European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 9, Issue 3, Winter 2022

The Correlation Between High-Density Lipoprotein Cholesterol and Glomerular Filtration Rate Estimation in a Community-Based Population

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ABSTRACT

Background: In individuals with end-stage renal disease (ESRD), those on hemodialysis, and those with stage 3–5 chronic kidney disease, reduced kidney function is linked to low levels of high-density lipoprotein cholesterol (HDL-C) (CKD). However, there is a scarcity of epidemiological data on the link between HDL-C levels and renal function in the general population with roughly normal kidney function, and the results are conflicting. The goal of this study was to see if there was a link between HDL-C levels and estimated glomerular filtration rate (eGFR) in an Indian community.

Methods: This was a cross-sectional survey conducted in the community. During routine health status assessments, a total of 4925 participants (ages 18–96 years; mean, 51.30±11.98 years) were recruited. Each participant's age, smoking status, and history of hypertension and diabetes mellitus were all determined using a questionnaire. We took each participant's BMI, waist circumference, systolic and diastolic blood pressure, as well as fasting glucose, total cholesterol, triglyceride, HDL-C, low-density lipoprotein cholesterol, and uric acid, and serum creatinine levels. The Modification of Diet in Renal Disease equation was used to calculate eGFR.

Results: The first quartile (lowest quartile) of eGFR had a greater HDL-C level than the fourth quartile (the highest quartile). Additionally, as eGFR decreased, HDL-C levels declined. HDL-C levels were related to eGFR (r=0.16), according to Pearson's correlation analysis. HDL-C was shown to be linked with all quartiles of eGFR in the subjects after controlling for various covariates.

Conclusions: In a community-dwelling general population, HDL-C was found to be linked with kidney function independently. As eGFR fell, the link between low HDL-C levels and lower eGFR became stronger**.**

INTRODUCTION

Reduced kidney function is a risk factor for cardiovascular disease (CVD) and cardiac events independently [1]. Meanwhile, renal function is affected by CVD risk factors such as age, hypertension, hyperglycemia, and dyslipidemia [2]. Reduced kidney function has been linked

to low high-density lipoprotein cholesterol (HDL-C) levels in patients with end-stage renal disease (ESRD), those on hemodialysis, and those with stage 3–5 chronic kidney disease (CKD) in previous studies [3-5], and low HDL-C levels are a hallmark of ESRD-related dyslipidemia [6]. Some researchers believe the link between renal function and HDL-C is due to deregulation of HDL-C metabolism caused by decreased kidney function [7].

The cardioprotective benefits of HDL-C have been proven by clinical and experimental research as an essential cardiovascular risk factor. However, whether HDL-C has an independent protective effect on kidney function is unknown. The amount of epidemiological evidence on the link between HDL-C and kidney function in people with roughly normal kidney function is limited, and the conclusions are inconsistent [8,9]. Odden et al. recently showed that HDL-C was related with a lower cystatin C-based estimated glomerular filtration rate (eGFR) across the age spectrum, with the relationships appearing to be stronger in older persons [10].Prior research, however, found that after adjusting for age, HDL-C was not related with kidney function independently. As a result, we studied the association between HDL-C and creatinine-based eGFR in a community-based Indian population in the current study.

METHODS

Through routine health status assessments, this community-based cross-sectional survey was meant to investigate the link between HDL-C and eGFR. The study population has previously been described [11]. The communities were chosen for their convenience, as well as their ability to represent various economic, civilizational, and lifestyle profiles (village, town and city). A minimum of 90% of residents in each community took part in the study, and the participants were all of the same ethnicity (100 percent Han people). All of the participants were permanent residents, above the age of 18, and capable of giving informed permission. The study eliminated participants who had malignant tumours, were bedridden, had mental illnesses, had significant heart and lung function failure, or were on dialysis.The data was collected over the course of a year. This poll included 5100 people (2111 from the urban community, 1513 from the rural community, and 1476 from the town community). We removed patients with missing data for critical factors (n=175) from the current study. There were 69 missing height and weight measurements, 27 missing systolic and diastolic blood pressure (SBP) measurements, 135 missing serum creatinine (Scr) values, 120 missing blood glucose (Glu), total cholesterol (TC), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C), or HDL-C values, for a total sample size of 4925.

