



Computational Intelligence Techniques

SMART COMPUTATIONAL INTELLIGENCE IN BIOMEDICAL AND HEALTH INFORMATICS

Edited by

Amit Kumar Manocha, Mandeep Singh, Shruti Jain,
and Vishal Jain

Smart Computational Intelligence in Biomedical and Health Informatics

Computational Intelligence Techniques

Series Editor: Vishal Jain

The objective of this series is to provide researchers a platform to present state of the art innovations, research, and design and implement methodological and algorithmic solutions to data processing problems, designing and analyzing evolving trends in health informatics and computer-aided diagnosis. This series provides support and aid to researchers involved in designing decision support systems that will permit societal acceptance of ambient intelligence. The overall goal of this series is to present the latest snapshot of ongoing research as well as to shed further light on future directions in this space. The series presents novel technical studies as well as position and vision papers comprising hypothetical/speculative scenarios. The book series seeks to compile all aspects of computational intelligence techniques from fundamental principles to current advanced concepts. For this series, we invite researchers, academicians, and professionals to contribute, expressing their ideas and research in the application of intelligent techniques to the field of engineering in handbook, reference, or monograph volumes.

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Smart Computational Intelligence in Biomedical and Health Informatics

Amit Kumar Manocha, Mandeep Singh, Shruti Jain, Vishal Jain

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*Amit Kumar Manocha, Mandeep Singh,
Shruti Jain, and Vishal Jain*



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Preface

Health informatics involves multidisciplinary domains to extract information and knowledge from physiological data to use in decision making for improved human health through the effective use of recently developed technologies and algorithms. The aim is to provide a cross-disciplinary forum to share information on research, simulations and modeling, measurement and control, analysis, information extraction, and monitoring of physiological data in clinical medicine and the biological sciences. Emphasis is placed on contributions dealing with the practical, applications-led research on the use of methods and devices in clinical diagnosis, disease prevention, patient monitoring, and management. Health informatics is closely related to artificial intelligence where heuristic as well as metaheuristic algorithms are designed to provide better and optimized solutions in reasonable amounts of time. These algorithms have been successfully applied to different application domains in biomedical, bioinformatics, and biological sciences. The practice of recent biomedical research requires sophisticated information technologies to manage patient information, and plan for diagnostics, prognostics, procedures, interpretation, and investigations. This provides a conceptual framework and practical inspiration for the quickly growing and promising engineering and scientific disciplines of computer science, decision science, information science, cognitive science, and biomedicine. The objective of this book is to provide the researchers a platform to present state-of-the-art innovations, research, design, and implement methodological and algorithmic solutions to data processing problems by designing and analyzing evolving trends in health informatics and computer-aided diagnosis. This book will provide support and aid to the researchers involved in designing decision support systems that will permit the societal acceptance of ambient intelligence. The overall goal of this book is to present the latest snapshot of the ongoing research as well as shed further light on future directions in this space. This book presents novel technical studies as well as position and vision papers comprising hypothetical/speculative scenarios.

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1 Impact of Gender on the Lipid Profile of Patients with Coronary Artery Disease

A Bayesian Analytical Approach

Vivek Verma, Ashwani Kumar Mishra, Anita Verma, Hafiz T. A. Khan, Dilip C. Nath, and Rajiv Narang

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1.1 INTRODUCTION

Cardiovascular diseases are grouped into diseases based on problems of the heart and blood vessels [1], including acute coronary syndrome and coronary artery disease (CAD). CAD occurs when the heart has not received adequate amounts of oxygen and blood due to plaque buildup within the coronary arteries, and CAD is the most common type of heart disease. The deposition of cholesterol (known as atherosclerosis) and other materials (called plaque) within the coronary arteries causes the arteries to narrow and harden, which affects the blood supply to the heart. If such deposition continues, then it will lead to heart failure. According to the World Health Organization, CAD is one of the leading causes of morbidity and mortality and is also the leading cause of death.

