Effects and a dose response relationship of physical activity to high density lipoprotein cholesterol and body mass index among Saudis

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ABSTRACT

Objectives: The objective of our study was to examine the effects and a dose response relationship of physical activity on plasma high density lipoprotein cholesterol (HDL-C) levels and body mass index (BMI) among Saudi men and women living in the metropolis of Riyadh, Kingdom of Saudi Arabia (KSA).

Methods: The sample population of 474 Saudi men and women visiting the health centers in and around Riyadh was studied from September 2003 to February 2004. The population was classified in 4 physical activity groups on the basis of frequency (F), intensity (I) and time (T) of exercise. The F, I and T value was calculated by multiplying the scores of 3 parameters. Plasma HDL-C and BMI were measured and the association of HDL-C and BMI with all 4 levels of physical activity, sedentary, light, moderate and heavy were calculated applying Pearson's correlation coefficient.

Results: We found that the sedentary Saudi men had mean HDL-C levels of 0.65 $\pm$ 0.25 and BMI of 28.7 while women had 0.70 $\pm$ 0.22 HDL-C levels and 31.06 BMI. The moderate and heavy physical activity showed an increase of 53-92% and 44.2-95% in the HDL-C levels in both men and women. The physical activity had a strong association to HDL-C and an inverse association to BMI.

Conclusion: The substantial increase in the levels of plasma HDL-C and a moderate reduction in BMI is seen in men and women who are at moderate and heavy physical activity status, however the HDL-C level does not reach to the coronary heart disease protective level, if not combined with proper dieting. A health awareness program is urgently needed at the primary care level in KSA to educate people regarding the significance of physical activity and proper diet.

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Saudi Arabia a middle eastern country with a population of approximately 24 million is having a hot tropical climate. It has undergone significant economic and cultural changes over the past 30 years. Approximately 60% of the population is now urbanized, which has led to adoption of a "westernized" lifestyle both in terms of diet and physical activity, ultimately putting them at a higher risk of coronary heart disease (CHD). Obesity and the associated symptoms of metabolic syndrome, dyslipidemia, hypertension and glucose intolerance are far more common in the native Saudi population.[1,3]

Physical activity has long been associated with increased levels of high density lipoprotein cholesterol (HDL-C) and a reduced risk of CHD,[4-11] but it's direct relationship to the type and intensity of physical activity and the serum levels of HDL-C provides scope for further in depth study. The results of the dose response relationship have been varied.[10-18]

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Table 1 - Gender distribution of subjects in 4 physical activity groups.

Physical activity group	Men n	Men (%)	Women n	Women (%)
Sedentary	65	(31.3)	98	(37)
Light	102	(49)	135	(50.7)
Moderate	27	(13)	25	(9.3)
Heavy	14	(6.7)	8	(3)
Total	**208**	**(100)**	**266**	**(100)**

Table 2 - High density lipoprotein (HDL) levels of men and women in different physical activity groups.

Physical activity group	n	Mean HDL ± SD	*p*-value
Sedentary			
Men	65	0.65 ± 0.25	0.05
Women	98	0.70 ± 0.22	0.05
Light			
Men	102	0.75 ± 0.20	0.05
Women	135	0.80 ± 0.21	0.045
Moderate			
Men	27	1.00 ± 0.25	0.01
Women	25	1.20 ± 0.24	0.01
Heavy			
Men	14	1.25 ± 0.29	0.001
Women	8	1.37 ± 0.30	0.001

SD - standard deviation

Table 3 - Mean body mass index (BMI) in different physical activity groups of men and women.

Physical activity group	n	Mean BMI ± SD	*p*-value
Sedentary			
Men	65	28.70 ± 2.56	0.05
Women	98	31.06 ± 5.90	0.01
Light			
Men	102	28.60 ± 4.69	0.01
Women	135	30.90 ± 5.36	0.45
Moderate			
Men	27	27.07 ± 3.20	0.05
Women	25	28.80 ± 4.60	0.02
Heavy			
Men	14	25.10 ± 6.50	0.01
Women	8	26.90 ± 5.92	0.01

SD - standard deviation

Moderate exercise in young men having low levels of HDL resulted in significant effect on their triglycerides levels but no considerable change in their HDL-C levels.[19] Some of the studies have shown significant changes in HDL-C levels only after certain miles ran per week,[20] or after exercise intensity equal to 75% of maximal heart rate.[21] Lifestyle has affected the serum lipids of Americans of Japanese[12] and Hispanic[22] origin, whose risk of CHD is higher than that of indigenous population.