QUESTIONNAIRE AND ANTHROPOMETRIC MEASUREMENTS

Using standardised self-report questionnaires, information about the participants' age, smoking status, history of hypertension and diabetes mellitus, and medication use was gathered. Face-to-face counselling was used to deliver this questionnaire. The inquiry was done by physicians from the XXXX Hospital's Department of Cardiology, who had been educated by the research team.

Anthropometric and blood pressure measurements were part of the physical examination. Height, weight, and the circumferences of the waist and hips were all measured. The waist-to-hip ratio (WHR) and body mass index (BMI) were computed. The BMI was computed by dividing one's weight in kilogrammes by one's height in metres squared (kg/m2). WHR was computed by dividing the waist circumference (WC) by the hip circumference (HC). The participants' blood pressure was taken while they were sitting. Blood pressure was taken three times in a row, with a one-minute interval between each test. For the statistical analysis, the mean value of blood pressure was employed.

DEFINITION OF VARIABLES

Cigarette smoking was defined as smoking at least one cigarette per day for at least a year. I a systolic blood pressure (SBP) of ≥140 mmHg; (ii) a diastolic blood pressure (DBP) of ≥90 mmHg; and/or (iii) the administration of an antihypertensive medicine [13]. A conventional 75 g oral glucose tolerance test was given to all individuals without a history of diabetes mellitus (4559 people) (OGTT). To measure blood glucose, patients with a history of diabetes mellitus had their fasting venous blood taken. A fasting glucose level of ≥7.1 mmol/L, a 2 h venous blood glucose level of ≥11.11 mmol/L, or the use of a hypoglycemic medication or insulin were all used to diagnose diabetes mellitus [14].

The following calibration equation was generated from the results ($R2$=0.999) [15]: Jaffe's kinetic method Scr (mg/ dL)=0.795×[enzymatic method Scr (mg/dL)]+0.29.eGFR was calculated using the Chinese modified Modification of Diet in Renal Disease (CMDRD) equation as follows [16]: eGFR (mL/min/1.73 m2)=175×standard creatinine (mg/dL)−1234.×age (year)−0.179×0.79 (if female).

STATISTICAL ANALYSIS

Continuous variables are expressed as the mean and standard deviation (SD). Normality was tested using the Kolmogorov–Smirnov criterion. Skewed variables are expressed as the median value (with an interquartile range). Categorical variables are expressed as numbers and percentages. Baseline characteristics were separated according to the eGFR quartiles. eGFR levels were classified as follows: quartile 1 (≥102.35 mL/min/1.73 m^2), quartile 2 (92.42–102.34 mL/min/1.73 m^2), quartile 3 (83.67–92.41 ml/min/1.73 m^2), and quartile 4 (≤83.66 mL/min/1.73 m^2). Statistical comparison of the groups was undertaken by one- way ANOVA (continuous variables).

In univariate analyses, Pearson's correlation analysis for continuous variables or Spearman's correlation analysis for categorical variables were used to evaluate the correlation between HDL-C levels and eGFR as a continuous variable, and multivariable linear regression analysis was performed for variables with a probability value ≤0.10, and variables with a probability value less than 0.05 remained in the model after adjusting for several confounders (covariates). In addition, logistic regression models were employed to better understand the relationship between HDL-C levels and different eGFR quartiles. The odds ratios (ORs) and 95 percent confidence intervals (CIs) for variables with a probability value ≤0.10 were calculated using forward stepwise multivariate logistic regression, and those with a probability value less than 0.05 remained in the model after correction. The reference was the first quartile of eGFR.Model 1 was adjusted for age and gender, while model 2 was adjusted for model 1 variables plus smoking status, a history of hypertension, and a history of diabetes. Model 3 was modified for BMI, WC, WHR, SBP, and DBP, as well as model 2 variables. Model 4 included fasting glucose, triglyceride, LDL-C, and uric acid values, as well as model 3 variables.

All data entry and management activities were undertaken on an Excel spreadsheet, and data were analyzed using SAS statistical software (SAS Institute Incorporated, Cary, NC, USA), version 9.1. A 2-sided P-value <0.05 was considered significant.