According to the American Heart Association, among several risk factors for coronary heart disease, the components of the lipid profile, namely triglycerides, low-density lipoprotein cholesterol (LDL-C), direct high-density lipoprotein cholesterol (HDL-C), and total cholesterol are very common. According to the Centers for Disease Control and Prevention (CDC), CAD is the leading cause of death in the United States for both men and women. CAD alone is responsible for more than 4.5 million deaths worldwide [2].

Risk factors associated with CAD include lifestyle, environment, and genetic factors [3]. Previous CAD studies have documented the association of the lipid profile; in this sense, intensive lifestyle changes can also stop or reverse its progression without the use of lipid-lowering drugs [4]. According to the American Heart Association, the recommended normal range prescribed for a lipid profile is: total cholesterol < 200 mg/dL, triglycerides < 200 mg/dL, HDL-C > 40 mg/dL, and LDL-C < 130 mg/dL. The lipid profile acts as a diagnostic tool for the detection and clinical management of cases of CAD. For example, in dyslipidemia, patients with CAD, LDL-C, total cholesterol and triglycerides, will be higher, and HDL-C cholesterol will be lower [5]. It is also well known that in patients with CAD, triglycerides [6], total cholesterol, and LDL-C are significantly higher, and HDL-C is significantly lower [7–10].

The influence of gender on the components of the lipid profile is also studied in various situations. Total cholesterol levels in women are significantly reduced in the 25- to 49-year age group and are higher in the 50- to 64-year age group than in men [11]. Total cholesterol, LDL-C, and the ratio of total cholesterol to HDL-C levels are significantly higher in older women (> 50 years) than in younger women (30–46 years), but in men, these levels do not change dramatically with age [12]. The impact of gender on triglycerides turns out to be significantly different [13–15].

In a study [6], it had shown that 13.3% of the population older than 55 years were affected by CAD and, among them, the percentage of men was higher than that of women. The appearance of CAD is associated with changes in the lipid profile, which is influenced by several factors, and among them, the sex of an individual is also an important factor. Therefore, the objective of the present study is to examine the impact of sex on the lipid profile in patients with CAD. For this study, the data set from the National Health and Nutrition Examination Survey (NHANES), 2015–2016, was used. The study population is made up of people 50 years of age or older. To compare the differences in the lipid profile between the sexes when the sample size is comparatively small, both a classic two-tailed Student test and a non-parametric Wilcoxon rank sum test, as well as the Bayesian t-test were adopted. Statistical significance was measured using p-values in the context of the Student's t-test and the Wilcoxon rank sum test, while the Bayes factor was used for the Bayesian t-test.

1.2 METHODS

For the evaluation of the health and nutrition component of the noninstitutionalized population in the United States, since the early 1960s, the CDC has conducted the NHANES. The NHANES program was initiated to assess the level of health

and nutritional status in the United States, collecting information on various characteristics—household, physical, and medical examinations of sampled children and adults. In this study, we used NHANES 2015–2016, which was launched with 15,327 people. The NHANES (2015–2016) database was considered, which included 9,971 individuals, who completed the interview.

1.2.1 STUDY POPULATION

Participants aged less than 50 ($n = 8635$) and lipid profiles were not observed or declared ($n = 291$), are excluded. There were 1,045 participants, aged 50 years or older, and among them, 91 were clinically diagnosed with CAD and the remaining 945 did not have CAD (non-CAD), and their lipid profiles were observed and reported.

1.2.2 LABORATORY METHODS

Information on laboratory parameters, including lipid profiles, including triglycerides (mg/dL), LDL cholesterol (mg/dL), direct HDL cholesterol (mg/dL), and total cholesterol (mg/dL), were obtained from the participants, who were recommended too fast for at least nine hours before physical examination at the mobile examination center (MEC) for blood collection.

The criteria of the lipid standardization program of the CDC were used to standardize the parameters of the serum lipid profile due to changes in laboratory methods during years of research to ensure accuracy and comparability of measurements between studies.