Few studies which have been carried out in Saudi Arabia have shown changing lipid profile with advancing age and increased body mass index (BMI),[2,3] but no literature is available on the correlation of physical activity and the levels of HDL-C and BMI among middle aged Saudis. In this study we tried to find the effect and a dose response relationship between physical activity and HDL-C levels and BMI, among Saudis.

Methods. A 6-months data supplied by health centers in and around Riyadh were analyzed. In all 474 subjects, 208 men and 266 women, were studied. Informed consent was taken from each potential subject. They underwent complete history taking, based on a questionnaire and a thorough physical examination. Subjects who appeared healthy and free from any ailment were included in this study. The questionnaire included a comprehensive account of their physical activity profile, based on frequency (F), intensity (I) and time (T) (duration) of exercise. A scoring system of 1-5 depending on level of activity was assigned. If the "frequency" of exercise was daily or 6-7 times a week it was given a score of 5 and for once per month the score was one. The scores of 2-4 were for the frequency in between. The "intensity" of physical activity was judged on the levels of aerobic exercises. "Aerobic activity resulting in heavy breathing and perspiration" was given a score of 5 while "light aerobic," for example normal walking was scored as one. The moderate aerobics depending on intensity were scored from 4-2. The maximum score of 4 for the parameter of "time" (duration of exercise) was earned by the subjects who exercised "more than 30 minutes everyday". Exercise for "less than 10 minutes a day" was scored as one. The scores of 2-3 were for the timings of more than 10 minutes but less than 30 minutes. Finally, F, I and T scores were multiplied (F x I x T) to achieve FIT value. On the basis of FIT value we divided subjects into 4 study groups. Subjects scoring 0-7 were labeled as sedentary and acted as the control group. The other scoring, 8-32 were designated as light, 36-75 as moderate, and 80-100 as heavy physical activity groups.

The plasma HDL-C levels were estimated in the Riyadh Central Laboratory observing World Health

Table 4 - Correlation coefficients of different parameters in 4 physical activity groups.

Physical activity group	n	Physical activity to HDL r	BMI to HDL r	Physical activity to BMI r
Sedentary				
Men	65	0.45	-0.06	-0.17
Women	98	0.38	-0.13	-0.09
Light				
Men	102	0.58	-0.038	-0.10
Women	135	0.66	-0.051	-0.15
Moderate				
Men	27	0.61	-0.16	-0.30
Women	25	0.60	-0.17	-0.29
Heavy				
Men	14	0.68	-0.20	-0.20
Women	8	0.65	-0.30	-0.18

r - correlation coefficient, HDL - high density lipoprotein, BMI - body mass index

Organization lipid reference criteria, on a synchron system of Beckman of USA. The BMI was calculated as weight in kilograms divided by height in square meters (kg/m^2).

Statistical analysis. In all the 4 study groups the levels of HDL-C and BMI among males and females are presented as mean ± standard deviation. Comparisons between groups were performed by calculation of student t-test.

Correlations of physical activity with HDL-C levels and BMI were calculated by Pearson's correlation coefficient. Associations of BMI and HDL-C to physical activity were measured by multiple linear regression after adjustment of age and other potential confounders. For *p*-value a confidence interval of 95% was applied to all the tests. All statistical analysis was carried out on Statistical Package for Social Sciences 11 software.

Results.

Sixty-five (31.3%) of men and 98 (37%) of women were categorized as sedentary.One hundred two (49%) of men and 135 (50.7%) of women into light, 27 (13%) of men and 25 (9.3%) of women into moderate and 14 (6.7%) men and 8 (3%) of women were involved in heavy physical activity **(Table 1).**

Women were less physically active compared to men ($p<0.05$). The mean age for men was 45.7 (range 30– 80) years and for women 42.5 (range 27-73) years. The mean HDL-C levels were subnormal in men (0.65 ± 0.25) and women (0.70 ± 0.22) both, (p-value< 0.05) in the control sedentary group. **(Table 2)**

Considering 25 BMI as the cut off, we found that both sedentary men and women were overweight[2] and the women had higher BMI (31.06 versus 28.70) in comparison to men (**Table 3**).

It was observed that at moderate level of physical activity, the rise in HDL-C levels was 53% ($p<0.05$) in men and 44.2% ($p<0.05$) in women. Heavy physical activity resulted in more significant increase in HDL-C levels of 92% ($p<0.01$) in men and 95% (p=0.02) in women. The other observation was that physical activity had a positive effect on the BMI. The men (12%, $p=0.32$) and women (13%, $p=0.012$) at heavy physical activity levels had lesser BMI in comparison to men and women in sedentary group.

