Original Article

Serum iron levels are negatively correlated with serum triglycerides levels in female university students

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Background: Dyslipidemia is common among the general population, and its prevention is urgently needed particularly for the health of students. The purpose of our study was to explore the relationship between serum iron level and blood lipids.

Methods: A sample of 290 university students was collected in this cross-section study. The blood lipids and serum iron levels were determined. Pearson's correlation coefficient was used to determine the correlation between serum iron level and blood lipids.

Results: The prevalence of dyslipidemia was 8.8% among male students and 5.4% among female students. The overall prevalence of dyslipidemia was7.2% among the total students. The results showed that serum iron level was negatively correlated with triglyceride (TG), but was positively correlated with high-density lipoprotein cholesterol (HDL)-cholesterol, low-density lipoprotein cholesterol (LDL)-cholesterol, and total cholesterol (TC) in female students. Female students with serum iron less than 15 mmol/L had higher levels of serum TG than female students with serum iron 15 mmol/L or above ($P<0.05$).

Conclusions: These findings suggest that lower serum iron levels may be a risk factor of high serum TG in female students. Supplementation of iron may be a strategy for prevention of high serum TG in female students.

Keywords: Cholesterol; prevention; serum iron; students; triglycerides (TGs)

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Introduction

Dyslipidemia is defined as the derangement of 1 or more of the lipoproteins in blood, which includes elevated triglyceride (TG), total cholesterol (TC), and/or low-density lipoprotein cholesterol (LDL-C), or low levels of high-density lipoprotein cholesterol (HDL-C) alone (1). Epidemiology survey found that dyslipidemia is a major risk factor for atherosclerotic cardiovascular disease (CVD), cerebrovascular accident, and peripheral arterial disease (2). Additionally, evidence suggesting that elevated TG-rich lipoproteins represent causal risk factors for low-grade inflammation and all-cause mortality is growing (3). One epidemiology study showed that the prevalence of dyslipidemia was about 43% in China (4). Thus, prevention of dyslipidemia is urgently required for the primary prevention of CVD.

The available evidence indicates that the prevalence of dyslipidemia in students from primary and middle schools is 18.6% (5). Meanwhile, various international studies suggest prevalence of dyslipidemia in university students to be 33.9%

for Nepalese students (6), 86.7% for Yemeni students (7), and 25.7% for Chilean students (8). However, there is little research on the prevalence of dyslipidemia among university students in China, and thus its status should be promptly clarified.

Epidemiology research has also found that disruptions in iron homeostasis are linked to a broad spectrum of chronic disease including cardiovascular, malignant, metabolic, and neurodegenerative diseases (9). Therefore, we hypothesized that serum iron might be associated with serum lipids, and few studies examining this relationship have been conducted.

Collectively, this study aimed to explore the relationship between serum iron level and blood lipids. We found that serum iron level was negatively correlated with TG, but was positively correlated HDL-cholesterol, LDL-cholesterol, and TC in female students. The current study suggests that iron supplementation can be a strategy to prevent high serum TG in female students.

Methods

Subjects

This cross-sectional study recruited a total of 3,900 university students who participated in a physical examination. Then, we randomly selected a sample of 290 students aged 16–23 years old for this study.

Anthropometric measurements

Height and weight were measured using a method described in our pervious study (10). Briefly, standard stadiometer was used to measure height, while electronic scales were used for measuring weight. Body mass index (BMI) was calculated as weight (kilograms)/height (metres^2).

Measurement of blood lipids

First, 10 ml of venous blood was collected. Then, TG, TC, HDL-C, and LDL-C were measured by automatic biochemical analyzer at the school hospital of Wannan Medical College. Dyslipidemia was defined as follows: TC ≥6.22 mmol/L was defined as high TC, LDL-C ≥4.14 mmol/L was defined as high LDL-C, HDL-C <1.04 mmol/L was defined as low HDL-C, and TG ≥2.26 mmol/L was defined as high TG. Serum iron level was measured with the ADVIA 2400 (Siemens Healthcare Diagnostics, Illinois, USA) using colorimetric methods.

Statistical analysis

All data were analyzed using SPSS version 18(Chicago, IL, USA). Descriptive statistics were used for the characteristics (height, weight, BMI, total serum iron level, TC weight, HDL-cholesterol, LDL-cholesterol, TG, and age) of the students included. Mean level of TC, HDL-cholesterol, LDL-cholesterol, TG, and age were compared between male subjects and female subjects. Pearson's correlation coefficient was used to determine an association between serum iron level and blood lipids, with a value of $P<0.05$ being considered statistically significant.

Results

General characteristics

A total of 290 students (160 males and 130 females) were recruited in our study. General characteristics of the students are shown in *Table 1*.

Prevalence of dyslipidemia among university students

The prevalence of dyslipidemia was 8.8% among male students and 5.4% among female students. The overall prevalence of dyslipidemia was 7.2% among the total students (*Table 2*).

