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Atherogenic Index of Plasma's Association with Cardiovascular Disease Risk Factors Among Postmenopausal Pakistani Women

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This is to certify that the doctoral dissertation by

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has been found to be complete and satisfactory in all respects,
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Abstract

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MSc, Royal College of Surgeons in Ireland (NUI), 2009

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Proposal Submitted in Partial Fulfillment of the Requirements for the

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Abstract

Coronary heart disease (CHD) is an array of pathophysiologies affecting the cardiovascular system and causes global mortality and morbidity in both sexes. While literature is abundant on the association between CHD and risk factors like diabetes mellitus (DM), hypertension (HTN), and menopause in women, there is little on the correlation between novel lipid factors like atherogenic index of plasma (AIP) and CHD in Pakistani postmenopausal women. This quantitative cross-sectional study, guided by socio-ecological model, involved exploring possible links between AIP and lipid profiles, age and duration of menopause, physical activity, oral contraceptive pills OCP, smoking, DM, and socioeconomic and educational status. Hypertension ($\beta = 0.141$, $p = 0.002$) and cholesterol (($\beta = 1.557$, $p < 0.001$) were statistically associated with AIP (controlling for confounders). LDL ($\beta = -1.527$, $p < 0.001$) and HDL ($\beta = -0.426$, $p = 0.001$) were significantly associated with AIP cholesterol. Except for age at menopause and duration of menopause, all other predictors were positively associated with AIP. Implications for positive social change include developing strategies for escalating alternative plans to address the overburdening of hospitals, adapting patient-centered screening programs, and modifying existing plans for minimizing chronic disease load through prevention strategies. This could reduce the burden of interventional cardiology in Pakistan and improve the lives of individuals, families, and communities.

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Chapter 1: Introduction

The prevalence of coronary heart disease (CHD) has made it the leading cause of mortality among women, especially those in low-income communities (Abdalla et al., 2020; Cleveland Clinic, 2019). The study conducted by Shin et al. (2022) in Pakistan revealed a notable prevalence of (CHD), with particular emphasis on the atherogenic index of plasma (AIP) as a significant risk factor for unfavorable CHD outcomes. Liaquat and Javed (2018) reported that coronary heart disease (CHD) had the highest mortality rate among women in Pakistan. According to the Centers for Disease Control and Prevention (CDC; 2023), there is a notable rise in the risk of coronary heart disease (CHD) among women following menopause, typically exhibiting a temporal lag compared to men. Coronary heart disease (CHD) has been identified as the leading kind of cardiovascular disease (CDC., 2021) (CDC., 2023).

In actuality, the term *heart disease* commonly denotes Coronary Heart disease (CHD) (Coronary Heart Disease., 2022). El Khoudary et al. (2020) observed various patterns of hormonal fluctuations and adverse alterations in body composition, lipids, lipoproteins, and vascular health markers in women experiencing the menopausal transition. These alterations can potentially increase women's susceptibility to cardiac disease after the onset of menopause. Hence, the principal aim of this investigation was to evaluate the correlation between AIP and several risk factors linked to coronary heart disease (CHD).

In this study, I investigated the association between the Atherogenic index of plasma (AIP) and Coronary heart disease (CHD) risk factors, including age at menopause, duration of menopause, physical activity, and AIP levels. In a study conducted in South Asia, Barua et al. (2019) investigated a comparable notion by analyzing the relationship between AIP, physical activity, and several risk factors for cardiovascular disease (CVD) among postmenopausal women residing in a rural environment. Barua et al. (2019) developed a theoretical framework based on health beliefs. Barua et al. (2018) highlighted the anticipated prevalence of ischemic heart disease (IHD) in conjunction with an atherogenic index of plasma (AIP), as determined by the lifestyle patterns seen within the studied group. In contrast, an inverse relationship was seen between coronary heart disease (CHD) risk factors and the Metabolic event of task (MET) value. The authors proposed the necessity for additional research to ascertain precise lifestyle modifications for persons at high risk and to comprehend the connection between periodic physiological changes and coronary artery disease (CAD).

The mortality rate from coronary heart disease (CHD) among women closely mirrors that observed in males. Sudden cardiac death (SCD), a severe consequence of morbidity, is frequently manifested as the first indication of ischemic heart disease (IHD) in women. However, there was a dearth of knowledge regarding sudden cardiac death (SCD) in both women with and without coronary heart disease (CHD), as evidenced by studies conducted by Mehta et al. (2017) and Skjelbred et al. (2022). Skjelbred et al. (2022) emphasized the substantial impact of SCD, regardless of the presence or absence of coronary artery disease (CAD) blockage, on increased death rates. The enduring disparity in sickle cell disease (SCD) across genders has been ascribed to risk variables that exhibit a more pronounced impact on women than men.

Additional study was necessary to address these conventional risk factors (Bird et al., 2018). Research findings have indicated that there exists a higher vulnerability among women getting cardiovascular disease (CVD) and depression compared to men, as evidenced by studies conducted by Rivera et al. (2022). As mentioned earlier, the conditions significantly affected cardiovascular and overall mortality, as stated by Allabadi et al. (2019). The research study resulted in a reciprocal association between cardiovascular disease (CVD) and depression, wherein depression was identified as a potential precursor to the development of CVD. Rivera et al. (2022) observed a correlation between cardiovascular disease (CVD) and depression in women, indicating that depression can be considered a predictor of CVD.

Background

Since the turn of the last century, the incidence of cardiovascular disease has increased (Vaduganathan et al., 2022). CVD, predominantly CHD, was the primary cause of death worldwide, particularly in lower middle-income countries (LMIC) . Waheed et al. (2019) discovered that IHD was the leading cause of morbidity and mortality among U.S. women. Women with suspected myocardial ischemia had fewer stenotic plaques than males following coronary angiography (CAG). The leading cause of mortality among women was cardiovascular disease, particularly coronary heart disease, which increased after menopause (Prabakaran et al., 2021: El Khoudary et al., 2020). Roa-Diaz et al. (2021) determined that MT increased the incidence of CHD. El Khoudary et al. (2020) report that longitudinal studies of postmenopausal women have significantly enhanced our understanding of the association between MT and CHD risk over the past 2 decades.

Huang et al. (2015) examined 130 patients who underwent open-heart surgery. They examined the patients' exercise and physical activity levels at 3 and 6 months. Huang et al. (2015) used the socio-ecological model (SEM) to assess preparedness for behavioral change. However, the SEM's five stages could result in sufficient physical activity to maintain cardiac health.

Franny (2020) claimed that gender-specific risk factors increased a woman's atherosclerotic cardiovascular disease (ASCVD).Franny (2020) enumerated sex-specific risk factors in women's ASCVD. Multiple vulnerable moments in a woman's existence increase her CHD risk. Future ASCVD risk was associated with early menarche, pre-eclampsia, premature delivery, and early natural or surgical menopause. (Arnett et al. (2019), found that AIP was greater under these conditions and posed a higher risk. Stress, breast cancer, and autoimmune diseases may increase lipid and AIP levels, thereby increasing the risk of cardiovascular disease (Tagoe et al., 2020). Due to these risk factors, the clinical use of lipid-lowering medications for primary disease prevention may have decreased disease incidence (Tagoe et al., 2020). As CVD, specifically CHD, was women's leading cause of death, subclinical imaging could have enhanced risk assessment by monitoring coronary calcium scores.

According to Agarwala et al. (2020), women received fewer CHD diagnoses, preventative treatments, and aggressive therapies than men. Women had unique risk factors and indicators for CHD. The 2018 American heart association (AHA) and American college of cardiology (ACC) multi-society cholesterol guidelines and primary CHD prevention recommendations emphasized women-specific risk factors, lifestyle modifications, and statins for primary prevention to reduce risk. The AHA/ACC recommendations urged a thorough obstetrical and gynecological history during cardiovascular risk assessment. ACC multi-society formulated a theoretical framework for preventing sex-specific risk factors (Aerts et al., 2021).

Problem Statement

The incidence of coronary heart disease had increased in the subcontinent, especially among postmenopausal women, compared to other ethnicities worldwide. AIP was considered one of the most critical risk factors for CHD; however, no research has been conducted on the topic in Pakistan. CHD was a condition that did not occur in isolation (i.e., due to a single cause). Instead, it was a collection of pathophysiological reactions linked to alterations in the heart's functionality and a continuous decline in its function rate.

AIP, a distinctive and novel risk factor, predicted CHD risk and became a public health concern. Cai et al. (2017) found that CAG patients with CHD-related events had higher AIP indices than those without CHD-related events. However, no studies have been conducted in Pakistan to examine AIP as a risk factor for CHD in postmenopausal women.

Despite having the same plaque burden as men, women developed CHD 10 years later. This 10-year advantage has been lost by smokers, diabetics, and premenopausal women (Pathak et al., 2017). Men under the age of 40 had a higher CHD prevalence. Postmenopausal hypertension, diabetes, dyslipidemia, and obesity increase the risk of CHD (Sharma et al., 2021). Triple vessel disease was prevalent among half of the subcontinental individuals and one-third of premenopausal women, which was higher than in other ethnicities. There may have been a correlation between sexual orientation and gender in human subjects (Wenger, 2020). Sociocultural factors related to reproduction, education, lifestyle, and socialization substantially affect disease progression (Regitz-Zagrosek, 2018). Women-specific risk factors, such as pathophysiological variables such as the atherogenic index of plasma (AIP), menopausal age, and pregnancy complications, contributed to the severity of the disease (Stanhewicz et al., 2018).

Purpose of the Study

My objective in this study was to investigate the association between AIP and CHD risk factors among postmenopausal Pakistani women. Research has yet to be conducted in this field.

After menopause, the women were at greater risk due to hormonal changes. I conducted a cross-sectional study to determine whether a significant association existed between AIP and CHD risk factors (hypertension, total cholesterol, triglycerides, low-density lipoprotein, high-density lipoprotein, age at menopause, duration of menopause, and physical activity) among postmenopausal women in Pakistan while controlling for age at menarche, oral contraceptive pills (OCP), education level, income, smoking habit, and diabetes.

Theoretical Model

The SEM was initially proposed by Bronfenbrenner in the 1970s to explain human development (Kilanowski., 2017). According to social well-being theories, human health is affected by individual, interpersonal, workplace, social, environmental, political, and economic factors. McDaniel et al. (2018) demonstrated the five roles influencing disease progression: individual, interpersonal, institutional, community, and public policy. In addition, according to Sustaining Community (2015), there has been much discussion about how people in poorer regions tend to have poorer health and perish younger than those in wealthier regions. Health had been intricately intertwined with the social context, necessitating that it be addressed on multiple levels.

The SEM was an appropriate methodology for this research investigation. The SEM can be used to understand a person's characteristics, ancestry, biological components, and living conditions. The SEM has a broad scope and can been used to identify level-one personality traits. It was appropriate for the investigation of the relationship between CHD risk factors as independent variables and AIP as the dependent variable. All of these aspects were both individualistic and influenced by the social environment. For example, social context, peers, and family had influenced variables, including physical activity and smoking conditions. Thus, effective interventions could have been devised and implemented by employing the SEM to comprehend the associations between AIP and CHD risk factors among postmenopausal women while controlling for age at menarche, OCP, education level, income, smoking habit, and DM. In this study, I examined how CHD risk factors affected AIP in diverse populations.