1.3 STATISTICAL ANALYSIS

For the comparison of the descriptive statistics among gender, the results were expressed as Mean (μ) \pm Standard Deviation (s) and percentage (%). Under the assumption that the variation among the components of lipid profile and other continuous differences based on sex (for male (μ_M, s_M); female (μ_F, s_F)) are fixed quantities, to test the hypothesis

$$H_0 : \mu_M = \mu_F \text{ vs } H_1 : \mu_M \neq \mu_F \quad (1.1)$$

the classical two-tail Student's t-test and Wilcoxon rank sum test under parametric and nonparametric setup, respectively, were appropriately used and discussed, and statistical significances were measured using their p-values. For testing the hypothesis of equation (1.1), the test statistic takes the following form under the classical paradigm:

$$t = \frac{\bar{x}_M - \bar{x}_F}{\left(\frac{(n_M - 1)s_M^2 + (n_F - 2)s_F^2}{n_M + n_F - 2} \right)^{1/2} / \sqrt{n_0}} \quad (1.2)$$

where, $n_0 = \left(\frac{1}{n_M} + \frac{1}{n_F}\right)^{-1}$, the degrees of freedom are $\tau = n_M + n_F - 2$, \bar{x}_i and μ_i respectively, denotes the sample and population mean corresponding to each the continuous quantity of the i^{th} gender, $\{i = Male(M), Female(F)\}$.

In real sense, the exact characterization of the randomness inherent in the quantitative measurement is ignored. Under such situation, the comparison of any continuous quantities and their assessments under a traditional test of significance becomes a serious concern. Therefore, the present work emphasizes another promising paradigm of the statistical framework that can address such a situation by considering the formulation under the Bayesian t-test. In this analytical procedure, a reasonable and useful prior has suggested to obtain a closed form of Bayes factor for emphasizing the statistical significance. To test the hypothesis under two-sided alternatives, the Bayesian version of the two-sample t statistic under the null and alternative hypotheses was adopted, and the decision was made using the value of Bayes factor (B). In the present study, common variance, say σ^2 , has assumed both sex corresponding to each quantity. In order to work with the Bayesian paradigm, we need to specify the prior distribution of the effect size (difference) that needs to be tested. Under the suggested hypothesis of a nonzero difference, the standardized difference $\frac{|\mu_M - \mu_F|}{\sigma}$ has prior mean, say θ , and prior variance, say σ_θ^2 . The Bayes factor for testing H_0 against H_1 of equation (1.1) is:

$$B(\mathbf{x}) = \frac{T_\tau(t|0,1)}{T_\tau(t|\theta\sqrt{n_0}, 1+n_0\sigma_\theta^2)} \quad (1.3)$$

where $T_\tau(t|\alpha, \beta)$ denotes the value that results from plugging t into noncentral t distribution probability density function with f degree of freedom and parameters α for location and $\beta^{1/2}$ for scale [16]. The rule of thumb [17–18] followed for inference is as follows, if $\log_{10}(B(\mathbf{x}))$ varies between 0 and 0.5, the evidence against null hypothesis H_0 will be poor, if $\log_{10}(B(\mathbf{x}))$ lies between 0.5 and 1, it is substantial, if it is between 1 and 2, it is strong, and if it is above 2 it is decisive. The results are simulated by following the Gibbs sampling, with 100,000 iterations, by using R-software version 3.6.2, and data processing is done using the SAS University edition.

1.4 RESULTS

1.4.1 DESCRIPTIVE CHARACTERISTICS

Table 1.1 shows the comparison of patients with CAD and non-CAD, which includes the age at which CAD occurred, its duration, if the doctor ever said the person was obese and/or to reduce salt and fat/calories intake. A total of 91 CAD and 954 non-CAD participants [males (CAD = 55; non-CAD = 450) and females (CAD = 36; non-CAD = 504)] were included in this study. The overall mean age \pm general standard deviation of the participants was 69.8 ± 7.5 years in CAD (54–80 years) and 64.5 ± 9.2 in non-CAD (50–80) years. The mean age of presentation to seek

TABLE 1.1
Demographic and Clinical Characteristics of the Patients with CAD Versus No CAD

