference and type of tour (p<0.05). Finally, BMI and type of tour were the most influential factor. Long-distance cyclists have a synergistic effect of lipid profile and anthropometry measurements, and heavier cycling tour participant, that represent cycling training habits, tend to have lower TC/HDL ratio(< 4).

Introduction

Numerous studies show that levels of HDL and total cholesterol ratio is a major predictor for Coronary Artery Disease (CAD) (Arquer, 2006; Lemieux, 2011; Riwanto, 2013). Increasing level of serum cholesterol will increase risk of CAD (Ahn, 2016; Rosjidi, 2017). The Framingham study about cardiovascular risk factors has shown that a decrease in plasma HDL cholesterol levels are associated with increased risk of CAD, with levels of HDL less than 40 mg/dl as a major risk factor of CAD, while HDL levels of more than 60 mg/dL protects against CAD occurrence (Penalva, 2003; Natarajan, Ray, 2010; Azam, 2017). High total cholesterol level is a risk factor of CAD.

✉ Correspondence Address:
Public Health Department, Sport Sciences Faculty, Universitas Negeri Semarang, Indonesia.
Email : mahalul.azam@mail.unnes.ac.id

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Optimal total cholesterol level in the body is 200 mg/dL (Penalva, 2003; Health & Human Service, 2005). Total Cholesterol to HDL Cholesterol TC/HDL ratio is a well-known parameter of CAD risk factor (Millan, 2009; Endarti, 2016). TC/HDL ratio cut-off point of 4.5 is determined as risk factor of CAD (Millan, 2009).

It is generally known that athletes have higher levels of HDL compared to non-athletes. The relationship between physical activity and health and HDL cholesterol has been studied extensively. Some studies have shown that marathon runner, jogging (Scheers, 2008), sky (Taralov, 2000; Kannan, 2014) and other sports athlete have higher HDL cholesterol. Study in Spain for amateur and professional cyclists also found a difference in average total cholesterol and HDL level, and also TC/HDL ratio profile. These parameters are also compared to high intensity workouts for long periods (Aguiló, 2003).

It is known that lipid profiles, especially HDL cholesterol, are strongly influenced by the levels of physical activities on athletes or non-athletes alike. However, little is known about the information of HDL profile and TC/HDL ratio for long distance cyclists based on distance that will describe their daily workout intensity and cycling training habits. The aims of this present study was to investigate the difference in TC/HDL levels ratio between cyclists based on distance and intensity of training.

Methods

The study was carried out at Indonesia cycling touring event of 2017 North Coast (NC) and Tour de Borobudur (TdB), which involved 1,211 participants. They consist of 31 NC participants, 207 participants of TdB140K and 973 participants of TdB100K. Study participation was offered through leaflets, social media, and the internet along with the publication of touring event. Inclusion criterias were as follow: male, between 20 to 75 years old. A minimum sample size of 78 participants was required, which was then divided into groups consisting of at least 26 participants into each group: NC240K, TdB140K, and TdB 100K. Exclusion criterias were the following: clinical conditions that is harmful for participating in the events and a medical history of the previous acute coronary syndrome.

Eighty-eight volunteer and eligible participants of long-distance cycling (LDC) touring, i.e. NC and TdB 2017 (Indonesia), were recruited to this observational study. The study protocol was approved by the local ethical board (no. 607/EC/FK-RSDK/X/2017) and conformed to the concepts of the Declaration of Helsinki. This study was registered in clinicaltrial.gov (ID number NCT03310450). The study was funded by the Directorate of Research and Public Service, Ministry of Research, Technology and Higher Education of the Republic of Indonesia, and delegates all the research procedures to the researchers.

All participants completed a questionnaire about subject characteristics, health conditions, medical history and the intensity of daily cycling activities. Participants have their anthropometric profile measured, i.e. weight, height, body mass index (BMI), waist circumference, hip circumference and waist to hip ratio. Body weight was measured using body weight scale SECA 813® and body height was measured using microtoise SECA Bodymeter 206®, whereas waist/hip circumferences were measured using ergonomic circumference measuring tape SECA 201®.

Blood sample for laboratory analysis was collected one day before cycling tour activities, in the afternoon on after fasting for 8-10 hours. Five mililiter of venous blood was taken from antecubital vein. The blood samples were stored in a silicon tube without anticoagulant and clotted in room temperature for an hour. Then, the blood samples were centrifuged for 10 to 20 minutes at 2.500–3.600 rpm. The serum were aliquoted and transferred into a labeled plastic tube. The levels of total cholesterol and HDL cholesterol were analyzed using biochemical analysis method by an automated analyzer (Cobas C-501, Roche Diagnostics, USA).