The SEM can be used to consider multiple dimensions in a study. However, the scope of this investigation was limited to a two-tier system that could have influenced AIP. The Tier 1 or individual-level variables included CHD risk factors while controlling for age at menarche, OCP, education level, income, smoking propensity, and Type 2 diabetes. Tier 2 or second-level variables, which were not the focus of the study, included environmental characteristics, social environment variables such as family and relatives, and environmental factors such as stress, health, and well-being, living conditions, mobility, access to healthcare, and variables related to social networks. The Bronfenbrenner believed that synergies between the individual, the community, and the physical, social, and political environments affected health.

Delimitations

I conducted this study using data from 2018 and 2019 and collected by Barua et al. (2018-19) in a primary healthcare setting in rural Bangladesh, employing a STEP-wise approach to noncommunicable diseases. Patients and socioecological factors in rural Bangladesh that influenced associations between AIP and CHD in postmenopausal women. There was a time gap between information acquisition and the secondary analysis. This study's limitations included the following:

- This investigation was limited to a quantitative descriptive cross-sectional study.

- Only ancillary information was used. I did not collect primary data.
- The purview of the analysis was limited to the data collected by the data collectors.

Assumptions

Typically, such assumptions pertained to data characteristics, such as distributions, correlational trends, and variable type. Contravening these assumptions could have resulted in wildly invalid results, although this frequently depended on sample size and other variables. I made the following assumptions in this study:

- < UNK> The participants' medical records showed they lacked coronary heart disease.
- AIP concentrations were determined accurately in all disease-positive cases.
- Menopause dates and status were accurate.
- The menopause was physiological and not pathological.
- No bias was incorporated into the investigation due to the random occurrence of missing data.
- The dataset contained sufficient cases and variables for an objective analysis of the variable of interest; considering these assumptions enhanced the study's validity.

Definitions

Angina: is chest pain caused by ischemia

Atherosclerosis: Atherosclerotic plaque is made up of clumps of cholesterol and fibrinogen. Over time, the buildup of plaque makes the inside of the vessels smaller. This process is known as "atherosclerosis."

AIP: The atherogenic index of plasma (AIP) is made up of triglycerides and high-density lipoprotein cholesterol. It is a new way to measure atherogenicity vulnerability and cardiovascular and metabolic health (Kim et al., 2022).

Menopause is the process that happens a year after a woman's last period.

Body-Mass-Index (BMI): This number is found by dividing a person's weight in kilograms by the square of their height in meters. (WHO, 2018).

Chronic kidney disease (CKD) is when there are changes in the shape or function of the kidneys that have been going on for more than 3 months and are bad for your health (N.D., 2013). A list of illnesses that cause the kidney and its functions to get worse. Loss of kidney function happens slowly and gets worse over time, so that a person needs dialysis or a kidney donation to stay alive (Tonelli, 2006).

Chronic noncommunicable diseases (CNCD) are diseases that last a long time and get worse slowly. They are caused by genetic, physiological, environmental, and behavioral factors, as well as those that are passed down from generation to generation (WHO, 2017). CNCDs include, but are not limited to, heart and lung diseases, cancers, diabetes, and other long-term conditions.

Coronary heart disease: The plaque building in the coronaries, which decreases blood supply to the heart muscles, the narrowing of lumen leads to decrease oxygenation to cardiac muscles produces ischemia that leads to coronary artery disease.

Diabetes mellitus (DM, also called Type 2 diabetes or T2DM) is a disease in which the cells can't use blood sugar (glucose) as an energy source as well as they used to. (Oberg, Balentine, Cunha, & Shiel Jr., 2017) T2DM happens when the body's cells stop responding to insulin and blood sugar.

Dyslipidemia: is a metabolic disorder that causes a steady rise in the amount of cholesterol and triglycerides in the blood (Moor et al., 2017).

Hyperglycemia: It is another name for high blood sugar. It is clinically described as blood glucose levels of more than 7.0 mmol/L (126 mg/dl) when fasting or more than 11.0 mmol/L (200 mg/dl) 2 hours after a meal (Diabetes CO.UK, 2018).

Hypertension: It is a condition when systolic blood pressure is over 140 and your diastolic blood pressure is over 90. This is because your arteries are getting thicker (CDC, 2014). Hypertension is a long-term health problem where the blood pressure in the arteries stays high for a long time.

Incidence: According Roe and Doll (2000) the incidence is a way to measure how often a new case of a condition or sickness happens.

Ischemia: The muscles don't get enough oxygen, which could cause chest pain.

Macrovascular disease (MVD): A disease of the large blood vessels, such as the coronary arteries, aorta, and the large arteries in the brain and limbs (Macrovascular disease, n.d.).

Myocardial infarction: also called a "heart attack," is a condition in which the blood flow to the heart muscles is cut off, causing severe Ischemia.

Mineral bone disease: A condition common in people with chronic kidney disease (CKD). It happens when calcium and phosphorus levels in the blood are out of balance because the kidneys are damaged or hormone levels are off (n.d., 2015).

Obesity: Obesity is when a person has too much fat or fat that doesn't belong to them, which is bad for their health (WHO, 2018). A person is called obese if their body mass index (BMI) is over 30.

Postmenopausal: Post menopause is when a woman hasn't had a period for more than a year after menopause.

Prevalence is the number of people who have a sickness. (CDC, 2019a).

Risk factors: Factors that cause or contribute to the spread of a disease or lead to a decline in disease prevalence. (CDC, 2014a).

Research Questions and Hypotheses

Research Question 1: Is there an association between CHD risk factors of Hypertension (HTN), Total cholesterol (TC), Triglycerides (TG), Low-density lipoprotein (LDL), High-Density Lipoprotein (HDL), and AIP in Pakistani women after controlling for age at menarche, oral contraceptive pills (OCP), education level, income, smoking and Diabetes Mellitus (DM)?

Null Hypothesis ($H_0$1): There is no significant association between CHD risk factors (HTN, TC, Trig, LDL, and HDL) and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis (H_a1): There is a significant association between CHD risk factors (HTN, TC, Trig, LDL, and HDL) and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM.

Research Question 2 (RQ2): Is there an association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM?

Null Hypothesis ($H_0$2): There is no association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis (H_a2): There is an association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Research Question 3 (RQ3): Is there an association between physical activity and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM?

Null Hypothesis ($H_0$3): There is no association between physical activity and AIP in Pakistan women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis (H_a3): There is there an association between physical activity and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Nature of the Study

I selected a quantitative cross-sectional method as the most pertinent research strategy to resolve the issues raised in this study. To test the relationship between the independent and dependent variables, I used a suitable quantitative method for measuring clinical, laboratory, social, environmental, individual, and household determinants (see Bo et al., 2018). This study included CHD risk factors and the dependent variable AIP while controlling for age at menarche, level of education, income, smoking propensity, OCP, and diabetes. In addition to the comparative approach, the secondary quantitative method was utilized to account for demographics, age, education, and socioeconomic status. A test for multiple linear regression measured the relationship between independent and dependent variables. (Scott & Siltanen, 2016) Therefore, this quantitative research study could result in establishing a link and identify the mechanism(s) predisposing women to a higher risk of AIP after menopause.

Combining a quantitative cross-sectional methodology with secondary research was appropriate for this study because it facilitated a fast and straightforward procedure. The advantages of secondary research included cost-effectiveness and the availability of credible and up-to-date information, especially since the size of a quantitative research study could be substantial (Saldanha et al., 2019).

Barua et al. (2018) examined the relationship between physical activity and cardiovascular disease (CVD) risk factors among postmenopausal rural women in Bangladesh. Barua et al. (2019) evaluated the association between AIP levels and CHD risk among postmenopausal women in rural Bangladesh in another study. AIP was a novel risk factor that had received limited attention. However, AIP has recently received increased attention, and additional research is anticipated. Similarly, research on other risk factors, such as smoking, dietary practices, and alcohol consumption, has been conducted in Nepal (Dhungana et al., 2018).

Significance of the Study

The purpose of the study was to shed light on the concept of positive social change, which involves fortifying agents of transformation, fostering a sense of unity, and enhancing the effects of social modification. The focus was on information that could be rapidly applied to address urgent social problems for the benefit of the global good. In addition, I uncovered a need for more data regarding CHD risk factors and their relationship with AIP in postmenopausal Pakistani women contemplating DM, indicating the need for additional research in the field.

This research may be used to reconcile the social chasm within the community through an optimistic outlook on collective change and produce a road map for future research on AIP in Pakistan. It would also be used in identifying the function of AIP and reducing morbidity and mortality among Pakistani postmenopausal women. I investigated the CHD risk factors associated with age and duration of menopause, as well as physical activity, in correlation with AIP (AIP variations during physiological changes and their association with AIP and, ultimately, CHD) while controlling age at menarche, OCP, educational attainment, income, smoking habit, and dm.

Regulatory Constraints (Limitations)

Even though the potential disadvantages of secondary sources were known, it was decided to proceed with this strategy. For instance, participant securitization may have impacted the dependability of responses. It could have altered the number of individuals who responded to the initial assessment and those with combined risks or independent variables to evaluate against the AIP. In addition, the responses may have been influenced by what the respondent's family or acquaintances said rather than what the respondent himself thought, thereby creating bias. Due to the smaller sample size, the research may not have accurately reflected the population's problems.

The data were collected from a different population than the study population to ensure a superior fit. The collected and stored data could have been altered, which could have affected the measured data. As part of an observational study, the exposure and result were examined. This made it more difficult to believe the connection between exposure, choices, and disease outcome. The full range of how frequently the AIP could be used with the various variables was examined simultaneously, which assisted in examining potential service and program plans. However, the disease's etiology remained unknown. The number of cases would make it more challenging to determine the disease's cause. Despite all of this, the researcher hoped to contribute to the research.

Future research would strengthen the recommendations made in this study. Even if this study had some flaws, it would have been among the first to demonstrate how the combination of pathological and physiological risks affected AIP and caused illness and mortality in the population. Secondary data may be helpful as a reference but may also be appropriate for the study alone. These datasets were readily accessible online, although authentication may have been required for some. For ethical approval, registration was optional (Stommel & Rijik, 2021). Consequently, caution would have been exercised when comparing the findings of other studies to those of this study. Considering these assumptions for an objective analysis variable of interest improved the study's validity.

Chapter 2: Literature Review Strategy and Theoretical Model

CHD has become the primary cause of death and disability in the United States and worldwide. The etiologies underlying CHD develop over an extended period of time, resulting in a substantial portion of the disease being asymptomatic and leading to life-threatening outcomes (Nishimura et al., 2017). While numerous risk factors existed for the development of CHD, hypertension, hypercholesterolemia, diabetes, and a family history of CHD were the main contributors (Nishimura et al., 2017). Changes in individual lipid parameters, such as TAG, HDL, and LDL, are used to identify high-risk individuals with frank dyslipidemia. However, atherogenesis may occur without blatant changes in individual lipid parameters. This necessitated more sensitive parameters to identify high-risk individuals who may not have exhibited blatant changes in individual lipid parameters and to implement early therapeutic and lifestyle modifications to reduce CVD mortality and morbidity (Bakshi et al., 2019). AIP evolved as a recent novel risk factor (Barua et al., 2019). Various epidemiological investigations (Bo et al., 2018; Wu et al., 2018) demonstrated the association between AIP and the development of CHD.