RESULTS

CHARACTERISTICS OF PARTICIPANTS

The current study included a total of 4925 participants. There were 2383 males (48.39 percent) and 2542 females in the sample (51.61 percent). The average age was 51.30±11.98 years, with a range of 18–96 years. There were 1483 smokers (30.11 percent), 571 diabetics (11.59 percent), and 1751 hypertensive people in the study (35.55 percent). 145 of the 4559 people

who completed the OGTT had recently been diagnosed with diabetes (2.94 percent). A total of 317 people were newly diagnosed with hypertension (6.44 percent).
The clinical features of the study subjects are shown in Table 1. Based on their eGFR quartiles, the subjects were separated into four groups. Participants in quartile 4 were more likely to be hypertensive and older than those in quartile 1, and they had higher SBP, total cholesterol, triglyceride, LDL-C, and uric acid ($P<0.05$) and lower HDL-C ($P<0.05$) values than those in quartile 1. In contrast, between quartiles 1 and 4, the percentage of males, smoking status, and DBP and fasting glucose readings were not substantially different ($P>0.05$). Furthermore, as eGFR decreased, HDL-C levels decreased.

THE ASSOCIATION OF HDL-C WITH EGFR IN ALL PARTICIPANTS

All subjects were subjected to univariate and multivariate analysis of the link between HDL-C and eGFR as a continuous variable. The results of Pearson's correlation and multivariable linear regression analyses are shown in Table 2. HDL-C levels were related with eGFR ($r=0.16$, $P<0.001$), according to Pearson's correlation analysis. HDL-C levels were found to be linked with eGFR in a multivariate linear regression analysis. In addition, eGFR was linked to male gender, age, diabetes mellitus, BMI, WC, WHR, and triglyceride, LDL-C, and uric acid levels. Table 3 shows the connection between HDL-C and different quartiles of eGFR among the subjects. The reference quartile 1 of eGFR was utilised to develop a stepwise logistic regression model. After controlling for all confounders such as age, gender, smoking status, a history of hypertension and diabetes mellitus, SBP, DBP, triglyceride, LDL-C, fasting glucose, and uric acid (model 4), the results revealed that HDL-C was independently linked with all quartiles of eGFR. Furthermore, with decreasing eGFR values (quartiles 2–4), the OR declined gradually.

DISCUSSION

This is the first study in India to look into the link between HDL-C and renal function in a community setting. In this study, we found a link between HDL-C levels and eGFR in a community-based general population. HDL-C was also independently linked with all quartiles of eGFR among the subjects after adjusting for all covariates (model 4), and the OR declined progressively as the eGFR fell (quartiles 2 to 4).When we controlled for key covariates in a stepwise way, however, HDL-C was not independently linked with eGFR. As a result, these findings suggest that confounders such as age, blood pressure, and lipid characteristics may alter the independent connection between low HDL-C levels and impaired kidney function. Furthermore, when eGFR drops, this connection should improve gradually in all people.

Table1: The clinical characteristics of the study participants.

Characteristic	Overall (n=4925)	Quartile 1 ≥102.35 (n=1232)	Quartile 2 92.42–102.34 (n=1230)	Quartile 3 83.67–92.41 (n=1232)	Quartile 4 ≤83.66 (n=1231)
eGFR (ml/min/1.73m^2)	92.42 (83.66–102.36)	110.73 (106.30–117.69)	97.12 (94.76–99.62)	88.21 (86.05–90.22)	77.08 (71.00–80.60)
Age (years)	51.30±11.98	44.61±14.28	46.97±13.23*	52.55±13.32*	61.13±13.42**
male sex [n (%)]	2383(48.3%)	584(47.4%)	606(49.3%)	602(48.9%)	591(48.0%)
Currentsmoking[n(%)]	1483(30.1%)	368(29.9%)	380(30.9%)	350(28.4%)	385(31.3%)
Hypertension[n(%)]	1751(35.6%)	360(29.2%)	406(33.0%)*	451(36.6%)*	534(43.4%)**
Diabetesmellitus[n(%)]	571(11.6%)	121(9.8%)	133(10.8%)	152(12.3%)*	165(13.4%)*
BMI(kg/m^2)	25.68±3.73	25.34±4.06	25.66±3.65	25.78±3.63	25.95±3.55
WC (cm)	99.15±7.58	97.85±7.88	98.82±7.28*	99.56±7.53*	100.40±7.39*
Waist-hip ratio	0.87±0.07	0.86±0.07	0.86±0.06	0.87±0.06	0.88±0.06*
SystolicBP(mmHg)	128.15±18.58	123.52±17.79	125.45±17.98*	128.88±18.50*	132.75±19.08*
DiastolicBP(mmHg)	77.87±10.57	77.85±10.58	77.47±10.38	78.35±10.37	77.82±10.93
Total cholesterol (mmol/L)	4.97±0.96	4.70±0.93	4.92±0.93*	5.08±0.92*	5.20±0.99**
Triglyceride (mmol/L)	1.38(0.96–2.01)	1.23(0.85–1.82)	1.32(0.93–1.96)*	1.39(1.00–2.04)*	1.51(1.11–2.16)**
LDLcholesterol(mmol/L)	2.81±0.77	2.64±0.75	2.75±0.77*	2.85±0.74*	2.99±0.78**
HDLcholesterol(mmol/L)	1.42±0.35	1.43±0.34	1.42±0.55*	1.41±0.26*	1.38±0.36*
Fastingglucose(mmol/L)	5.27±1.36	5.30±1.61	5.22±1.32	5.26±1.17	5.29±1.32
Uricacid(mmol/L)	287.80±77.95	258.59±71.32	280.37±72.89**	291.86±73.75**	320.40±80.58**