Statistical analyses were performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 23.0, IBM Corp., NY, USA). Numerical data presented in mean±SD for Gaussian data, whereas non-Gaussian data were presented in the interquartile value and categorical data were presented in proportion. Differences between groups were tested using either Independent *t*-test, one way Anova test or chi-square test. Multivariate analyses was conducted by binary logistic regression.

Results and Discussion

The subject was classified into three groups based on cycling distances that they participated. The heavier the tour, the greater the required preparation and performance for cyclists. As such, it represent their daily cycling training habits. Group NC 240K, the heaviest tour in this study, rode 240 km from Semarang to Cirebon through Java North Coast main road. NC 240K was held in October 20th 2017 in clear weather, with mean temperature of 33ºC. The minimum temperature was 28ºC and maximum temperature was 41ºC. Total elevation gained during NC 240K through Java North Coast road was 826 m.

TdB was divided into two groups i.e. TdB 140K group and TdB 100K. TdB 140K rode 140 km from Semarang to Magelang via Boja/Limbangan road. TdB 140K took place on November 11th 2017 in almost rainy weather, with mean temperature of 26ºC. The minimum temperature was 21ºC and maximum temperature was 37ºC. Total elevation gained during TdB 140K was 2,754 m and is often called Climbing Challange tour.

TdB 100K, the lightest tour of this study, rode 100 km from Semarang to Borobudur via the main road of Semarang-Yogyakarta. TdB 100K was held on November 12th 2017, one day after TdB 140K in very clear weather, with mean temperature of 30ºC. The minimum temperature was 28ºC and maximum temperature was 34ºC. Total elevation gained during TdB 140K was 1,117 m.

Characteristics of participants based on age and anthropometry parameters was presented in Table 1 which showed no significant difference in all parameters, i.e. age, weight, height, body mass index, waist circumference, hip circumference, and waist to hip circumference ratio. These data showed that all parameters were not influenced by the distance of the tour.

Mean age of all participants were 45.3±11.4 years old. The mean age of participants from NC 240K, TdB 140K and TdB 100K were as follows: 43.3±9.33 years old, 43.5±10.18 years old and 49±13.70 years old, respectively. Minimum and maximum age of all participants

Table 1. Subjects Characteristics Based on Tour Groups

No	Parameters	NC 240K n=28	TdB 140K n=30	TdB 100K n=30	Total n=88	***p* value**
	Characteristic of Age and Anthropometry					
1.	Age (years, mean±SD)	43.3±9.33	43.5±10.18	49±13.70	45.3±11.47	0.090*
2.	Age (years, min; max)	25; 63	24; 59	22; 71	22; 71	
3.	Weight (kg, mean±SD)	67.9±7.51	68.5±9.10	66.8±11.21	67.7±9.36	0.779*
4.	Height (cm, mean±SD)	167.2±5.02	167.1±4.35	167.3±4.5	167.2±4.58	0.969*
5.	BMI (kg/m^2, mean±SD)	24.2±2.26	24.5±3.11	23.7±3.60	24.2±3.03	0.653*
6.	Waist circumference (cm, mean±SD)	84.2±6.69	86.4±8.50	85.1±9.78	85.2±8.41	0.539**
7.	Hip circumference (cm, mean±SD)	89.8±5.43	89.5±7.09	88.2±7.89	88.2±6.87	0.617**
8.	Waist-hip ratio (mean±SD)	0.94±0.069	0.96±0.044	0.96±0.053	0.95±0.057	0.157*
	Characteristic of Workout and Exercise Frequency					
9.	Duration of cycling experience (years;me;min-max)	3; 0-42	5; 1-26	4.75;1-25		0.019**
10.	Long distance tour experience		9;30	6;20		0.088***
	No (n%)	2;7.1	21;21	24;80		
	Yes (n%)	26;92.9				
11.	Frequency of tour participating					0.020***
	Never (n ;%)	2;7.1	9;30	6;20		
	1–3 times (n ;%)	9;32.1	11;36.7	6;20		
	4–6 times (n ;%)	2;7.1	7;23.3	11;36.7		
	≥ 7 times	15;53.6	3;10	7;23.3		
12.	Cycling distance in a month (km; mean±SD)	779±388.1	600±322.2	642±318.0		0.025***
	Characteristic of Lipid Profile					
13.	TC levels (mg/dl; mean±SD)	216.6±55.04	208.1±27.13	203.1±31.95		0.427*
14.	HDL-C levels (mg/dl; mean±SD)	68.9±19.09	52.1±13.9	53.6±12.45		<0.001*
15.	TC/HDL-C (ratio; mean±SD)	3.3±1.12	4.2±1.07	4.0±1.06		0.007*

BMI: Body Mass Index *One way Anova test **_Kruskal-Wallis_ test ***_Chi Square_ test was 22 years old and 71 years old; NC 240K: 25 years old and 63 years old; TdB 140K: 24 years old and 59 years old; and TdB 100K: 22 years old and 71 years old. Characteristic of age in all group were not different significantly (p>0.05).