AIP evolved as a critical predictor of atherogenous plaque formation (Khosravi et al.,2022). It correlated substantially with HDL and LDL sizes and cholesterol esterification fraction. Clinicians and epidemiologists also discovered a correlation between variations in AIP and plasma cholesterol levels and CHD (Bakshi et al., 2019). TAG plasma log calculated it in relation to HDL. The risk of cardiovascular disease could be stratified based on the AIP index, with values greater than 0.24 and less than 0.10 associated with an increased risk and a decreased risk of CVD, respectively.

In India, the outcome of a cross-sectional study was that the average AIP level was 0.21 +/- 0.11. Increased levels of AIP and elevated systolic and diastolic blood pressure were found to be highly correlated with increased BMI; they could predict the progression of coronary heart disease (Moussavi Javardi et al., 2020). In order to prevent CHD, the identification of its risk factors in postmenopausal women was beneficial. Few studies have been conducted in Pakistan, but none have investigated the association between AIP and other known risk factors in postmenopausal women (Fawwad et al., 2023). There was a need for additional research on the function of health awareness in preventing and managing high-risk factors (hypertension, lipid profile, and physical activity) for CHD in women of a certain age and circumstance (Khanal et al., 2017). The author sought to identify potential associations between AIP and other CHD risk factors, including HTN, lipid profile, age at menopause, and duration of menopause.

The Rationale of the Study

Globally, CHD is the primary cause of disease in women, especially in low-income communities (Yahagi et al., 2015). There may have been a correlation between sex and gender in human subjects. Due to diverse vasculature, the effects of key risk factors on CHD outcomes were more significant in females than in males (Wenger, 2020). Sociocultural factors related to reproduction, education, lifestyle, and socialization substantially affect disease progression (Regitz-Zagrosek, 2018). Women-specific risk factors, such as pathophysiological variables including menopausal age and pregnancy complications, might contribute to the disease's severity (Stanhewicz et al., 2018).

In the same region, Fawwad et al. (2020) investigated the association between AIP and CHD. However, this association had to be studied more thoroughly to understand better the relationship between AIP and CHD among postmenopausal women in Pakistan. The relationship between CHD risk factors, such as TC, TG, LDL, HDL, HTN, physical activity, age at menopause, duration of menopause, and AIP in postmenopausal Pakistani women was utterly unknown. In postmenopausal Pakistani women, I examined the association between AIP and CHD risk factors, including age at menopause and duration of menopausal activity.

El Khoudary et al. (2019) found that hormone-mediated physiological changes in women were highly diverse and could have significantly impacted the cardiovascular and other body systems, making them a unique risk factor for women. During the premenopausal period, sex hormones exhibited steroid-like protective properties (Duda-Pyszny et al., 2018). However, the knowledge vacuum regarding the relationship between menopause and CHD risk factors necessitated additional investigation. (Mehta et al., 2016; Pagidipati & Peterson, 2016; Parbakaran et al., 2021) The exact hormonal cause placing women at a higher risk for CHD had remained unknown. In addition to menopause-related pathophysiological changes (AIP), sex-specific and classic risk factors also contributed to an increased CHD risk in women (Bellamy et al., 2007; Raeisi-Giglou et al., 2017; Tooher et al., 2017; Wu et al., 2017). Sex and gender disparities in CHD remained unexplored (Zhao et al., 2021: Den Ruijter et al., 2020). The population adhering to the lower income bracket had a higher disease risk.

El Khoudary et al. (2018) linked menopause to adverse lipid profile changes, increased susceptibility to weight gain and metabolic syndrome, and epicardial and paracardial fat deposition as emergent risk factors. Lee et al. (2019) indicated that early and late menarche predicted a higher risk of adverse CHD outcomes. Most researchers say CHD is more prevalent in low-income countries than in high-income countries (Zubair et al., 2018).Given the above context and research gaps, I evaluated the progression of CHD in Pakistani women and the potential associations between their CHD risk factors, menopausal age and duration, physical activity, and AIP.

Literature Search Strategy

I reviewed the literature relevant to the prevalence and risk factors associated with IHD in women, focusing on AIP, which is emerging as a critical risk factor for CHD and CAD. I also examined the literature on tertiary protective health behaviors relevant to mitigating CHD. The research was performed using the following search terms: IHD in women, IHD and other risk factors, DM, adverse experiences of pregnancy on women and newborns, CHD diversity and other chronic diseases, heart disease and sex hormones, tertiary prevention strategies, as well as protective health behaviors and DM. I searched Databases such as ProQuest, EBSCOhost, Science Direct, PubMed, CDC, Medline, Walden University, and the National Institutes of Health were searched. The articles used for this study spanned a period from 2017 to 2022 and included one seminal paper relevant to developing the study's theoretical foundations. The literature search also spanned other publications dating from 2017 to 2022. The search was confined to retrieving materials in English. Some common strings used in the literature search included the following:

- *Health information* AND *health outcomes* AND *Socio-ecological Model*
- *Health knowledge* AND *health outcome* AND *Socio-ecological Model*
- *Health information* AND *health outcome* AND *Socio-ecological Model*
- *Menopause* AND *AIP* AND *Coronary heart disease*
- *Coronary heart disease* AND *health outcomes* AND *Socio-ecological model*

- *Coronary heart disease* AND *Atherogenic index of plasma* AND *Socio-ecological model* AND *postmenopausal women*
- *Coronary heart disease* AND *health outcome* AND "*Atherogenic index of plasma* AND *South Asia*
- *Health information* AND *health outcomes* AND *AIP* AND *cardiovascular disease*
- *Health knowledge* AND *health outcome* AND*AIP* AND *cardiovascular disease*
- *Health information* AND *AIP* AND *hypertension* AND *cardiovascular disease*
- *Health knowledge* AND *AIP* AND *hypertension* AND *cardiovascular disease*
- *Health information* AND *AIP* AND *lipid levels* AND *Ischemic heart disease*
- *Health knowledge* AND *AIP* AND *lipid levels* AND *Ischemic heart disease*

Walden University's database included pertinent material from Psych Info, EBSCO host, and ProQuest. The searches were restricted to peer-reviewed, full-text scholarly journals.

Review of Literature on Key Variables

The events that can lead to early mortality and morbidity are linked to adverse outcomes in adulthood, including inferior quality of life, increased risk for chronic conditions, low self-esteem, and poor self-regulation (Stillerman, 2018). Accordingly, during the search for literature on key variables of the study, the following search terms were used: *Atherogenic index of plasma* and *CAD* (210,000 results), *atherogenic index of plasma* and *coronary artery disease risk in postmenopausal women* (6500 results), *CVD in women* (22,854 results); *coronary heart disease* (86,346 results), and *CAD risk factors* (81.254 results).

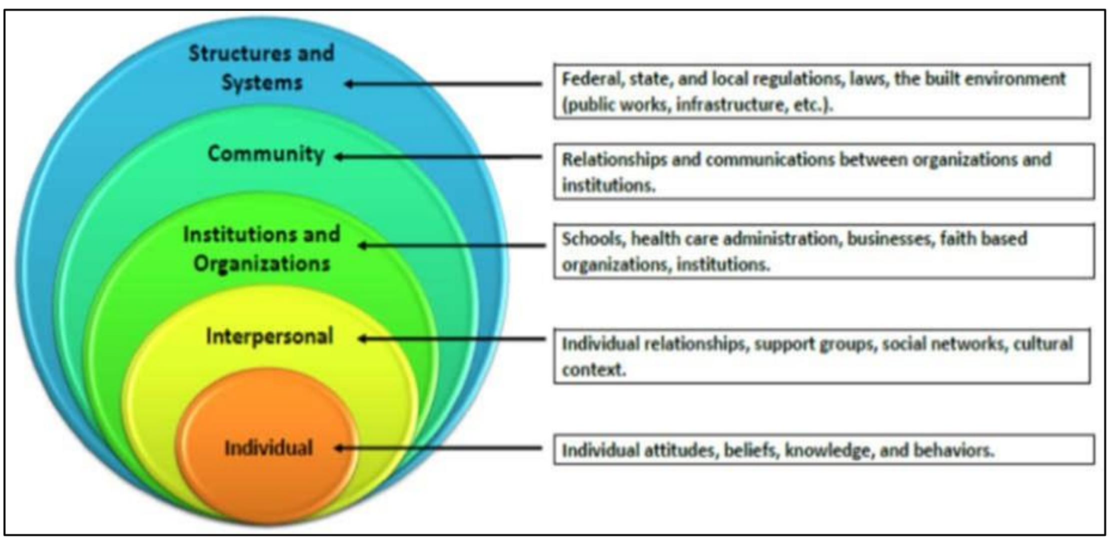
The Socio-Ecological Model

The SEM is a theoretical framework for comprehending the complex interplay among the myriad personal and environmental factors that determine human behavior (Eward et al.,2023). The Theory's consequences are the identification of behavioral influence points that can be targeted for the promotion of health and well-being (Singh et al., 2021). First introduced in the 1970s, SEM has undergone various modifications and is now used as a framework to target health interventions (Lee et al., 2017).

Individual, interpersonal, organizational, community, and policy variables influenced public health. The intrapersonal SEM level constituted knowledge, attitudes, and actions. The interpersonal level of the SEM described familial and social networks that might have impacted healthcare practices and experiences.

Figure 1

Diagram of the Socio-ecological Model



Note. From http://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel.html

These interactions impacted an individual's overall physical and mental health and health decision-making. The social impact of interpersonal interactions determined a range of health-related behaviors, including health-seeking, breastfeeding, and family planning. The institutional level of the SEM described how social institutions, such as hospitals and their staff, shaped healthcare decision-making. Essential resources and social and physical environments were grouped under the SEM's community-level factors (Markus & Sadison, 2019).

Integration of variables in the SEM CHD risk factors, AIP, and other mediators constituted the paradigms of the research study. According to Callahan-Myrick (2014), the SEM depicted the ecological theory underlying a health behavior or result. It helped make sense of the various determinants and barriers that impacted health behaviors and results, in this case, excluding CHD and AIP. The SEM is driven on political and environmental elements that determined personal and social features. Different variants of the SEM effects various environmental components differently. Bronfenbrenner et al. (1970), regarded variables impacting behavior as layers, each affecting the subsequent one.

The SEM's innermost layer refers to the personal behaviors and is the most significant aspect of the model (Lakhan & Ekundayo, 2013). It identified biological and personal elements that increased safety and promoted well-being, such as age, gender, knowledge, attitudes, and risk-taking behaviors. This level included factors that affected a person's innate aspects, such as knowledge, attitudes, beliefs, perceived barriers, motivation, enjoyment skills (including basic motor skills and sports-specific skills), abilities, disabilities or injuries, age, gender, and level of education, as well as socioeconomic and employment status. Behavioral modification techniques within this layer focused on impacting personal knowledge, attitudes, behavior, and abilities.

The next level dealt with interpersonal; Scarmeo et al.(2019) examined the intimate interactions among variables that might have affected AIP and the risk of developing CHD in Pakistan. This covered the person's immediate physical surroundings and social networks, such as family, friends, classmates, local amenities, and coworkers. There was a possibility that the social environment could have affected CHD risk variables, including age and duration of menopause, and that the level of physical activity could have impacted AIP. The interpersonal level included persons and small groups with whom the at-risk person interacted.