We studied the association between physical activity and HDL-C and BMI, BMI and HDL-C through a multivariate regression analysis. We found that physical activity had a strong positive correlation with HDL-C (r=0.82, $p<0.05$) and a negative correlation with BMI (r=-0.14, $p=0.064$). The correlation between BMI and HDL-C was also negative (r=-0.41, $p=0.032$).

Table 4 illustrates the gender wise distribution of correlation coefficients between HDL-C and BMI at all 4 levels of physical activity.

Discussion.

Our study is a cross sectional survey of an urbanized population of Saudi Arabia. The association of physical activity to plasma HDL-C and BMI among Saudis has not been studied before. The present study reveals a strong association between physical activity and HDL-C levels and an inverse association with BMI. In contrast to the earlier reports from Saudi Arabia[2] and from other parts of the world,[13,23,24] we observed that the mean plasma HDL-C in sedentary Saudi men and women is lower and even subnormal. We also discovered that on an average sedentary middle aged Saudi men and women were overweight (BMI >25).[2] The subnormal levels of HDL-C and a higher BMI in the sedentary Saudi population may be attributed to urbanization, a rapidly changing lifestyle and food habits in the last 3 decades.[2,3] The women, in our study, also had a little higher HDL-C levels compared to men, but no significant variation was seen, as reported earlier.[2,13]

Another revelation in the present study was that women had a higher BMI compared to men and a tendency to become obese (BMI>30). These findings are in agreement to a previous study from Saudi Arabia,[3] but in contrast to the Framingham Offspring Study,[24] where men were found to be overweight. The marked difference in the lifestyle, cultural and social behavior of Saudi and American women may be a reason for this variation in the body composition.

One of the significant findings in our study is the dose–response relationship between physical activity and HDL-C plasma levels and BMI. In the present study, men in the moderate and heavy physical activity groups (53-92%) and women (44.2-95%) had higher plasma HDL-C levels compared to sedentary men and women. Although the positive effect of physical activity on HDL-C has been widely reported earlier, the results have been remarkably varied.[5-18] In variation with the ATTICA study, we observed that HDL-C in the moderate and heavy exercise group is much higher and that too without any gender bias.[13]

We further studied the association of different levels of physical activity with HDL-C and BMI to assess a dose response relationship. In accordance with numerous previous observational studies, we too discovered, a significant positive association of HDL-C and an inverse association of BMI with physical activity.[4,13,15] However the inverse association of BMI to HDL-C in our study is not as strong as reported by other authors. We observed that the effect of even vigorous exercise (heavy physical activity) on BMI is not as significant as on HDL-C.

The HDL-C levels of 1.55 mmol/L is considered to be adequate and protective against CHD.[24] The most significant finding of the present study is that the subjects involved in heavy physical activity and having >90% HDL-C levels compared to sedentary, do not reach the CHD protective levels. It was observed that Saudis have a very low base level of HDL-C. This could be well attributed to the fact that dieting was not combined with physical activity. It is also reflected in only a marginal reduction in BMI. A study carried out in Washington, USA on a dose response relationship of physical activity to HDL-C,[20] revealed that the best results are seen with 7-14 miles run per week. Williams[16] and Kokkinos et al[20] have reported significant change in HDL-C levels after running 80 km per week. It is difficult to compare the results of a dose response and how much intensity of exercise is required to achieve CHD protective HDL-C levels. Different studies have adopted different methods of evaluating the status of physical activity. We realized our limitation in categorization of physical activity status on a self declared exercise history. However, corresponding with the previous studies, we report a substantial rise in the plasma HDL-C levels with increasing intensity of physical activity among Saudis. The dose response relationship between physical activity and concentrations of HDL-C is substantiated in our study, which corresponds well with all the previous similar studies.[13–21]

The subnormal levels of HDL-C among Saudis is an adverse effect of prosperity. The leisure time physical activity has become almost negligible. Cycling and walking even for Saudi youth are a social taboo.

The inference is that until proper dieting is combined with physical activity, it is difficult to achieve an ideal BMI, and the CHD protective levels of HDL-C.

This study recommends a health awareness drive for Saudi men and women at the primary health care level to promote physical activity. Counseling for proper dieting and exercise is the need of the day to minimize the risks of coronary heart disease.

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