Similar to age, anthropometry parameters were not different in all groups. Mean weight of all participants were 67.7±9.36 kg. The mean weight in NC 240K, TdB 140K and TdB 100K were as follows: 67.9±7.51 kg, 68.5±9.10 kg and 66.8±11.21 kg, respectively. Mean BMI of all participants were 24.2±3.03 kg/m^2. Mean BMI in NC 240K, TdB 140K and TdB 100K were as follows: 24.2±2.26 kg/m^2, 24.5±3.11 kg/m^2 and 23.7±3.60 kg/m^2, respectively. Mean waist circumference of all participants were 85.2±8.41 cm. Mean waist circumference in NC 240K, TdB 140K and TdB 100K were as follows: 84.2±6.69 cm, 86.4±8.50 cm and 85.1±9.78 cm, respectively. Mean hip circumference of all participants were 88.2±6.87 cm. Mean hip circumference in NC 240K, TdB 140K and TdB 100K were as follows: 89.8±5.43 cm, 89.5±7.09 cm and 88.2±7.89 cm, respectively. Finally, mean waist-hip ratio of all participants were 0.95±0.057 cm. Mean hip circumference in NC 240K, TdB 140K and TdB 100K were as follows: 0.94±0.069 cm, 0.96±0.044 cm and 0.96±0.053 cm, respectively.

Distribution of workouts characteristic was also showed in Table 1. It showed a significantly different duration for cycling experience (p=0.019), with the median value and the value of minimum-maximum at NC 240K, TdB 140K, TdB 100K as follows 3;0–42, 5;1–26, 4.75;1–25, respectively. The difference was not significant (p=0.088) on long distance cycling tour experience categorized as no experienced at all and experienced, with frequency at NC 240K, TdB 140K, TdB 100K as follows 7.1%; 92.9%, 30%; 21% and 20%; 80%, respectively.

Significant difference (p<0.05) was also found in frequency of tour participation categorized as never, 1-3 times, 4–6 times and more than seven times, with the frequency at NC240K, TdB140K, TdB100K as follows 7.1%; 32.1% 7.1%; 53,6%, 30%; 36.7%; 23.3%, 20%; 20%; 36.7%; 23.3%, respectively. The cycling distances (km) in a month, showed as mean ± SD on the NC240K, TdB140K, TdB100K were as follows 779±388.1 km, 600±322.2 km, 642±318.0 km, respectively.

Test results of statistical analysis in Table 1 also showed that there are significant differences between the levels of HDL cholesterol (mg/dL) and distance (p value <0.001), with mean and standard deviation of NC240K group 68.9±19.09, TdB140K group 52.1±13.9 and TdB100K 53.6±12.45. Then, the ratio of total cholesterol to HDL cholesterol was significantly different as well (p= 0.007), with mean and standard deviation on NC240K group 3.3±1.12, TdB140K group 4.0±1.06, and TdB100K group 4.0±1.06. Meanwhile, a significant relationship was not found in total cholesterol (p=0.427), with mean and standard deviation on NC240K group 216.6± 55, TdB140K group 208.1 ± 27.13, and TdB100K group 203.1±31.95.

Levels of TC indicates that different distance did not affect this parameter. These results are in line with the study that stated the load of sports is not associated with levels of TC (Scheers *et al.*, 2008). High levels of HDL-C were found in the group of cyclists with a longer distance, this finding in line with previous studies which showed high levels of HDL-C after performing high intensity sport (Olson, 2000; Skoumas, 2003; Lecheminant, 2005). Discovery of high levels of TC/HDL in cyclists with longer distance on this study is in accordance with the study which stated that the higher the intensity of physical activity, the higher the levels of TC/HDL (Tran, 2003; De Groot, 2003).

This study used two category of TC/HDL ratio with a cut-off point of ≥ 4.0 as first category and the second category was < 4.0, based on cut-off point used to predict CAD. Higher levels of TC/HDL ratio progressively increases the risk of CAD (Robert F. Dons,Frank H. Wians, 2009). Difference parameter cut-off point TC/HDL ratio also used for 4.5 as the target of primary prevention of CAD (Millan, 2009), but since the mean of this ratio in this study were relatively lower in all subjects, less then 4.5 as showed on Table 1, the cut-off point of 4 was used to determine the groups. Then, based on this group, the data was described in Table 2.