Intrapersonal obstacles, such as a lack of awareness, the limited ability of expression, and a lack of adherence to pre-diagnostic drugs, could have been highlighted to raise awareness among postmenopausal individuals with cardiovascular risk factors and could have motivated individuals to access healthcare facilities for prevention and early diagnosis of CHD. Generally, the lack of understanding in populations regarding CHD and its risk factors was consistent across global studies (Kilkenny et al., 2017). Impacting the personal level by altering associated qualities could have resulted in individuals beginning to think about CHD and seeking out relevant information regarding risk factors, preventive strategies, and the benefits of early intervention, which led to improved outcomes. According to Lee et al. (2016), it could have subsequently created an interpersonal impact on people by preparing them to rectify their behaviors in personal relationships and social networks.

Further, by understanding the then-current health situation related to CHD, AIP, and risk factors among postmenopausal Pakistani women, along with the health organizational structure in the country, the framework for improving the healthcare system could have been better laid.

MY study was limited to personal and interpersonal levels, but the effects of other factors and surroundings could not have been ruled out completely.

The SEM related factor could have enabled this study to explore possible constraints and illness variations among postmenopausal Pakistani women. In South Asia, maintenance would have been complex, owing to patients' need for more awareness of the advantages and downsides of changing their behaviors and going to the next stage. While staying in the current setting of change, social and environmental impacts might have led to evolution (Khakurel et al., 2018). No two patients would have had the same motive for improvement. Some patients would have sailed through.

As levels migrated farther from the center, they would have affected health behavior less directly and more indirectly. In this condition, the person's surroundings may have included a religious institution (church, temple, or mosque), school, club, office, work, union, informal support group, or volunteer organization (Okoye, 2016).

Scientists would have employed education, counseling, and timed exercises to enhance hypertensive results (Daley et al., 2009). The idea would have overlooked socioeconomic class and money. Without clear criteria, phase differences would have seemed arbitrary. Inconsistent and unreliable surveys would have been used to classify people's transition phases. No one would have known how long each stage or setup took.

Studies Using Socio-Ecological Model: The SEM would have assisted this researcher in developing an appropriate research strategy, analysis methodologies, and procedures. Jean et al. (2020) would have stated that the SEM enhanced the validity of research and the generalizability of cross-domain study conclusions. A relevant theoretical framework would have facilitated research, focused research studies, relevant literature searches, academic presentations, problem-solving, and data analysis (Grant & Osanloo, 2014). The SEM would have served as an ideal theoretical framework for this project. It would have helped to focus and contextualize this research study in a broader context and enhance its practical relevance by promoting positive health-seeking behavior designed to ameliorate CHD-related mortality and morbidity. The SEM would have been used to guide cardiovascular studies before. For instance, researchers such as Jean et al. (2020) and Grassi et al. (2019) would have concluded that social and environmental variables might have contributed to CHD and AIP. Williams et al. (2018) have recommended adjusting the reproductive cycle, controlling body weight, and reducing stress to reduce CHD risk. Another study would have indicated that upward socioeconomic mobility was more associated with lower CHD-related hazards than individuals in the lower economic strata (Kozela et al., 2022).

Information regarding the etiology and progress of CHD in postmenopausal Pakistani women needed apprising. The proposed research study would have provided much-needed information, keeping benchmark adaptive measures comparable to those used in the United States, including clinical, laboratory, social, environmental, individual, and household variables.

Multiple articles would have emphasized that further work was needed to determine whether menopause increased cardiovascular risk. In this context, the SEM would have investigated cultural, environmental, organizational, psychological, and biological behavior factors (Jin et al., 2019). It would have worked at interpersonal, institutional, community, and policy levels. The SEM would have categorized health-related events and behaviors, allowing behavioral change and environmental betterment (Jin et al., 2019). Social and environmental variables could have varied conformance and been modeled to affect CHD policy compliance among women (Gould et al., 2017). Individuals would have had to implement the preventive strategy regardless of danger; the SEM could have assisted in these circumstances.

Findings of the Literature Review

Coronary Heart Disease

While addressing diverse demographic populations for promoting health awareness, such as participants in law enforcement courses and training first responders in cardiopulmonary resuscitation, the terms "CVD" and "heart disease" were used interchangeably (CDC, 2019, p. 12). CVD is a component of the overall spectrum of heart disease and is classified under CHD. CHD mainly impacts the arteries and is an acute condition resulting in angina and MI (Khan et al., 2020). Accumulation of fibro-fatty plaques in the coronary arteries in the form of atherosclerosis leads to CAD, which may be asymptomatic or present as unstable angina (Khan et al., 2020). In a Dutch study of 4854 people (mean age 65 years), 54% of the participants were women, and the ACC/AHA guidelines recommended statin therapy in 66% of the women. The older ATP-III guidelines recommended statin therapy in 36% of the women (Gracia et al.,2016). CHD and CAD are interlinked, as CAD can result in CHD. Atherosclerotic plaque formation causes stenosis of the coronary arterial artery lumen, thereby reducing coronary blood flow to the myocardium and causing ischemic damage to the myocardial pump (CDC, 2019). Physical inactivity contributes to CHD-associated morbidity, clinically manifesting as stable or unstable angina, MI, or silent myocardial ischemia. Baura et al. (2019) reported that sedentary lifestyles observed in a cohort of postmenopausal women in Bangladesh were associated with a greater risk of developing cardio-metabolic risk factors such as DM, obesity, and HTN, further amplifying the need for behavioral changes in vulnerable populations. Atherosclerotic dyslipidemia is a common disease often presented as a component of metabolic syndrome. It is characterized by an increase in TG and LDL- C blood levels and a decrease in HDL-C blood levels. Frank alterations in parameters of this lipid triad accelerate atherogenesis in postmenopausal women, relative to their premenopausal counterparts, and are considered a significant risk factor for developing atherosclerotic heart disease (Prabakaran et al.,2021: Mandrup et al., 2017).

Atherogenic dyslipidemia has emerged as a substantive predictor for developing CHD; therefore, several studies have employed various lipid profile indices to investigate the association of dyslipidemia with cardio-metabolic risk factors and CHD. AIP, previously described as the logarithmic transformation of the ratio of triglycerides to high-density lipoproteins (HDL-C), has recently emerged as a novel and reliable predictor for the development of atherosclerosis and subsequent CVD. AIP correlates with the size of lipoproteins (such as HDL, LDL, and VLDL), which are among the most sensitive markers for developing CHD. An earlier study by Khakurel et al. (2019) found a significant inverse correlation between menopausal duration and non-modifiable risk factors associated with CHD. Another study conducted in Australia found a significant association between AIP and the duration of menopause (Ambikairajah et al., 2019).

Atherogenic Index of Plasma and Coronary Heart Disease

In the modern world, CHD is the leading cause of death owing to dyslipidemia. Diabetes mellitus, obesity, hypertension, and dyslipidemia are well-known CHD risk factors. The plasma lipid profile has recently been regarded as the most critical CHD risk factor. Elevated AIP increases the risk of CHD and is common in obese adolescents, highlighting the preventative function of AIP. AIP is also linked to CVD outcomes and is a clinically accessible prognostic indicator with more substantial predictive power than other lipid levels. High AIP levels relate to worse results for cardiac events (Cai et al., 2017).

Several studies have linked AIP to CVD prognosis. Wu et al. (2018) studied 696 patients and controlled them equally. After they corrected established risk variables, AIP was revealed to be a CVD risk factor. According to Garg et al. (2020), AIP is the sole lipid measure independently related to atherosclerotic occlusion.

According to Liu et al. (2021), a Chinese research study, post-angiography observation of selected CAG patients revealed that AIP was an independent predictor of CHD severity. AIP was found as an independent predictor of rapid plaque development in patients who had undergone serial coronary computed tomography angiography (CCTA) with a median inter-scan duration of 3.4 years. However, fewer studies have examined the relationship between AIP and CCTA results.

AIP in Postmenopausal Women

A landmark study in South Asia by Khakurel et al. (2019) established AIP as an independent lipid parameter in postmenopausal women; the author reported statistically significant increases in AIP levels in postmenopausal women when compared to pre-menopausal controls. This increase in AIP levels mirrored increased individual lipid markers (TC, TG, and LDL) in postmenopausal women. Furthermore, AIP was strongly associated with individual CHD risk factors, such as increased BMI systolic and diastolic blood pressure. These results were consistent with a previous study by Niroumand et al. (2015), who reported a significant correlation between AIP and other CHD risk factors, such as waist circumference BMI and physical activity in both sexes.

Some other researchers observed identical outcomes; HDL-C levels fell dramatically after menopause. AIP was found to be much higher in postmenopausal women than pre-menopausal women. These researchers found that postmenopausal women were at a greater risk of having CHD due to the considerable link between AIP and the post-menopause stage (Garg et al., 2020; Liu et al., 2021).

CHD in Women: AIP as Risk Factor

When teaching diverse demographic populations about health and wellness, such as in some law enforcement courses, and when certifying officers for cardiopulmonary resuscitation, the terms “CHD” and “heart disease” are used interchangeably. However, CVD is simply a subset of the more significant issue of heart disease. CHD is a kind of CAD that impacts the arteries; it is an acute condition involving angina and MI (CDC, 2019). CHD is potentially harmful and develops due to atherosclerosis; it may be asymptomatic or present as unstable angina (CDC, 2019).

CVD remains a leading cause of mortality in females, accounting for 398,086 deaths in the United States in 2013 alone, with ACC/AHA guidelines recommending statin therapy in 66% of women (Garcia et al., 2016). Previous ATP III guidelines had recommended statin therapy in 36% of females (Gulati & Noel Bairey Merz, 2015). There has been a disproportionate burden of CHD in South Asia, with one study in rural Bangladesh reporting a relatively 17-fold increase in CHD mortality amongst females compared to males (Karar et al., 2019). In another study in rural Bangladesh, Barua et al. (2018) reported high-risk levels of AIP among postmenopausal women.

Multiple linear regression(MLR) analysis established the association between AIP and CVD risk factors such as age, duration of menopause, waist-to-hip ratio, and random blood sugar, TC, and LDL levels. A subsequent study by the same author (Barua et al., 2019) reported a significant inverse correlation between CVD, as mentioned earlier, risk factors and physical activity.

Other studies by Mirjani et al. (2015) and Barua et al. (2019) investigated the relationship between postmenopausal women in Iran and metabolic syndrome; these studies reported a significant frequency of low HDL cholesterol levels. Postmenopausal estrogen insufficiency is estimated to be responsible for elevated cardio-metabolic risk factors in postmenopausal women. Other underlying reasons, besides physical inactivity, may have led to these cardio-metabolic risk factors in postmenopausal women. One probable cause is ovarian failure caused by estrogen insufficiency. The fact that women have a high amount of adiponectin in their bodies supports the centralization of body fat during the MT.

However, more significantly, a study by Elgendy et al. (2018) employed the Duke activity status index to demonstrate that, among the women evaluated for CHD, there may not be any link between their low functional abilities and underlying CHD; yet such low functional abilities constitute a good predictor of long-term mortality. Further, significant data linking microvascular dysfunction in women with CHD symptoms and indications have been found. Additional evidence indicates that such microvascular dysfunction is systemic rather than localized to the coronary arteries (Elgendy et al., 2018).

