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LETTER TO THE EDITOR

Evaluation of Friedewald's Formula for Plasma LDL-Cholesterol Estimation

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SUMMARY

Background: **Low-density lipoprotein cholesterol (LDL-C) can contribute to atherosclerosis if it is oxidized within the walls of arteries. Therefore, LDL-C plays an important role in cardiovascular disease risk assessment and prevention. The current study aims to evaluate the validity of Friedewald's formula in the Taiwanese population.**
Methods: **In this analytical cross-sectional study, a data set containing 31,729 results was used and lipid profiles of all samples were measured using the Beckman Coulter AU680 clinical chemistry analyzer. This study was conducted from September 2016 to August 2019.**
Results: **The agreement between the direct and calculated LDL-C was significant with Pearson's correlation coefficient (r) of 0.904 ($p < 0.001$). Mean LDL-C levels were 99.3 ± 32.8 mg/dL and 95.3 ± 37.6 mg/dL for direct and calculated LDC-C, respectively.**
Conclusions: **Good agreement was observed between direct and calculated LDC-C. Therefore, it can be concluded that Friedewald's formula is applicable in LDL-C estimation when the direct method is not affordable.**
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KEYWORDS

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Low-density lipoprotein cholesterol (LDL-C) concentration is widely recommended to assess the risk factor of coronary heart disease (CHD) owing to a strong positive association between increased LDL-C and CHD [1]. Moreover, this factor plays an important role in assessing cardiovascular risk [2]. As such, LDL-C measurement is focal to clinical efforts to reduce cardiovascular risk events [3,4]. Studies showed that an almost 1% reduction in LDL-C can reduce the risk of cardiovascular disease by 1% as well [5]. Therefore, it is vital to ensure accuracy and precision in the method used to estimate blood LDL-C. In Taiwan, CHD is one of the leading causes of death and, therefore, public health efforts need to address this issue [6]. To date, measurement of LDL-C by Friedewald's formula is applied in

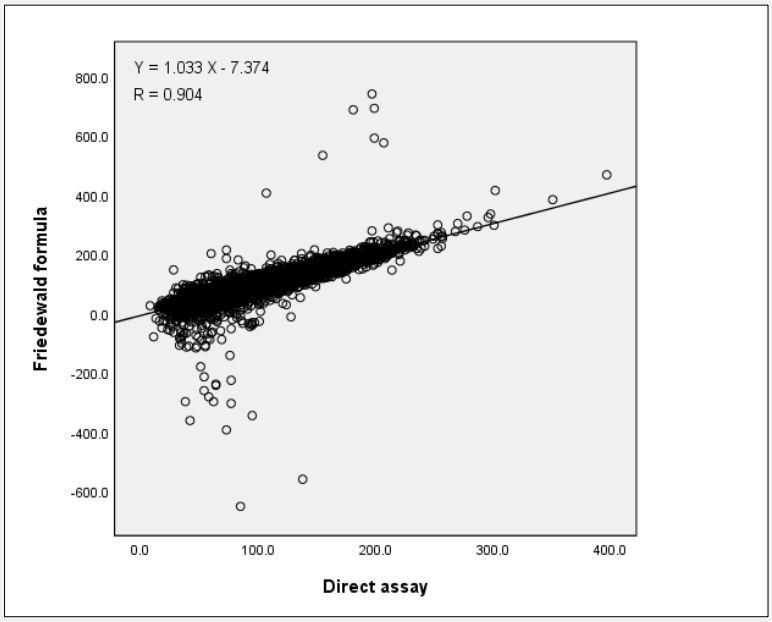

Figure 1. The correlation between direct and calculated LDL-C.

clinical and research settings worldwide because direct LDL measurement is expensive [3,7]. Therefore, the current study aims to evaluate the validity of the Friedewald's formula in the Taiwanese population.

In this analytical cross-sectional study, a data set containing 31,729 results was collected and the lipid profiles of the samples were analysed using the Beckman Coulter AU680 clinical chemistry analyzer. This study was conducted from September 2016 to August 2019. Ethics approval was obtained from Institution Review Board of China Medical University Hospital (CMUH 111-REC2-130). The requirement for informed consent from each patient was waived. LDL-C was calculated using Friedewald's formula and these values were compared with direct LDL-C assay used routinely in our laboratory. Plasma lipid concentrations were measured using the AU680 clinical chemistry analyzer, which provided direct homogenous assays for LDL-C and HDL-C, and enzymatic color assays for total cholesterol and triglycerides. The calculated LDL-C levels were determined using the Friedewald's formula (Cholesterol-(HDL-C + Triglyceride/5)).

Figure 1

Shows the strong agreement between two methods, with Pearson's correlation coefficient (r) of 0.904 ($p < 0.001$). The overall mean LDL-C levels were 99.3 ± 32.8 mg/dL and 95.3 ± 37.6 mg/dL for direct LDL-C and calculated LDC-C, respectively.

As mentioned before, assessing LDL-C concentrations helps in the further assessment of cardiovascular risk, confirming LDL-C as a target in therapy decisions. Therefore, accuracy and precision in the method used to estimate blood LDL-C are vital. Inaccurate estimation of LDL-C may delay treatment and lead to inappropriate medical prescription. Although we showed a strong agreement between direct and calculated LDC-C, Friedewald's formula has certain limitations; one of these limitations is that it is not applicable in subjects with triglyceride levels over 400 mg/dL, diabetes, kidney or liver diseases, or other metabolic conditions [8]. For instance, this current study shows a lack of agreement between LDL-C estimated by a direct assay and Friedewald's formula if triglyceride levels are over 400 mg/dL ($r = 0.5$). In addition, Friedewald's formula will underestimate when LDL-C is present at low concentrations [9], making it unreliable. A recent study also showed that Friedewald's formula tends to underestimate LDL-C levels in high-risk settings [10].

The major drawbacks in the present study was that we did not evaluate other formulae to calculate LDL-C levels and did not compare them with LDL-C estimated by a direct assay. In summary, we observed good agreement between direct and calculated LDL-C in our study populations. Thus, Friedewald's formula is applicable in LDL-C estimation when the direct method is not affordable.

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Declaration of Interest:
There is no conflict of interest associated with this paper.

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