The relationship between serum iron level and blood lipids

Table 3 showed that the serum iron level was negatively correlated with TG, but was positively correlated HDL-cholesterol, LDL-cholesterol, and TC in female students ($P<0.05$). No correlation was found between serum iron level and blood lipids in male students and overall students($P>0.05$). Then, we determined whether serum iron level had a normal distribution in the study population. Our results showed that distribution of serum iron level displayed two-peak profiles in male students (*Figure 1A*), female students (*Figure 1B*), and overall students (*Figure 1C*). The mean level of serum iron was about 15 mmol/L. Next, we divided the study population into 2 groups according to the level of serum iron (the <15 mmol/L group and the ≥15 mmol/L group). No significant difference of serum TG level was found between male students with serum iron levels lower than 15 mmol/L and male students

Table 1 The general characteristics of the subjects grouped by gender

Parameter	Male		Female		Overall	
	Mean	SD	Mean	SD	Mean	SD
TG (mg/dL)	0.92	0.42	0.75	0.26	0.92	0.42
HDL-C (mg/dL)	1.35	0.21	1.47	0.27	1.35	0.21
LDL-C (mg/dL)	2.60	0.69	2.58	0.59	2.59	0.65
TC (mg/dL)	4.13	0.76	4.20	0.65	4.13	0.76
Serum iron level (mmol/L)	15.57	3.99	15.55	4.92	15.57	3.99
Age (years)	18.69	1.18	18.35	0.92	18.69	1.18
BMI (kg/m^2)	21.65	3.49	20.61	3.14	21.65	3.49
Height (m)	1.72	0.05	1.59	0.06	1.72	0.05
Weight (kg)	64.38	11.80	52.35	8.80	64.38	11.80

TG, triglyceride; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; BMI, body mass index.

Table 2 Prevalence of dyslipidemia among university students

Parameter	Male		Female		Overall	
	n	%	n	%	n	%
High TG	4	2.5	0	0.0	4	1.4
Low HDL-C	8	5.0	5	3.8	13	4.5
High LDL-C	2	1.3	1	0.8	3	1.0
High TC	0	0.0	1	0.8	1	0.3
Overall	14	8.8	7	5.4	21	7.2

TG, triglyceride; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol.

Table 3 Correlation between serum iron level and blood lipids

Parameter	Male		Female		Overall	
	r	P	r	P	r	P
Triglyceride (mg/dL)	–0.07	0.39	–0.19	0.03	–0.11	0.07
HDL-cholesterol (mg/dL)	–0.08	0.32	–0.10	0.25	–0.09	0.13
LDL-cholesterol (mg/dL)	–0.01	0.97	0.03	0.71	0.01	0.82
Total cholesterol (mg/dL)	–0.03	0.69	–0.03	0.75	–0.03	0.61

HDL, high-density lipoprotein; LDL, low-density lipoprotein.

with serum iron levels 15 mmol/L or above (*Figure 2A*). Female students (*Figure 2B*) with serum iron levels lower than 15 mmol/L had a higher level of serum TG than female students with serum iron levels 15 mmol/L or above (P<0.05), which is the same as the results in the overall students (*Figure 2C*).

Discussion

The principal finding of our study was that the prevalence

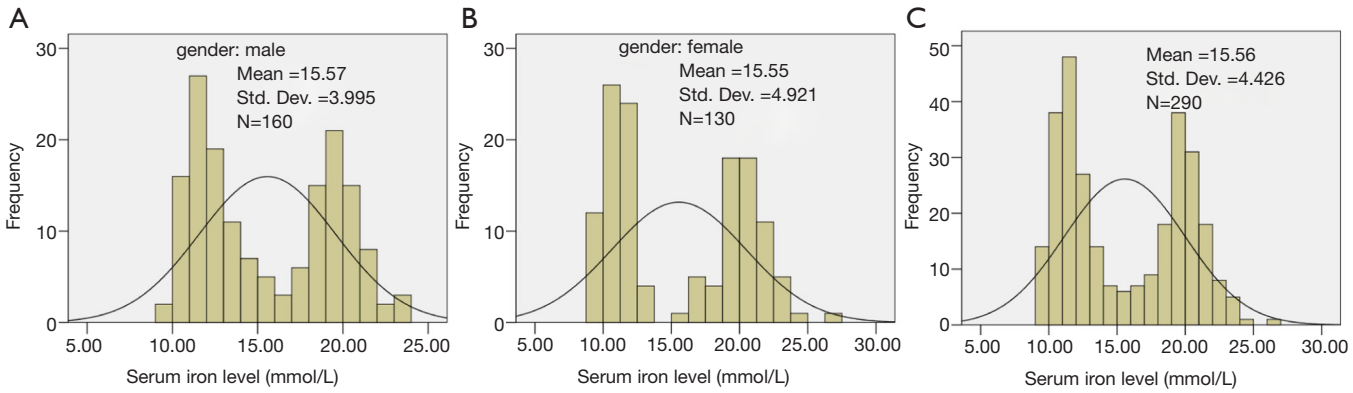

Figure 1 Distribution of serum iron level in male, female, and overall students. (A) male; (B) female; (C) overall students.