What is more concerning is that CHD mortality and acute MI have been increasing among younger women. Although the classic risk factors for CHD remained the same for both men and women, significant variations in the potency of risk variables must be recognized to allow for sex-specific approaches to CHD prevention. This conclusion is consistent with earlier studies conducted in various regions worldwide, which found an increased prevalence of CHD among postmenopausal women. According to reports, women generally encounter their first CHD episode after menopause; hence, this period serves as a warning for potential CHD in this population.

As per Hallström et al. (2022), in a Swedish research study, women with DM had a sevenfold greater CHD risk, whereas males with DM had a threefold greater CHD risk. Significantly, this greater risk predicts the development of CHD in women and increases mortality risk. Similarly, cigarette smoking has been a more potent risk factor for women, amounting to a 25% higher risk of CHD.

Premature Menopause

Menopause indicates a permanent termination of ovarian function and represents a transition in the reproductive phase of a woman's life. Premature menopause can be defined as natural or surgical menopause before 40 years and is an independent risk factor for female CVD (Honigberg et al., 2021). Dan et al. (2019) reported an inverse dose-response relationship between early menopause clinical hematopoiesis and CAD among postmenopausal women.

Early menopause and surgical menopause are indiscriminately associated with an increased risk of CHD, suggesting that women in these stages require cautious clinical monitoring. The increased risk is explained in part by traditional cardiovascular risk factors. Hence, these risk factors should be considered while monitoring the health of such women (WHO, 2017). However, a residual link still exists between menopausal features and CHD, the mechanism of which was unknown and warranted additional investigation. Controlling the traditional cardiovascular risk factors and reproductive variables reduces the increased risk of CHD among postmenopausal women. For instance, a genomic study by Dam et al. (2019) stated that 75% of genetic associations were mapped to pathways that mediated the repair of damaged DNA, thereby inferring that women with natural premature menopause could be predisposed to accumulate DNA damage. Thus, the age of the start of menopause could be a predictor of reproductive aging, overall health, and somatic aging.

Further, menopause has been described as the initial stage in a causative flow contributing to organ malfunction due to hormonal imbalances. The decrease in endogenous estrogen production has been significantly associated with CHD development after menopause. Estrogens relax and expand the blood vessels, particularly the healthy vessels, thereby helping accommodate blood flow; reduced estrogen levels result in stiffer blood vessels (Young et al., 2019). Further, menopausal ovarian performance deficit relates to renin-angiotensin-aldosterone system activation, which subsequently leads to endothelial dysfunction, inflammation, and immunological dysfunction (Muka et al., 2016).

Association Among Risk Factors, CHD, and AIP

Women who reach menopause before 45 are at a greater risk of CHD. However, access to individuals demonstrates that this association is constant and somewhat linear across the age range at menopause. As a result, among the approximate mean ages of the earliest (34 years) and later (56 years) categories of menopausal age, there is no obvious age barrier below which early menopause appears to be of inherent concern (Muka et al., 2016). Although the age of menopause was more difficult to recollect when women took HT, the findings of the sensitivity analysis omitting women using HT scarcely diverged. According to Cai et al. (2017), researchers have concentrated on a novel comprehensive lipid index, the AIP, which may thoroughly describe the equilibrium between atherogenic and anti-atherogenic components. Recently, AIP has been considered a reliable predictor of CHD risk.

According to a cross-sectional study performed in Iran, the value of AIP was positively correlated with waist circumference and BMI and negatively correlated with physical activity. Dyslipidemia is an established risk factor for CAD.

The correlation between traditional lipid measurements, such as TC, LDL-C, and TG, and the incidence of CAD has been well-established. Moreover, lipid ratios such as TC/HDL-C, LDL-C/HDL-C, AI, and LCI were excellent predictors of CAD. Consistent with the findings of Hartopo et al. (2016), the researcher discovered that AIP had a negative correlation with age. A previous study in a representative Chinese population revealed that AIP was associated with gender and increased with age. According to the study's findings, the AIP, a novel comprehensive lipid index, may effectively predict the risk of coronary artery disease (CAD). Men and women share several traditional IHD risk factors, including AIP. Newer studies may not adequately explain why women have a higher CHD risk than men.

Additional female-specific risk factors, most notably menopause, play an essential role in CHD. Menopause has been linked to increased CHD risk among women over 55 years of age. Menopause has also been linked to unfavorable changes in the lipid profile, increased vulnerability to weight gain and metabolic syndrome, and epicardial and paracardial fat deposition (El Khoudary & Thurston, 2018). A study by Guo et al. (2020) comprised a cohort of postmenopausal women (aged 50 or older) who underwent CAG at Anzhen Hospital (Beijing, China) between January and December 2014. A total of 65.43% of women were diagnosed with

CAD, whereas 34.57% had no CAD. Thus, AIP may be a more accurate and independent predictor of CAD in postmenopausal Chinese Han women than standard lipid indicators.

Furthermore, the risk of heart failure in diabetic women is five-fold higher than in non-diabetic women. This statistic is more significant than the two-fold rise in heart failure reported in diabetic males (Dal Canto et al., 2019). Gender variations in DM risk for CHD appear to be complex. Here, women are observed to have a greater prevalence of coronary microvascular dysfunction, hypercoagulability, and concomitant metabolic disorders (Wegner, 2017).

Hormonal Changes, AIP, and CHD

HTN is a well-known risk factor for CHD and the primary cause of CVD globally. Women with HTN showed more significant population-adjusted CV mortality than males and were less likely to be treated according to guideline-directed blood pressure objectives. Postmenopausal women are more vulnerable to this phenomenon; as estrogen levels fall, so do estrogen's protective vasodilatory actions and blood pressure advantages. The age of menarche in a young woman may also play a role in determining the risk of cardiovascular events later in life. Interestingly, patients who began menstruating "early" or "late" have a higher risk. Studies have found that early and late menarche indicates a greater risk of unfavorable CHD outcomes; however, the reasons remain unknown. Menopause has been linked to more significant atherogenic changes in the lipid profile. Women after menopause had more significant TC, TG, and LDL-C levels and lower HDL-C levels (Parbarka et al., 2019). According to previous research, midlife weight gain, notably increased fat mass, loss of skeletal mass, and increased waist circumference cannot be explained by growing age alone but is also influenced by ovarian aging related to the final menstrual cycle.

MT has been shown to contribute to the development of metabolic syndrome by decreasing glucose metabolism and negatively impacting blood pressure, weight gain, and central abdominal obesity. Menopause is linked to a higher percentage of epicardial and paracardial adipose tissue, which are growing risk factors for CHD (El Khoudary & Thurston, 2018). Menopausal Hormone Therapy has been found to be ineffective in preventing CHD among postmenopausal women.

New research reveals that dyslipidemia significantly contributes to coronary artery disease (CAD). AIP is a dyslipidemia indicator. The link between AIP and CAD in postmenopausal women remains uncertain. We hypothesize that AIP predicts CAD in postmenopausal women (Wu et al., 2018).

Menopause, the permanent stop of menstruation following ovarian inactivity, affects a woman's social, reproductive, physical, and psychological health. Postmenopausal women had less cardiovascular-friendly lipid profiles (Nannseu et al., 2016). Menopause modifies CVD risk variables, according to cross-sectional and longitudinal studies. Postmenopausal women had higher plasma TC, LDL-C, VLDL-C, and TG levels than premenopausal women. Menopause is related to central obesity, increased diastolic blood pressure, and increased insulin resistance, increasing the risk of CHD. The lipoprotein sub-fraction, AIP, is strongly associated with CHD, all-cause mortality, and emergency cardiovascular events. Cultural, racial, dietary, lifestyle, demographic, laboratory, postmenopausal, and metabolic variables can also impact AIP levels. Dyslipidemia in postmenopausal women indicates their susceptibility to atherosclerosis and other cardiovascular disorders. Larger, community-based, and well-designed studies are warranted to investigate the relationship between AIP and the risk of CHD among postmenopausal women.

Research findings have revealed that AIP might better predict CHD risk among postmenopausal women (Wu et al., 2018). Hence, the AIP must be considered a more helpful benchmark for postmenopausal CHD diagnosis.

Chapter 3: Research Methodology

MY objective for this cross-sectional study is to determine if there is a significant relationship between CHD risk factors (HTN, TC, Trig, LDL, HDL), age, duration of menopause, physical activity, and AIP (atherogenic index of plasma) in postmenopausal women of Pakistan, while controlling for age at menarche, OCP, education level, income, smoking, and diabetes mellitus.

Gap and Research Significance

Roa-Diaz et al. (2021) found different patterns of sex hormone fluctuations, adverse changes in body composition, lipids, lipoproteins, and the vascular system during menopause, which can increase a woman's risk of CHD (El Khoudary et al., 2019). The American Heart Association (AHA) guidelines for CVD prevention in women from a few years ago do not contain the latest evidence on the link between MT and CHD in women. Enhancing awareness of midlife and MT's cardio-metabolic health changes, menopause, and CHD risk statistics must be reviewed (El Khoudary et al., 2020). One study found that dyslipidemia causes CHD. A new comprehensive lipid index AIP may predict CHD risk. A Chinese case-control study compared CHD patients and controls. In a Chinese case-control study, those with CHD had higher conventional and nonconventional lipid profiles (HDL-C, TC/HDL-C, LDL-C/HDL-C, non-HDL-C/HDL-C (atherogenic index, AI), TC*TG*LDL/HDL-C (lipoprotein combine index, LCI), and (TG/HDL-C) (AIP). CHD patients showed lower HDL-C. All atypical lipid profile characteristics (AIP) were substantially higher in CHD (54.5%) than in non-CHD (45.5%). AIP and TC were positively correlated in Pearson correlation analysis. AIP was the lipid measurement most associated with heart disease (Cai et al., 2017).

Wu (2018) stated that AIP is a novel dyslipidemia indicator. AIP and CHD in postmenopausal women are uncertain. AIP may predict postmenopausal CHD (Wu et al., 2018). Wu probed 348 postmenopausal CHD cases and 348 controls in a propensity-score-matched case-control study. AIP predicted CAD independently in multivariate logistic regression. Wu et al. (2018) observed that AIP might be a CHD risk factor after controlling for DM and HTN. According to the study, AIP may predict CHD risk in postmenopausal women. AIP and CHD risk association literature for postmenopausal women was scarce, the author believed. Thus, future researchers may examine the relationship between AIP and CAD in postmenopausal women to establish if it is a risk factor. Postmenopausal case-control research showed that AIP is a risk factor. The Gensini score, a reliable measure of coronary artery stenosis, was favorably linked with AIP across all lipoprotein markers (Susanto et al., 2020). The author identified AIP as a CHD risk marker independent of smoking and DM/HTN history. This seems better than TC, LDL-C, HDL-C, and other lipid values.

Fawwad et al. (2020) examined AIP and CVD risk variables in Pakistani adults aged 20 and older from all four provinces. 27 Pakistani clusters volunteered for the project. AIP was linked to CHD risk variables; hence, elevated AIP levels in Pakistanis could suggest CVD onset (Fawwad et al., 2020).