		CAD (<i>n</i> = 91) (Mean ± SD/ Percentage) (Range)	No CAD (<i>n</i> = 954) (Mean ± SD/ Percentage) (Range)
Characteristics and Categories			
Age (in years) (Mean ±SD) (range)	Male	69.3 ± 7.2 (54–80)	64.5 ± 8.9 (50–80)
	Female	70.6 ± 7.9 (57–80)	64.5 ± 9.4 (50–80)
	All	69.8 ± 7.5 (54–80)	64.5 ± 9.2 (50–80)
CAD Occurrence Age (in years) (Mean ±SD)	Male	57.2 ± 9.8	NA
	Female	60.4 ±10.5	NA
	All	58.5 ± 10.2	NA
Duration of period of CAD	Male	12.2 ± 8.1	NA
	Female	10.1 ± 8.9	NA
	All	11.4 ± 8.4	NA
“Doctor ever said you were overweight”*	Yes	47 (51.7)	370 (38.8)
“Doctor told to reduce salt in diet” *	Yes	48 (52.8)	350 (36.7)
“Doctor told to reduce fat/calories”*	Yes	47 (57.7)	371 (38.9)

*From the questionnaire used in the study.

treatment for CAD in men (57.2 years) was earlier than in women (60.4 years). The duration of CAD in men (12.2 years) was longer than in women (10.1 years). Most of the patients with CAD were obese (51.7%), and it was recommended to reduce their salt intake (52.8%) and diet control (57.8%). Among non-CAD participants, the percentage distribution of obese people prescribed to reduce salt intake and diet control is almost the same.

1.4.2 CLINICAL FEATURES

A comprehensive gender comparison between the lipid profile parameters as well as some of the derived parameters, namely triglycerides (mg/dL), LDL cholesterol (mg/dL), direct HDL cholesterol (mg/dL) and total cholesterol (mg/dL), non-HDL cholesterol, TC: HDL and LDL: HDL ratio are listed in [Tables 1.2–1.4](#). The gender association between the various components of the lipid profile and their derived proportions has been measured under the classical (both parametric and nonparametric) and Bayesian paradigms. Furthermore, the empirical gender-wise distribution pattern of each of the lipid parameters and their means are shown in [Figures 1.1–1.2](#), participants without CAD (*n* = 945) and CAD participants (*n* = 91).

In [Table 1.2](#), it was hypothesized (null hypothesis) that there is no gender difference in the lipid profile of the participants (independent of CAD and absence of CAD). The classical t-test and nonparametric Wilcoxon rank sum test based

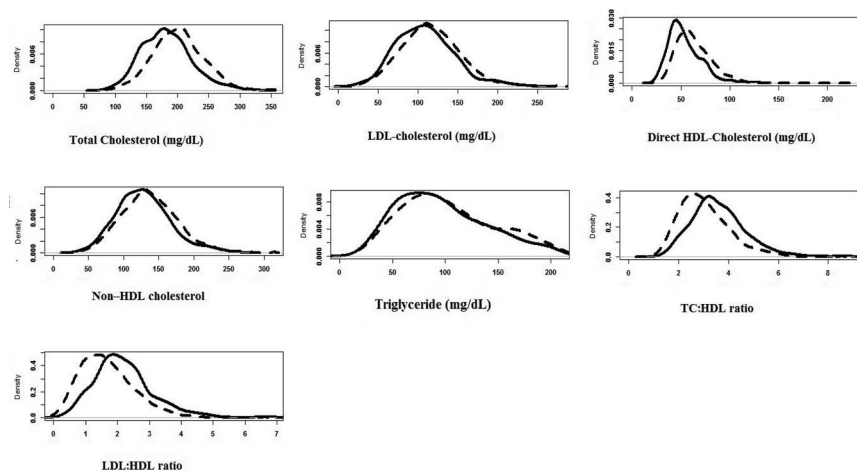


FIGURE 1.1 Gender-wise empirical distributional patterns of the lipid parameters pattern of no CAD participants (Male = 450; Female = 504), black denotes male and dashed denotes female.

on participants ($n = 1,045$) suggested a significant difference between the sexes ($p < 0.05$) for triglycerides, LDL cholesterol, direct HDL cholesterol, total cholesterol, and non-cholesterol, HDL, TC:HDL ratio and LDL:HDL ratio of the lipid profile. The similar significant gender difference in lipid profiles was also captured by Bayesian t-tests and revealed that the Bayes factor (Log (B)) is greater than 2