Mean age of all participants based on group with TC/HDL ratio ≥4.0 and

Table 2. Subjects Characteristics Based on TC/HDL Ratio Groups

	Variables	TC/HDL		p value
		≥ 4.0	< 4.0	
1.	Age and Anthropometry			
	Age (years, mean±SD)	47.0±9.70	44.6±12.16	0.352*
2.	Weight (kg, mean±SD)	72.7±7.28	65.5±9.38	0.001*
3.	Height (cm, mean±SD)	167.7±4.19	166.9±4.85	0.225*
4.	BMI (kg/m^2, mean±SD)	26.0±2.63	23.3±2.85	0.001*
5.	Waist circumference (cm, mean±SD)	89.5±7.50	83.4±8.17	0.001*
6.	Hip circumference (cm, mean±SD)	92.8±6.13	87.6±6.61	0.001*
7.	Waist-hip ratio (mean±SD)	4.5±3.03	6.3±7.09	0.349*
	Cycling touring characteristics and training habits			
8.	Duration of cycling experience (years; mean±SD)	4.5±3.03	6.3±7.09	0.225*
9.	Long distance tour experience			0.899**
	No (n;%)	5;29.4	12;70.6	
	Yes (n;%)	22;31	49;69	
10.	Frequency of participating in cycling tour			0.998**
	Never (n ;%)	5;29.4	12;70.6	
	1–3 times (n ;%)	8;30.8	18;69.2	
	4–6 times (n ;%)	6;30	114;70	
	≥7 times (n ;%)	8;32	17;68	
11.	Cycling distance in a month (km; mean±SD)	648±336.6	723±372.6	0.354*
12.	Type of Tour participated			0.047**
	NC (n;%)	7;25.0	21;75.0	
	TdB140K (n;%)	16;53.3	14;46.7	
	TdB 100K (n;%)	14;46.7	16;53.3	

*Independent *t*-test **Chi Square* test

<4.0 were 47.0±9.70 and 44.6±12.16, and were not significantly different (p=0.352). Anthropometry measurement were significantly different in the groups. Mean weight of participants based on group with TC/HDL ratio ≥ 4.0 and < 4.0 was significantly different (p= 0.001), with the mean of 72.7±7.28 kg vs 65.5±9.38 kg. Mean BMI of participants based on group with TC/HDL ratio ≥4.0 and <4.0 was also significantly different (p= 0.001), with the mean of 26.0±2.63 kg/m^2 vs 23.3±2.85 kg/m^2. Mean height was not significantly different (p=0.225). These finding is consistent with other studies that concluded BMI is related to serum cholesterol levels (Al-Ajlan, 2011; Kumar, 2014; Nwaiwu, 2015), TC/HDL ratio (Lemieux, 2015), and other conditions due to overall lipid profile (Ali, 2011; Yildiran, 2011; Febrianti, 2013). Quebect study (Lemieux, 2011) showed that mean BMI of 25.3±3.6 tend to be normolipidemic than mean BMI 27.6±3.4 which tend to be dyslipidemic.

Mean waist circumference of all participants based on group with TC/HDL ratio ≥ 4.0 and < 4.0 were 89.5±7.50 cm and 83.4±8.17, and were significantly different (p=0.001). Similarly, mean hip circumference of participants based on group with TC/HDL ratio ≥ 4.0 and < 4.0 was significantly different (p= 0.001), with mean of 92.8±6.13 cm vs 87.6±6.61 cm. Nevertheless, mean waist to hip ratio which was not significantly different (p=0.349). This finding was in line with many other studies which concluded that waist circumference and hip circumference are related to lipid profile, including TC/HDL ratio (Mohanna, 2006; Alhamdan, 2008; Rizk, 2012; Devi, 2017).

To the best of our knowledge, the present study is the first report concluding characteristic of cycling training related to lipid profile, especially TC/HDL ratio. Based on the test result analysis for characteristic of exercises frequency on Table 2. It was found that all variables, i.e. duration of cycling experience, long distance tour experience, frequency of participating in cycling tour, and cycling distance in a month. Only type of participation, that represent overall characteristics of cycling

Table 3. Multivariate binary logistic regression

Variable	B	Wald	P	OR	95% CI
BMI	-0.364	13.35	0.001	0.695	0.572 – 0.845
Type of tour	-0.580	3.563	0.049	0.827	0.307 – 0.938
Constants	9.772	15.157	0.001	17.338	

R^2=0.770 (Cox and Snell)

training habits, that have significantly different proportion in both groups (p=0.047). The heaviest tour participated, i.e. NC had more proportion of TC/HDL ratio < 4 (75%) than ratio ≥ 4 (25%); on the other hand, TdB 140K and TdB 100K have similar proportion of around 50% in TC/HDL ratio < 4 and ≥ 4.