Fawwad et al. (2020) found that men had a higher risk of atherosclerosis than women. Due to hormonal influences during childbirth, women who have had children are safeguarded. Temporal trends were not assessed because the study excluded under-20s. Thus, boys may have been more likely to develop AIP before 20 (Jamee et al., 2013). The researchers did not explicitly study AIP in postmenopausal women and CHD risk, but rather a broad area.

Despite several research articles published in recent years on coronary heart disease in the Pakistani population, Fawwad et al. (2023) emphasized the involvement of AIP and CHD in the Pakistani population. However, no study has been conducted on AIP and CHD in postmenopausal women in Pakistan.

Research Method

My intent and the purpose of this study was to see if there is a correlation between age and menopause duration and their association with CHD risk variables, atherogenic plasma index, hypertension, physical activity, and their relationship to CHD while adjusting for race, age, education, and geography. In this chapter, I discuss the quantitative research technique and used in-depth research on the study topics utilizing variable comparisons. I also discuss the methodology for gathering research data on the target population, as well as a description of the participants, the data collection, data operationalization, data analysis process, any threats to the research, and the ethical considerations permitted by the Institutional Review Board (IRB) through informed consent.

Research Design and Rationale

In my study, a quantitative, cross-sectional design was ideal for determining whether a correlation existed between the dependent and the independent variables. The analysis was quantitative. I used the relative technique, using a cross-sectional design while accounting for age, race, education, and geographical location variables.

The rationale and foundation for this study design were demonstrated to be compatible with the style required to provide further information to increase our understanding of how the combined factors related to CHD in women. Lipid profile, HTN, age, and duration of menopause, physical activity, and hyperlipidemia were independent variables. AIP was a dependent variable while controlling for age at menarche, Oral contraceptive pills (OCP), education level, income, smoking, and diabetes mellitus (DM). My use of secondary data in this quantitative study enabled an assessment of variables from a large sample. Subject and participant bias were removed because there was no direct interaction between the participants and me. Using secondary data from Mendeley's reduced time and resource restrictions.

Methodology

Population

The population selected for this study were women who resided in a part of the South Asian region of the globe who responded to the research by Barua et al. (2018) and were middle-aged when they took the survey. A cross-sectional study was undertaken in 2016 among postmenopausal women living in a rural area of Bangladesh.. Two hundred sixty-five postmenopausal women aged 40–70 was chosen using a suitable sample approach. The sample size was calculated using the CVD risk prevalence found in a similar kind of study of postmenopausal women in Nigeria.

Based on self-reported statements, clinical history, and medical record examination, the individuals included were without any trace of CVD. The researchers described menopause as a condition where there is no menstrual bleeding for at least 12 months, and they used a revised STEP-wise method to the World Health Organization's (WHO) Surveillance of Non-communicable Diseases Risk Factors (STEPS) questionnaire to obtain sociodemographic and behavioral data from the respondents.

Sampling Procedure

I used secondary data source in this study, which consists of the population size of 265 respondents in 2017–2018, the preliminary study conducted by (Barua et al.,2018,2019); the data set consisted of a population from the South Asian region. The preliminary study included a sample of these individuals that met the research question criteria. The author used a probability sampling technique during data collection.. The stratified random sampling technique gave a sample representative of the population with greater precision. This form of sampling aided in preventing a sample that differed from the population. This sampling technique supported a particular point of separate analysis of the subgroups of the variables under study. The sample size was determined using G* power Version 3.1.9.4. This procedure enabled a priori type of statistical power analysis focused on a significance level of 0.03 and a power of 0.99 for the population effect size. Multiple linear regression was used for this study. The test family is *z* tests. The power analyses was a priori to compute the required sample size for the 3 years. The error of probability (α) was 0.05.

The power (1-β err prob) was 0.99. The odds ratio used was 1.65. The similar selection in effect size that I chose for my study was also represented in the study conducted by Barua et al. (2019), where they found that when individuals worked out strenuously, there were variable risk factors and associated with each other was variable and associated with risk factors; however, the significant risk factor was central obesity where the CI was 67.9–78.5. Because the effect size measures the strength of association in the relationship of the variables, having this odds ratio/Prevalence risk ratio is more significant than zero, where zero was reflecting no relationship between the variables. After performing the sample size calculations for each year in my study, I analyzed a sample population of 265 respondents.

Data Sources of the Study

The research design of this study required quantitative data from a combination of two data sets: one from Barua et al. (2018) and Barua et al. (2019). It was available from Mendley's data sets for secondary use.

Further, I utilized data set available from the "Indian Heart Journal." The data points of this study comprised AIP as the dependent variable. Independent variables included HTN, lipid levels, age at menopause, duration of menopause, and physical activity. I chose secondary data which were drawn from the recent study done in Bangladesh. The data sets by Barua et al. (2018) looked at the relationship between physical activity and risk factors for CVD among postmenopausal women living in rural areas of Bangladesh. In another study, Barua et al. (2019) examined the AIP levels of postmenopausal women in rural Bangladesh to identify links between AIP levels and CHD risk.

Data Collection

Barua et al. (2018) originally collected the data.in the outpatient department of a primary healthcare center located in the rural area of one district in the South Asian region after the written agreement was obtained using a semi-structured pretested questionnaire. A modified STEP-wise approach to the World Health Organization's (WHO) Surveillance of Non-communicable Diseases (NCD) risk factors (STEPS) questionnaire was used to collect sociodemographic and behavioral information from respondents. They calculated their physical activity (PA) level using the Dietary Reference Intakes Committee's Estimated Energy

Requirement and a Microsoft Excel spreadsheet template. Another article by Ndahimana et al. (2017) thoroughly describes the technique for measuring PA.

Operationalization

The independent variables in this study were age at menopause, duration of menopause (lipid profile, HTN), and physical activity. The dependent variable was AIP. The covariates were age at menarche, Oral contraceptive pills (OCP), education level, income, smoking, and (DM). The respondents' h/o DM and oral contraception use were nominal and represented 0 for no and 1 for yes. Similarly, education level and income were also recorded as insignificant. The respondent's geographic location was well known; respondents were categorized based on their monthly salary to determine their socioeconomic position. Similarly, education status was classified into four levels. Along with family history of diabetes and NCD, smoking was a co-variable or controlling variable.

Table 1

Breakdown of Variables

Name	Meaning
Atherogenic index of plasma (CHD risk marker)	Cholesterol, Triglycerides, High density lipoproteins and low-density lipoproteins
HTN	Hypertension (high blood pressure)
Age of menopause	Commencement of stage where menstrual cycle stops.
Duration of menopause	Period elapsed since cycle stopped

Physical activity	Body movement consumes energy

Table 1 shows the breakdown of variables that are essential to operationalize the research question as well as the responses given by each participant. In addition, it shows the measurement for each variable and if it is the independent, dependent variable or a co-variate variable.

Operationalization for Each Variable

Table 2 shows the definition of variables.

Table 2

Definition of Variables

Definition	Category	Variable type	Measurement
AIP		Numerical	DV
HTN	1= No 2= YES	Nominal	IV
Cholesterol		Scale	IV
Triglycerides		Scale	IV
HDL		Scale	IV
LDL		Scale	IV
Age of menopause	31-62	Nominal	IV
Duration of menopause	1-31	Nominal	IV
Physical activity	1 not active 2= Low active	Nominal	IV

Definition	Category	Variable type	Measurement
	3= sedentary		
	4=active	Nominal	
Smoking 1	1=No	Nominal	Covariate
DM	2=yes		
	1=NO		
	2=Yes	Nominal	Covariate
OCP	1=NO	Nominal	Covariate
	2=Yes		
Age At menarche		Scale	Covariate
Income	High		
	MID	Scale	Covariate
	Low		
Education level	1=No Covariate	Nominal	
	2=high school		
	3=graduate		
	4=post-graduate		

Physical measurements HTN (blood pressure) were taken in accordance with the 'non-communicable disease risk factors survey,' with a certified female assistant ensuring acceptable privacy. Independent variables age and duration of menopause, physical activity was documented based on the history, lipid levels were analyzed in laboratory with standard methodology. The 'Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure' was used to define blood pressure, or a person was a known hypertensive or using an antihypertensive drug. To assure quality, three criteria were investigated: standard measuring techniques, instruction by an experienced national level trainer, the use of strong equipment, and pre-testing to appraise the complete operation.

Data Analysis Plan

The IBM statistical program for social sciences (SPSS) Grad Pack version 28 was used for the analytical work. The data existed as data set for secondary research analysis was entered into SPSS for analysis. The data analysis was led by the following research questions:

Research Question 1: Is there an association between CHD risk factors of Hypertension (HTN), Total cholesterol (TC), Triglycerides (TG), Low-density lipoprotein (LDL), High-Density Lipoprotein (HDL), and AIP in Pakistani women after controlling for age at menarche, oral contraceptive pills (OCP), education level, income, smoking and Diabetes Mellitus (DM)?

Null Hypothesis ($H_0$1): There is no significant association between CHD risk factors (HTN, TC, Trig, LDL, and HDL) and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis (H_a1): There is a significant association between CHD risk factors (HTN, TC, Trig, LDL, and HDL) and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM.

Research Question 2 (RQ2): Is there an association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM?

Null Hypothesis ($H_0$2): There is no association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis (H_a2): There is an association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Research Question 3 (RQ3): Is there an association between physical activity and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM?

Null Hypothesis ($H_0$3): There is no association between physical activity and AIP in Pakistan women controlling for age at menarche, OCP, education level, income, smoking, and DM.

Alternative Hypothesis (H_a3): There is there an association between physical activity and AIP in Pakistani women controlling for age at menarche, OCP, education level, income smoking, and DM

I used multiple linear regression for both the bivariate and multivariate data analyses. This analysis test was appropriate because it allowed me to evaluate my various explanatory variables against my continuous dependent variables since I wanted to explain the primary uses of regression analysis, which are forecasting, time series modeling, and finding the cause-and-effect relationship between variables with a 95% confidence interval, the outcome from the multiple linear regression model.

The multiple linear regression model had eight assumptions that were met. The first assumption was that the dependent variable should be measured on a continuous scale (Diraj, 2019).

Furthermore, two or more independent variables had to be present, which could be continuous or categorical, such as ordinal or nominal (Diraj, 2019). Third, observations had to be independent, which could be readily confirmed using the Durbin-Watson statistic (Diraj, 2019). Fourth, a linear connection had to exist between (a) the dependent variable and each independent variable, as well as (b) the dependent variable and the independent variables collectively. There were other approaches to check for these linear associations, including using SPSS Statistics to create scatterplots and partial regression plots (Diraj, 2019). Fifth, the data had to exhibit homoscedasticity, defined as the variances along the line of best fit remaining comparable as they advanced. This explained more about what this meant and how to assess the homoscedasticity of the data in our enhanced multiple regression guide.

Sixth, the data must not have exhibited multicollinearity, which happens when two or more independent variables are substantially associated with each other. Then, no notable outliers, high leverage points, or very impactful points should have existed (Diraj, 2019). Finally, ensure that the residuals were roughly regularly distributed. To test this assumption, two approaches were commonly used: (a) a histogram (with a superimposed standard curve) and a Normal P-P Plot or (b) a Normal Q-Q Plot of the studentized residuals. The significant threshold of the regression results was set at p 0.05 (Frankfort Nachmias and colleagues, 2018). The p-value represented the probability distribution where a one-tailed test was done in my analysis. It was the outcome of my analysis shown in the table of variances output $p > .05$; I would retain the null hypothesis. On the contrary, $p \leq .05$ was significant, and I would reject the null hypothesis.