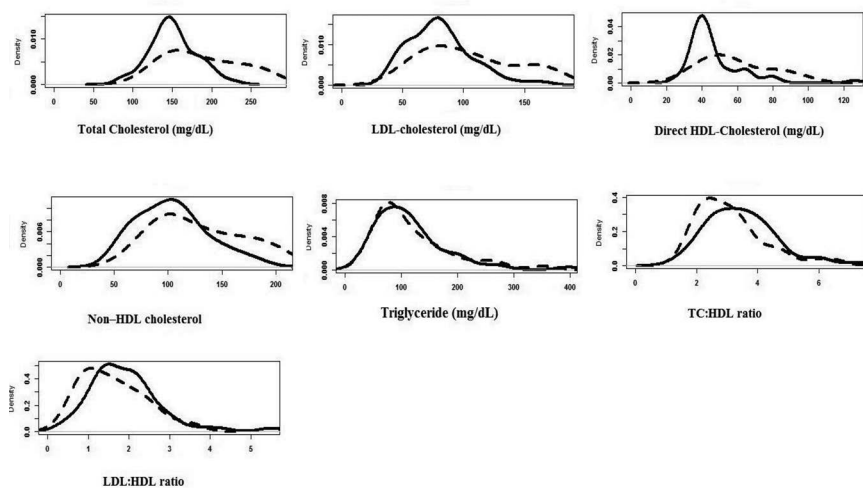


FIGURE 1.2 Gender-wise empirical distributional patterns of the lipid parameters pattern of CAD participants (Male = 55; Female = 36), black denotes male and dashed denotes female.

TABLE 1.2
Classical and Bayesian Evaluation of Gender Differences in Association of Lipid Profile Among Total Patients (Large Sample Size)

Parameter	Gender (<i>n</i> = 1,045)		Parametric Test for Difference in Mean		Nonparametric Wilcoxon rank sum test	Bayes Factor (Log(B))
	Male (<i>n_M</i> = 505) Mean ± SD	Female (<i>n_F</i> = 540) Mean ± SD	t-value	p-Value	p-Value	
Total Cholesterol (mg/dL)	178.80 ± 39.91	200.30 ± 40.97	-8.56	< .0001	< .0001	14.03
LDL Cholesterol (mg/dL)	105.90 ± 36.25	115.80 ± 36.54	-4.39	< .0001	< .0001	2.76
Direct HDL Cholesterol (mg/dL)	53.02 ± 16.73	63.41 ± 18.93	-9.37	< .0001	< .0001	16.96
Non-HDL Cholesterol	125.80 ± 38.28	136.80 ± 39.68	-4.57	< .0001	< .0001	5.11
Triglyceride (mg/dL)	99.21 ± 46.07	105.00 ± 46.66	-2.00	0.0457	0.0347	8.58
TC:HDL ratio	3.60 ± 1.11	3.36 ± 1.03	3.69	0.0002	< .0001	2.73
LDL:HDL ratio	2.17 ± 0.94	1.98 ± 0.85	3.40	0.0007	0.0005	2.29

as triglycerides (Log (B) = 8.58), LDL cholesterol (Log (B) = 2.76), direct HDL cholesterol (Log (B) = 16.96), total cholesterol (Log (B) = 14.03) and non-HDL cholesterol (Log (B) = 5.11), TC: HDL ratio (Log (B) = 2.73) and LDL: HDL ratio (Log (B) = 2.29).

The classical t-test and nonparametric Wilcoxon rank sum test based on no-CAD participants (*n* = 945) is presented in Table 1.3, which was also suggesting a significant (*p* < 0.05) gender-wise difference among Triglyceride, LDL cholesterol, direct HDL cholesterol, total cholesterol and non-HDL cholesterol, TC:HDL ratio and LDL:HDL ratio of lipid profile. Significant differences among lipid profiles of males and females were also captured by Bayesian t-tests with Bayes factor (Log(B)) greater 2, that is, triglyceride (Log(B) = 4.76), LDL cholesterol (Log(B) = 2.45), direct HDL cholesterol (Log(B) = 32.62), total cholesterol (Log(B) = 22.79) and non-HDL cholesterol (Log(B) = 3.51), TC:HDL ratio (Log(B) = 4.54) and LDL:HDL ratio (Log(B) = 4.06).