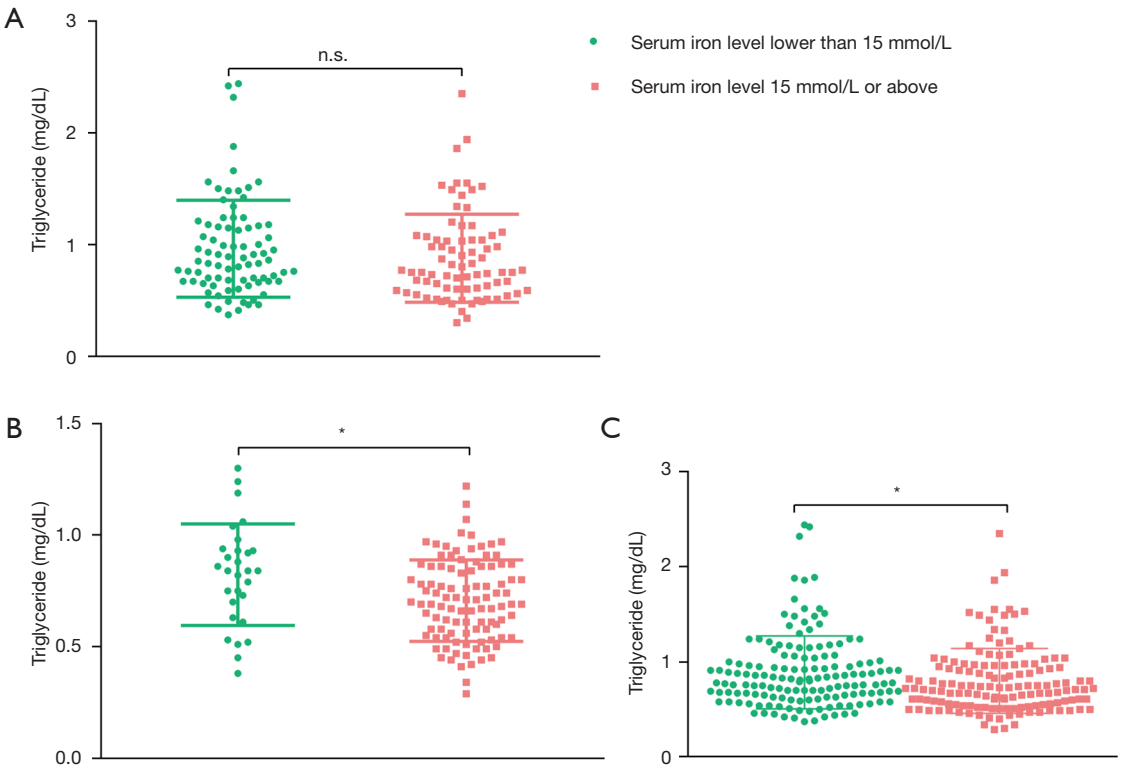

Figure 2 Comparison of mean serum triglyceride level between students with serum iron levels lower than 15 mmol/L and students with serum iron levels 15 mmol/L or above. (A) male; (B) female; (C) overall students. *, P<0.05.

of dyslipidemia was 8.8% among male students and 5.4% among female students. This result suggests that the prevalence of dyslipidemia among university students in our study is lower than that in other countries (11). The difference between our study and other studies may be accounted for by divergent socioeconomic status, behavioral habits, and lifestyles across different countries.

Another central result was that the serum iron level was negatively correlated with TG, but was positively correlated with HDL-cholesterol, LDL-cholesterol, and TC in female students. Elevated TG levels are a biomarker of cardiovascular risk (12). Therefore, it is interesting to find

the correlation of serum iron levels with TG among female university students. So far, there has been no direct evidence found between serum iron levels and serum TG levels. One meta-analysis did find that daily iron supplementation effectively improves exercise performance and symptomatic fatigue (13). Cohort studies should be conducted to confirm the relationship between iron supplementation and serum TG among female university students, and even the general female population.

Some limitations of this study should be addressed. First, we only selected a small sample for inclusion, and so large-scale study is still needed to confirm the results. Furthermore, our findings were derived from general health examinations. Thus, we failed to acquire more detailed information like behavior, habits, and diet. These shortcomings notwithstanding, our study describes the general profile of blood lipids of students from a medical university. Of further note, we found that serum iron level was negatively correlated with TG, but was positively correlated with HDL-cholesterol, LDL-cholesterol, and TC in female students. These findings can offer a basis for interventions against dyslipidemia in university students.

Conclusions

These findings suggest that the overall prevalence of dyslipidemia in the current sample population was relatively low compared to other countries. Furthermore, the total students lower serum iron level may indicate that high serum TG is a risk factor in female students. Iron supplementation could thus be a measure for preventing high serum TG in female students.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was approved by the ethics committee at Wannan Medical College. Written informed consent was obtained from all subjects.

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