Threats to Validity

The researcher did not conduct the research on experimental design and the sample size is representative of the target population, there could be few challenges to external validity. An external danger to validity, however, is the unknown issue of how many respondents consented or disagreed to participate in the initial study. This study was a cross-sectional study conducted in 2016 among postmenopausal women living in a rural South Asian community. 265 postmenopausal women aged 40 to 70 were recruited using an acceptable sampling technique.

The sample size was computed based on the CHD risk prevalence identified in a postmenopausal women's study in Nigeria. Because I computed a multiple linear regression model, the findings from the participants versus the dependent variable posed no danger to external validity when observed.

Furthermore, to address external validity, categorical variables with 95 percent confidence intervals were reported using frequency and percentage. Continuous variables are represented using the mean, standard deviation, median, and interquartile range. A multiple linear regression analysis was also computed to illustrate the association between AIP and other CHD risk factors. To assess the connection, numerous variables could be accounted for in the adjusted model, including menarche age, body mass index, systolic blood pressure, diastolic blood pressure, and fasting blood glucose. At a p 0.05 level, the value of the standardized coefficient has been declared statistically significant.

Statistical conclusion validity (SCV) entails determining how plausible my study conclusion is. In my study, I did not put my research at risk by repeating experiments or mining data for a link. The dataset was entered into SPSS, and a multiple linear regression analysis can be performed. Because the dependent variable is continuous, multiple linear regression was the appropriate statistical test for this study. The sample size was insufficient, which might have improved the statistical conclusion's validity. This study adhered to the methodologies and criteria established for a logistic regression model using SPSS.

Ethical Procedures

There were no agreements required to access the research participants or the data because this study used secondary, publicly accessible data. Because it operates in the public domain, Mendeley's allows anybody to acquire data from the site, and researchers can utilize the material without authorization. The states, however, ask that when a researcher publishes the data, they provide attribution to Mendeley and the original researcher's data source (Barua,2019). The Walden University IRB already granted permission to perform this study.

Summary

This section covered the cross-sectional research design and methodology that allowed for analyzing the relationship between CHD risk factors (HTN, TC, Trig, LDL, HDL), age, duration of menopause, physical activity, and AIP (atherogenic index of plasma) in post- menopausal women of Pakistan, controlling age at menarche, OCP, education level, income, smoking, and Diabetes Mellitus. The Statistical analysis and data analysis plans were laid out to demonstrate how the identified variables were used in the study to determine whether the null hypotheses for the RQs could be rejected. Threats to the validity of the study, as well as ethical considerations are considered.

Chapter 4: Results

The purpose of this quantitative cross-sectional research was to examine the associations between the AIP and its predictors (HTN, TC, TG, LDL, HDL, Age at menopause, duration of menopause and physical activity, AIP values are for low risk -0.3 to 0.1, for medium risk 0.1 to 0.24 and more than 0.24 are high risk for CHD.IV). Only secondary data were used. No primary information was collected. The study was guided towards its conclusion by the following research questions below.

Research Question 1: Is there an association between CHD risk factors of Hypertension (HTN), Total cholesterol (TC), Triglycerides (TG), Low-density lipoprotein (LDL), High-Density Lipoprotein (HDL), and AIP in Pakistani women after controlling for age at menarche, oral contraceptive pills (OCP), education level, income, smoking and Diabetes Mellitus (DM)?

Null Hypothesis ($H_0 1$): There is no significant association between CHD risk factors (HTN, TC, Trig, LDL, and HDL) and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis ($H_a 1$): There is a significant association between CHD risk factors (HTN, TC, Trig, LDL, and HDL) and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM.

Research Question 2 (RQ2): Is there an association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM?

Null Hypothesis ($H_0$2): There is no association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis (H_a2): There is an association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Research Question 3 (RQ3): Is there an association between physical activity and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM?

Null Hypothesis ($H_0$3): There is no association between physical activity and AIP in Pakistan women controlling for age at menarche, OCP, education level, income, smoking, and DM.

Alternative Hypothesis (H_a3): There is there an association between physical activity and AIP in Pakistani women controlling for age at menarche, OCP, education level, income smoking, and DM

Data Collection

Barua et al. (2018) originally collected the data in the outpatient department of a primary healthcare center located in the rural area of one district in the South Asian region after the written agreement was obtained using a Health Organization's (WHO) Surveillance of Non-communicable Diseases (NCD) risk factors (STEPS) questionnaire to collect sociodemographic and behavioral information from respondents. They calculated their physical activity (PA) level using the dietary reference intake committee's estimated energy requirement and a Microsoft

Excel spreadsheet temp. Another article by Ndahimana et al. (2017) thoroughly describes the technique for measuring PA.

Table 3

Sociodemographic, Reproductive, and Behavioral Characteristics Of The Study Population, N= 265.

Characteristics		Mean ± SD	Median (IQR)	*n* (%)
Sociodemographic	Age	53.51 ± 7.5 52	52(39-62)	
Education status	Illiterate			161(60.8)
	Literate			104(39.2)
Occupation	Housewife			239 (90.2)
	Service holder			26 (9.8)
Income	Monthly income (BDT)	12,279.34 ± 7920.26	10,000 (7000-15,250)	
Monthly income groups (BDT)	<4906 (low income)			24 (9.1)
	4907-19,488 (lower-middle income)			187 (70.6)

Characteristics		Mean ± SD	Median (IQR)	*n* (%)
	19,489-60,252 (upper-middle income)			53 (20)
	>60,252 (high income)			1 (0.4)
Reproductive	Age of menarche	13.54 ± 1.78 13	13 (12-15)	
	Age of onset of menopause	44.83 ± 5.22 45	45(40-48)	
	Duration of menopause	8.79 ± 6.45 7	6(3-13)	
Behavioral Current tobacco use	Smoking	0.1094± 0.33612	.00 (00-02)	4 (1.5)
	Smokeless	2.3736±0.85284	03(00-03)	119 (44.9)
Physical activity levels	Active			111 (41.9)
	Inactive			154 (58.1)

Characteristics	Mean ± SD	Median (IQR)	*n* (%)
Oral contraceptive pill use	0.3434 ±047574	.00(.00-1.00)	91 (34.3

Table 4

Physical and Biochemical Parameters of Cardiovascular Diseases Among The Study Population, n= 265.

Parameters	Mean+-SD	Median (IQR)	*n*%
BMI (kg/m2)	23.26 ± 4.74	23.05 (20.13-26.02)	
Nonobese			245(92.5)
Generalized obese (30 kg/m2)			20(7.5)
SBP (mm Hg)	120.56 ± 20.17	120 (100-140)	
DBP (mm Hg)	76.72 ± 11.49	80 (70-85)	
2-h PG (mmol/l), n =223	6.24 ± 1.97 6	5.8 (3.1-16.9)	
ND			215(96.4)
Diabetic			8(3.6)
Systolic hypertension140>	120.035±20.04	118(90-180)	
TC (mmol/l)	5.23 ± 1.3	5.33 (2.48-9.28)	
Desirable to borderline high			197(74.3)
Hypercholesterolemia (6.2>mmol)			68(25.7)
HDL-C (mmol/l)	1.1 ± 0.3	1(1-1)	
Low (<1.0 mmol/l)			70 (26.4)

Parameters	Mean+-SD	Median (IQR)	*n*%
High			195 (73.6)
LDL-C (mmol/l)	3.19 ± 1.139	3(2-4)	
Optimal to borderline high			210 (79.2)
High (>4.1 mmol/l)			55 (20.8)
TG (mmol/l)	1.86 ± 1.13	2(1-2)	
Normal to borderline high			153 (57.7)
High (>2.3 mmol/l)			112 (52.3)
AIP	0.16 ± 0.25	0.13(0.03 to 0.32)	
Low risk (<0.11)			124 (47.3)
Intermediate risk (0.11-0.24)			45 (17.2)
High risk (>0.24)			

Results

Table 5

ANOVA Results for the Regression Models

Model	Sum of Squares	Df	Mean Square	F	Sig.

1	Regression	15.940	17	.938	232.889	.000
	Residual	.994	247	.004		
	Total	16.934	264			

Table 6 depicts distribution of various physical and biochemical parameters among postmenopausal women.

Table 6

Physical and Biochemical Parameters of Cardiovascular Diseases among the Study Population

Parameters	N	Range	Minimum	Maximum	Mean	Std. Deviation
Age Years	265	30.00	40.00	70.00	53.4943	7.55040
Age at menopause	265	31.00	31.00	62.00	44.8340	5.22113
Atherogenic index of plasma	265	1.22	-.36	.86	.1560	.25327
Duration of menopause	265	25.00	.00	25.00	8.7887	6.44856
waist–hip ratio	265	.35	.68	1.03	.8837	.06116
total cholesterol	265	6.80	2.48	9.28	5.2333	1.29954
low-density lipoprotein cholesterol	265	6.72	.34	7.06	3.1866	1.13858
metabolic equivalent of tasks	265	28553.00	987.00	29540.00	4787.6989	2869.33985
physical activity levels	265	3.00	.00	3.00	2.3736	.85284

Parameters	N	Range	Minimum	Maximum	Mean	Std. Deviation
oral contraceptive pills	265	1.00	.00	1.00	.3434	.47574
Educational status	265	3.00	.00	3.00	.5547	.76737
Age of menarche	265	9.00	10.00	19.00	13.5358	1.77729
Smoking	265	2.00	.00	2.00	.1094	.33612
Diabetes Mellitus	265	1.00	.00	1.00	.2000	.40076
Triglycerides	265	600.00	50.00	650.00	165.6113	94.83476
HDL	265	55.00	25.00	80.00	45.1849	8.56215
Income	265	68500.00	1500.00	70000.00	12279.3358	7920.25485
2h glucose	223	13.80	3.10	16.90	6.2462	1.94716
Systolic blood pressure	265	90.00	90.00	180.00	120.3509	20.03466
Diastolic blood pressure	265	45.00	55.00	100.00	76.7170	11.48843
Fasting blood sugar	265	19.00	2.80	21.80	5.9223	2.35671

The dataset includes measurements from 265 Pakistani women, shedding light on various parameters. The participants' average age stands at approximately 53.49 years, with a standard deviation of 7.55 years, and a range spanning from 30 to 70 years. Notably, the (AIP), a key cardiovascular risk indicator, exhibits an average of 0.1560, accompanied by a standard deviation of 0.2533. Participants' attributes include an average age at menopause of 44.83 years, with a standard deviation of 5.22 years, and an average duration of menopause of 8.79 years, with a standard deviation of 6.45 years. The waist-hip ratio averages at 0.8837, with a standard deviation of 0.0612, while total cholesterol and LDL cholesterol levels average at 5.2333 mmol/L and LDL at 3.1866 mmol/L, respectively, with standard deviations of 1.2995 mmol/L and 1.1386 mmol/L. MET values signify diverse physical activity levels, with an average of 4787.70 and a standard deviation of 2869.34. Further variables encompass educational status (average: 0.5547, standard deviation: 0.7674), age of menarche (average: 13.54 years, standard deviation: 1.78 years), smoking (average: 0.1094, standard deviation: 0.3361), diabetes mellitus (average: 0.2000, standard deviation: 0.4008), triglycerides (average: 165.61 mg/dL, standard deviation: 94.83 mg/dL), HDL cholesterol (average: 45.18 mg/dL, standard deviation: 8.56 mg/dL), income (average: 12279.34 PKR, standard deviation: 7920.25 PKR), 2h glucose (average: 6.25 mmol/L, standard deviation: 1.95 mmol/L), systolic blood pressure (average: 120.35 mmHg, standard deviation: 20.03 mmHg), diastolic blood pressure (average: 76.72 mmHg, standard deviation: 11.49 mmHg), and fasting blood sugar (average: 5.92 mmol/L, standard deviation: 2.36 mmol/L). Understanding these summarized statistics provides a comprehensive overview of the dataset's characteristics and sets the foundation for further analysis and insights into relationships between variables.