Note: Characteristics are reported as percentages for categorical variables and means (±SD) or medians (with interquartile range) for continuous variables. The studyparticipants were divided into four groups based on eGFR quartiles (≥102.35, 92.42–102.34, 83.67–92.41, and ≤83.66 mL/min/ 1.73 m^2). Categorical variables are presented as counts and percentages. The values outside the parent hesesare the number of subjects, and the prevalence is presented in parentheses.

The first quartile of eGFR was used as the reference.

*p<0.05 vs.Quartile1.

**p<0.01 vs.Quartile1.

Abbreviations:eGFR,estimatedglomerularfiltrationrate;BMI,bodymassindex;WC,waistcircumference;BP,bloodpressure;HDL,high-densitylipoprotein;LDL,low-densitylipoprotein.

Previous research has found a link between HDL-C and renal function. However, the majority of these investigations were conducted on individuals with ESRD or who were on hemodialysis. 176 individuals with CKD (eGFR=50.3±29.1 mL/min/1.73 m^2) were recently

enrolled in a study and monitored for up to 84 months. Low HDL-C levels were linked to lower eGFR, according to the findings of this cross-sectional investigation. Low HDL-C levels were linked with earlier dialysis or a doubling of plasma creatinine level (P=0.017) at follow-up; HDL-C was the only lipid parameter that affected CKD development independently of diabetes [hazard ratio (HR)=0.951; 95 percent CI, 0.917–0.986; P=0.007].Epidemiological data on the link between HDL-C and renal function in the general population, on the other hand, is scarce. In this study, we looked at the relationship between HDL-C and eGFR in a community-based population with generally normal kidney function (93 participants had an eGFR of 60 mL/min/1.73 m^2). The findings demonstrated that in the general population, low HDL-C levels were related with lower eGFR.

Table2. Pearson's correlation and multiple linear regression analyses of the association between HDL-C and eGFR.

	Univariate			
Characteristics	**r**	**P**	**β**	**P**
Male	0.002	0.830	−3.654	<0.001
Age	−0.418	<0.001	−0.453	<0.001
Currentsmoking	−0.014	0.173	0.204	0.673
hypertension	−0.139	<0.001	0.550	0.289
Diabetesmellitus	0.063	<0.001	3.229	<0.001
BMI(kg/m^2)	−0.070	<0.001	0.302	0.001
WC (cm)	−0.157	<0.001	−0.127	0.008
Waist-hip ratio	−0.121	<0.001	11.566	0.035
SystolicBP(mmHg)	−0.159	<0.001	0.004	0.786
DiastolicBP(mmHg)	−0.011	0.293	0.034	0.186
Triglyceride (mmol/L)	−0.084	<.001	1.620	<0.001
LDLcholesterol(mmol/L)	−0.171	<.001	8.361	<0.001
HDLcholesterol(mmol/L)	0.162	**<0.001**	6.399	**<0.001**
Uricacid(mmol/L)	−0.303	<0.001	−0.061	<0.001
Fastingglucose(mmol/L)	−0.002	0.872	0.177	0.250

Abbreviations:BMI,bodymassindex;BP,bloodpressure;HDL,high-densitylipoprotein; LDL, low-density lipoprotein; eGFR, estimated glomerular filtration rate

Table3. Association between HDL-C and eGFR in all participants.