The classical t-test and nonparametric Wilcoxon rank sum test based on CAD participants (*n* = 91) is presented in Table 1.4, which suggested significant gender-wise differences only among LDL cholesterol, direct HDL cholesterol, total cholesterol, and non-HDL cholesterol, of lipid profile. On the other hand, Bayesian

TABLE 1.3
Classical and Bayesian Evaluation of Gender Differences in Association of Lipid Profile Among Patients with No CAD (Large Sample Size)

Parameter	Gender (<i>n</i> = 954)		Parametric Test for Difference in Mean		NonParametric Wilcoxon Rank Sum Test	Bayes Factor (Log(B))
	Male (<i>n_M</i> = 450) Mean ± SD	Female (<i>n_F</i> = 504) Mean ± SD	t-Value	p-Value	p-Value	
Total Cholesterol (mg/dL)	182.20 ± 39.67	201.10 ± 40.29	−7.28	< .0001	< 0.0001	22.79
LDL Cholesterol (mg/dL)	109.00 ± 36.14	116.60 ± 36.26	−3.23	0.0013	0.0006	2.45
Direct HDL Cholesterol (mg/dL)	53.76 ±16.62	63.72 ± 18.84	−8.61	< .0001	< 0.0001	32.62
Non-HDL Cholesterol	128.50 ± 38.04	137.40 ± 39.51	−3.55	0.0004	0.0003	3.51
Triglyceride (mg/dL)	97.12 ± 42.47	103.80 ± 44.28	−2.38	0.0176	0.0193	4.76
TC:HDL ratio	3.61 ± 1.10	3.35 ± 1.02	3.81	0.0001	< 0.0001	4.54
LDL:HDL ratio	2.20 ± 0.94	2.00 ± 0.86	3.68	0.0003	0.0001	4.06

t-tests suggested significant gender-wise differences among all lipid profile parameters with Bayes factor (Log(B)) greater 2, that is, triglyceride (Log(B) = 7.21), LDL cholesterol (Log(B) = 2.52), direct HDL cholesterol (Log(B) = 3.36), total cholesterol (Log(B) = 3.38) and non-HDL cholesterol (Log(B) = 4.55), TC: HDL ratio (Log(B) = 4.55) and LDL: HDL ratio (Log(B) = 3.76).

1.5 DISCUSSION

Table 1.1 shows that the mean age of participants with CAD is higher than that of non-CAD participants. The mean age of onset of CAD in men was lower than that of women; therefore, the mean duration of the CAD period was longer in men than in women. The age factor is an important predictor for CAD. The majority of the CAD prevalence occurred between the ages of 50 and 70, approximately four times the prevalence in people older than 70 years. Among patients with CAD compared to non-CAD, more than 50% of the individuals corresponding to each of the risk factors of being overweight, high salt intake, and high fat/calorie intake were prescribed to reduce the intake and food control. This suggests the need to focus on the daily routine of the participants.

TABLE 1.4
Classical and Bayesian Evaluation of Gender Differences in Association of Lipid Profile Among Patients with CAD (Small Sample Size)

Parameter	Gender (<i>n</i> = 91)		Parametric Test for Difference in Mean		Nonparametric Wilcoxon Rank Sum Test	Bayes Factor (Log(B))
	Male (<i>n_M</i> = 55) Mean ± SD	Female (<i>n_F</i> = 36) Mean ± SD	t-Value	p-Value	p-Value	
Total Cholesterol (mg/dL)	151.02 ±29.92	188.58 ±48.37	-4.15	< .0001	0.0004	3.38
LDL Cholesterol (mg/dL)	80.80 ±26.14	105.28 ±39.24	-3.29	0.0017	0.0039	2.52
Direct HDL Cholesterol (mg/dL)	46.96 ±16.60	59.14 ±19.88	-3.16	0.0021	0.0007	3.36
Non-HDL cholesterol	104.10 ±95.08	129.40 ±115.30	-3.21	0.0018	0.0054	4.55
Triglyceride (mg/dL)	116.29 ±66.93	120.8 ±71.31	-0.30	0.7613	0.8806	7.21
TC:HDL ratio	3.50 ±1.17	3.43 ±1.15	0.24	0.8110	0.5976	6.14
LDL:HDL ratio	1.91 ±0.90	1.91 ±0.79	-0.01	0.9893	0.9418	3.76