Descriptively, TC/HDL ratio ≥ 4 group had mean duration of cycling experience of 4.5±3.03 years and in TC/HDL ratio < 4 group it was 6.3±7.09 years, but statistically was not different (p=0.225). Similarly, long-distance cycling tour experience, which were divided into two categories, i.e. no experienced participating at all and experienced, had no significantly different proportion in both groups based on TC/HDL ratio ≥ 4 and TC/HDL ratio < 4. The proportion were about 30% in TC/HDL ratio ≥ 4 and about 70% in TC/HDL ratio < 4, both for inexperienced and experienced groups. Statistically, there was no different proportion (p=0.899).

The same goes with frequency of participation in cycling tour, which were divided into four categories, i.e. Never, 1-3 times, 4-6 times, and more than 7 times. In all groups, proportion were about 30% in TC/HDL ratio ≥ 4 and about 70% in TC/HDL ratio < 4. Statistical analysis also found that there was no significant different proportion (p=0.998). Mean distance of cycling over the past month which was done by participants indicated that there is no significance as well (p=0.354). Descriptively, participants with TC/HDL ratio ≥ 4 had mean distance of 648±336.6 km vs participants with TC/HDL ratio < 4 who had higher mean distance of 723±372.6 km.

Previous study in 2010, which was conducted to 36 non-trained men, found that high intensive exercise of interval running for 40 minutes within 12 weeks lowered the ratio of TC/HDL by 0.08 (Nybo, 2010). Other study also reported that physical training for 6 weeks to 30 men were able to lower their ratio of TC/HDL significantly (Sheikholeslami Vatani, 2011). It proves that people who have experience of exercise or cycling and doing longer physical activity will have lower levels of TC/HDL ratio. Many studies also concluded that exercise habits is related to body composition and lipid profile (Trejo-Gutierrez, 2007; Albuquerque Filho, 2014).

Multivariate analysis was conducted to find the best model of parameters that influence TC/HDL ratio in long distance cyclists. Multivariate analysis involved all independent variables having p< 0.25 in bivariate analysis influenced TC/HDL ratio status. Those variables were: weight, BMI, waist circumference, hip circumference, duration of cycling experience, and type of cycling tour participated. A backward stepwise binary logistic regression was used to determine variables that influenced TC/HDL ratio. Final regression model was shown in Table 2.

Multivariate analysis showed that BMI and type of tour participated were the best model that contribute to TC/HDL ratio category of ≥4.0 and <4.0. Present study identified that lower BMI (β=-0.364, *p*=0,001) with OR 0.695 (95% CI=0.572 – 0.845) and heaviest of cycling tour participated (β=-0.580, *p*=0.049) with OR 0.827 (95% CI=0.307 – 0.938) were the most influential variables toward TC/HDL ratio status in long distance cyclists. Our final regression model have R^2 (Cox and Snell) = 0.770, showing that 77.0 % of TC/HDL ratio status < 4 in long distance cyclists was influenced by this model variant (BMI and type of cycling tour) and the other 23.0% were influenced by other factors.

This study have limitations. This study did not measure complete lipid profile, such as, trygliseride, low density lipoprotein cholesterol, apolipoproteins, and other parameters which are the more valuable predictor of CAD events.

Lipid profile is predicted to have high levels after doing long distance cycling activities. In addition, total cholesterol, HDL, TC/HDL ratio were not measured before and after long-distance cycling activity.

Conclusion

There is significant differences in the levels of HDL-C based on the characteristics of cycling distance and cycling training habits. Present study also showed that there is difference in TC/HDL ratio in type of cycling tour which represent cyclist's daily exercise habits. Study also found that anthropometry measurement i.e. weight, BMI, waist circumference, and hip circumference have strong association with TC/HDL ratio status as well as the characteristics of the cycling tour. Final regression model involved BMI and type of tour to predict TC/HDL ratio status.

Practical Implications:

Long distance cyclists have a synergistic effect of lipid profile (TC/HDL ratio) and anthropometry measurements (weight, BMI, waist and hip circumference)

Long distance cyclists are shown to have an average TC/HDL ratio less than 4.5, in which cut-off point of CAD risk factor determined.

Experienced cyclists who participated in heavier cycling tour (NC cyclists), which represent their cycling training habits, tend to have lower TC/HDL ratio (< 4).

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