Quartile 1	Quartile 2	Quartile 3	Quartile 4
≥102.35	**92.42–102.34**	**83.67–92.41**	**≤83.66**
Model 1			
Odds ratio 1	0.97	1.00	0.72
95%CI Reference	0.74–1.27	0.75–1.33	0.51–1.02
P	0.836	0.979	0.063
Model 2			
Odds ratio 1	0.96	1.00	0.71
95%CI Reference	0.73–1.26	0.75–1.34	0.50–1.01
P	0.770	0.999	0.058
Model 3			
Odds ratio 1	1.15	1.29	1.00
95%CI Reference	0.85–1.55	0.94–1.78	0.68–1.46
P	0.370	0.116	0.982
Model 4			
Odds ratio 1	0.41	0.29	0.15
95%CI Reference	0.25-0.66	0.17–0.48	0.08–0.28
P	**<0.001**	**<0.001**	**<0.001**

Note:Model1:Adjustedforageandgender.
Model2:Adjustedformodel1variablesplussmokingstatus,historyofhypertension,andhistoryofdiabetesmellitus.Model 3: Adjusted for model 2 variables plus BMI, WC, WHR, SBP, and DBPModel. 4:Adjusted for allthe variables.

Although our study found a link between eGFR and HDL-C in the general population, the link between eGFR and HDL-C in individuals with moderate to severe renal disease is not as strong. Reduced kidney function causes deregulation of HDL-C metabolism in individuals with ESRD [18], and low HDL-C levels are a characteristic of ESRD-related dyslipidemia. Reduced renal function could be the source of lower HDL-C levels in this type of connection. The diminished hepatoprotective benefits of lower HDL-C levels, on the other hand, may be the cause of the connection of HDL-C with eGFR in the general population with roughly normal renal function.The association between low HDL-C levels and lower eGFR could be explained by a number of factors. Low HDL-C levels, for starters, are a well-known risk factor for atherosclerosis. Renal artery stenosis is a key cause of impaired kidney function [19]. Second, low HDL-C levels are independently related with arterial stiffness [20], which is a key cause of impaired kidney function [21], as our prior work demonstrated. Third, decreased HDL-C levels may have a role in renal microvascular dysfunction. Morton et al. [22] found a link between vascular risk factors and type 2 diabetes complications.After adjusting for potential confounders, patients in the lowest tertile had a 17 percent higher risk of microvascular disease (adjusted HR=1.17; 95 percent CI, 1.06–1.28; P=0.001) after a median of 5 years of follow-up compared to those in the highest tertile (adjusted HR=1.17; 95 percent CI, 1.06–1.28; P=0.001). The amount of HDL-C is an independent risk factor for the development of renal microvascular disease. Finally, HDL may have pleiotropic effects such as antioxidative, anti-inflammatory, and antiapoptotic effects, and these activities may help to protect renal function [23].

In the current study, eGFR values were classified by quartiles, and correlative confounders were adjusted stepwise to better understand the link between HDL-C and eGFR. After adjusting for all covariates, the results showed that HDL-C was independently linked with all quartiles of eGFR (model 4), and this independent association was not apparent in the other models (model 1, 2, 3). Other variables, such as age, blood pressure, and cholesterol factors, could impair renal function in the general population with roughly normal eGFR values, according to this finding.

The current study has a number of limitations. First, the current study is unable to determine causal links between the findings due to the cross-sectional methodology and its inherent constraints. As a result, longitudinal and interventional investigations are needed to confirm our findings. Second, we employ eGFR based on creatinine as a measure of renal function. Creatinine is a consequence of muscle mass, and it is less effective for measuring kidney function in elderly persons since muscle mass is generally reduced [24]. In the current study, about 1500 individuals were over the age of 60, which could have influenced the results.Third, the study population is Indian, and kidney function was measured using the MDRD method. Although the current study provides crucial ethnic data that helps to elucidate the link between HDL-C and eGFR, extrapolating our findings to other demographic groups should be done with caution. Fourth, even though the results were corrected for several factors that could be linked to eGFR values, residual confounding is still a possibility.

CONCLUSION

After controlling for several variables, HDL-C is found to be independently linked with eGFR in the general population. Furthermore, when eGFR decreases, this association should improve gradually. In addition, large-scale, well-conducted research is urgently needed to give more conclusive proof of this link.

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