Nonsignificant results obtained in both of the classic nonparametric Wilcoxon rank sum t-tests for some of the important lipid parameters, namely triglycerides, TC:HDL ratio and LDL:HDL ratio, which is considered a good predictor of CAD, was found significantly different in [Tables 1.2](#) and [1.3](#), which suggests that the null hypothesis is contrary to the theory of the difference between the sexes, and is also observed in the empirical densities shown in [Figure 1.1–1.2](#).

Previous studies that focused on the impact of triglycerides, the TC:HDL ratio, and the LDL:HDL ratio on CAD have shown that elevated triglyceride levels increase the risk of prevalence of coronary heart disease and is lowered through clinical management in addition to diet control, regular exercise, and pharmacotherapy [19]. This is of great importance for public health since such a suggestion can have positive reinforcement among patients toward adopting a healthy dietary pattern in their daily routine. The higher value of the LDL:HDL ratio shows a positive association with the prevalence of hypertension and hypercholesterolemia in men and women [20] and the higher TC:HDL ratio was considered an independent indicator of extensive coronary disease [21]. As with the classic t-test and nonparametric Wilcoxon rank sum paradigms, some of the important lipid parameters, namely triglycerides, the TC:HDL ratio, and the LDL:HDL ratio were not found to differ significantly across

gender, which were found to be different in earlier studies. Based on the results obtained, data-based estimates for lipid profile parameters were found to be consistent with clinical characteristics and were also found to be effective in demonstrating statistical significance with clinical significance. Therefore, the quality of the data was not questioned regarding the insensitivity to distinguish the theory from the null hypothesis. However, to clinically link the data to theory, apart from certain lipid parameters, namely LDL cholesterol, direct HDL cholesterol, total cholesterol, and non-HDL cholesterol, these were found to be nonsignificant in the classical tests, Bayesian technique was adopted in Table 1.4. The Bayesian t-test suggested evidence of differences in the lipid profile across gender and was also observed in the empirical densities shown in Figure 1.1. The significant difference in elevated levels of lipid parameters, namely triglycerides, LDL cholesterol, direct HDL cholesterol, and total cholesterol in women with CAD as compared to men, has also been discussed in several other studies [22–26], which has also been observed under the Bayesian test paradigm.

The lipid parameters of LDL cholesterol, direct total HDL cholesterol, and non-HDL cholesterol that were significantly different between sexes according to the classical test paradigms also corresponded to the Bayesian paradigms. On the other hand, the reverse is not true, as triglycerides, TC:HDL ratio, and LDL:HDL ratio also differed significantly across gender in Bayesian t-tests and were discussed in previous studies, but they were not captured in the conventional classical tests, possibly due to a small sample size.

1.6 CONCLUSION

In the study, the Bayesian inferential procedure is presented, where the sample size is comparatively smaller, with emphasis on the possible differences in the parameters of the lipid profile of patients with CAD between men and women. Assuming that the differences in parameters due to gender are fixed, the classical t-test and the nonparametric Wilcoxon rank sum test were not fully compatible to capture significant changes in lipid parameters due to gender. On the other hand, even with a small sample size, the results obtained on the basis of Bayesian t-tests turned out to be more reliable for concordance of clinical practices on the sex difference in the association of lipid profile in patients. Patients with CAD whose results were not fully recognized in the conventional t-tests and Wilcoxon rank sum nonparametric tests, viz. Triglycerides (p-value = 0.7613 (0.8806), Log (B) = 7.21), TC:HDL ratio (p-value = 0.8110 (0.5976), Log (B) = 6, 14) and LDL:HDL ratio (p-value = 0.9893 (0.9418), Log (B) = 3.76).

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