The presented descriptive statistics provide valuable insights into the characteristics of the dataset comprising measurements from 265 Pakistani women. The average age of approximately 53.49 years indicates a diverse range of participants traversing from 30 to 70 years. The atherogenic index of plasma (AIP) holds an average of 0.1560, suggesting a relatively low average cardiovascular risk level. Noteworthy is the diversity in menopausal participants attributed, with an average age at menopause of 44.83 years and an average duration of menopause of 8.79 years. The waist-hip ratio's average of 0.8837 implies a moderate body fat distribution. Total cholesterol and LDL cholesterol averages of 5.2333 mmol/L and 3.1866 mmol/L, respectively, reflected a moderate risk factor for cardiovascular health. The variation in MET values highlights differing levels of physical activity engagement. Other parameters, such as educational status, age of menarche, smoking habits, diabetes prevalence, triglycerides, HDL cholesterol, income, glucose levels, and blood pressure, further contribute to the comprehensive overview of the participants' health profile. Understanding these interpretations provides a foundation for exploring potential relationships among these variables and their implications for health and well-being.

Multiple linear Regression analyses were used to explore the associations between various independent variables and the dependent variable, the atherogenic index of plasma (AIP), in the study population. The analyses were conducted using SPSS V28.0 version software. The coefficients represented the estimated relationships between each independent variable and the dependent variable while controlling for other variables in the model. The regression analyses revealed several significant associations between independent variables and the atherogenic index of plasma (AIP) in the study population. Age years, age at menopause, duration of menopause, waist-hip ratio, total cholesterol, low-density lipoprotein cholesterol (LDL), diabetes mellitus, and metabolic equivalent of tasks (MET), Triglycerides, HDL cholesterol, and physical activity levels were found to be significant predictors of AIP. These findings provide valuable insights into the factors influencing AIP levels in the studied population.

Research Question 1

Research Question 1: Is there an association between CHD risk factors of Hypertension (HTN), Total cholesterol (TC), Triglycerides (TG), Low-density lipoprotein (LDL), High-

Density Lipoprotein (HDL), and AIP in Pakistani women after controlling for age at menarche, oral contraceptive pills (OCP), education level, income, smoking and Diabetes Mellitus (DM)?

Null Hypothesis ($H_0$1): There is no significant association between CHD risk factors (HTN, TC, Trig, LDL, and HDL) and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis (H_a1): There is a significant association between CHD risk factors (HTN, TC, Trig, LDL, and HDL) and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM.

To test the research question and hypotheses, a multiple regression analysis was conducted. The coefficients, standard errors, t-values, and p-values for each independent variable were examined (table 3).

Table 7

Coefficients and p Value of Association Between Atherogenic Index of Plasma and CHD Risk Factors

CVD risk factors	Standardized coefficient b	p value
Age	0.406 (0.002-0.023)	0.021
HTN	0.141(0.001-.0.003)	0.002
Total cholesterol	1.557 (0.228-0.341)	<0.001
LDL cholesterol	-1.527 (-0.366 - -0.243)	< 0.001
Triglycerides	0.790 (0.179.-.195)	<0.001
HDL	0.057 (-0.426- -00350)	<0.001

Age years showed a positive and significant association with AIP (β = 0.406, $p = 0.021$). For each one-unit increase in age years, the AIP score increased by 0.012, while considering other factors. Hypertension had a positive and significant effect on AIP (β = 0.141, $p = 0.002$). For each one-unit increase in hypertension, the AIP score was increased by 0.002, controlling other factors. Total cholesterol had a positive and significant impact on AIP (β = 1.557, $p < 0.001$). For each one-unit increase in total cholesterol, the AIP score increased by 0.284, while accounting for other variables. LDL cholesterol showed an positive or directly proportional and significant relationship with AIP (β = -1.527, $p < 0.001$). For each one-unit decrease in LDL cholesterol, the AIP score less by -0.304, holding other variables constant. High Density Lipoproteins (HDL) had a negative and significant effect on AIP (β = -0.426, $p = 0.001$). Higher HDL values were associated with lower AIP scores, while considering other variables, with AIP raised by one unit HDL decreases by -0.388 units. Triglycerides, a separate character than cholesterol and LDL, run separately along with HDL and physical activity in multiple linear regression analyses, exhibited a positive and significant association with AIP (β = 0.790, $p = 0.001$). For each one-unit increase in TG, the AIP score augmented by 0.1388, holding other factors constant.

Based on the regression analysis results, I can reject the null hypothesis and conclude that there is a significant association between several CHD risk factors (age years, hypertension ratio, total cholesterol, LDL cholesterol, Triglycerides) and the atherogenic index of plasma (AIP) in Pakistani women, after controlling for age at menarche, OCP, education level, income, smoking, and DM. These findings support the alternative hypothesis (Ha1) and provide valuable insights into the relationships between various risk factors and AIP levels in the studied population.

Research Question 2

Research Question 2 (RQ2): Is there an association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM?

Null Hypothesis ($H_0$2): There is no association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

Alternative Hypothesis (H_a2): There is an association between age at menopause and duration of menopause with AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking and DM.

To answer (RQ2) and test the null hypothesis (Ha2) and alternative hypothesis (Ha2), I conducted a multiple linear regression analysis. Based on the regression analysis results, I could determine the associations between age at menopause and duration of menopause with AIP in Pakistani women while controlling for age at menarche, OCP, education level, income, smoking, and DM (table 4). There was a significant negative association between age at menopause and AIP ($\beta = -0.259$, $p = 0.003$). For every one-unit increase in age at menopause, the AIP score is expected to decrease by -0.017, holding other variables constant. There was a significant negative association between duration of menopause and AIP ($\beta = -0.281$, $p = 0.002$). For every one-unit increase in duration of menopause, the AIP score is expected to decrease by -0.018, while controlling for other factors.

Table 8

Coefficients and p Value of Association between Atherogenic Index of Plasma and Age at Menopause and Duration of Menopause

Factors	Standardized coefficient b	p value
Age at menopause	-0.259 (-0.022 - -0.003)	0.003
Duration of menopause	-0.281(-0.020 - -0.002)	0.002

Based on the regression analysis results, I can reject the null hypothesis for both age at menopause and duration of menopause, as these variables show significant negative associations with AIP in Pakistani women, even after controlling for age at menarche, OCP, education level, income, smoking, and DM. Therefore, we have evidence to support the alternative hypothesis (Ha2), which suggests that there is an association between age at menopause and duration of menopause with AIP in Pakistani women while considering the control variables. These findings imply that age at menopause and duration of menopause are significant predictors of AIP levels in the studied population, after controlling for age at menarche, oral contraceptive pills, education level, income, smoking, and diabetes mellitus.

Research Question 3

Research Question 3 (RQ3): Is there an association between physical activity and AIP in Pakistani women controlling for age at menarche, OCP, education level, income, smoking, and DM?

Null Hypothesis ($H_0$3): There is no association between physical activity and AIP in Pakistan women controlling for age at menarche, OCP, education level, income, smoking, and DM.

Alternative Hypothesis (H_a3): There is there an association between physical activity and AIP in Pakistani women controlling for age at menarche, OCP, education level, income smoking, and DM

To test these hypotheses, I used multiple regression analysis (MLR), which included coefficients, standard errors, t-values, and p-values for the variable related to physical activity levels. Based on the regression analysis results, I can determine the association between physical activity levels and AIP in Pakistani women while controlling for age at menarche, OCP, education level, income, smoking, and DM. There was a significant inverse association between physical activity levels and AIP ($\beta = 0.056$, $p = 0.001$) (table 5). Participants with higher physical activity levels were associated with lower AIP scores compared to less active individuals, after controlling for other confounding factors.

Table 9

Coefficients and p Value of Association between Atherogenic Index of Plasma and Physical Activity.

Factors	Standardized coefficient b	p value
Physical activity	0.056 (0.007 - -0.026)	0.001

Based on the Multiple linear regression analysis results, I reject the null hypothesis as physical activity levels show a significant positive association with AIP in Pakistani women, even after controlling for age at menarche, OCP, education level, income, smoking, and DM. Therefore, we have evidence to support the alternative hypothesis, which suggests that there is an association between AIP and physical activity in Pakistani women while considering the control variables. These findings imply that physical activity is a significant predictor of AIP levels in the studied population, independent of other risk factors considered in the analysis.

Summary

The results of the study reveal important insights into the relationships between various independent variables and the dependent variable, the Atherogenic Index of Plasma (AIP), among a group of 265 Pakistani women. I employed a series of multiple linear regression analyses to explore these relationships. The method of variable selection used was the Enter method, where all variables were simultaneously entered into the analysis. Table 1 presents the results of the analysis of variance (ANOVA) for the regression model. The significant F-statistic (232.889) and low p-value (0.000) indicate that the independent variables collectively have a significant impact on the AIP. This suggests that the model is statistically significant in explaining the variability in AIP. Table 2 provided descriptive statistics for various physical and biochemical parameters among the postmenopausal women in the study population. These statistics give an overview of the participants' characteristics, such as age distribution, menopausal attributes, cholesterol levels, physical activity levels, and more.

The regression analysis was used to uncover associations between the independent variables and AIP. The coefficients in Table 3, along with their associated p-values, indicate the direction and significance of these relationships. For instance, age, Triglycerides, total cholesterol, LDL cholesterol, HTN, and HDL were found to be significant predictors of AIP.

These coefficients allow me to make quantitative interpretations about the expected changes in AIP for unit changes in the respective independent variables, while accounting for other factors.

With research question 1, I explored the association between coronary heart disease (CHD) risk factors and AIP while controlling for certain variables. The results suggest that age, Triglycerides, total cholesterol, LDL cholesterol, and hypertension, levels are positively associated with AIP score while HDL has negative correlation, after adjusting the control variables.

With research question 2, I investigated the associations between age at menopause, duration of menopause, and AIP. The results indicated that both age at menopause and duration of menopause have been significantly negatively associated with AIP, when controlling the confounders.

Research Question 3 was focused on the association between AIP and physical activity. The analysis revealed that physical activity levels were inversely associated with AIP, suggesting that higher physical activity levels are linked to lower AIP scores among the studied women.

A high AIP (>0.24) indicates an increased cardiovascular disease risk. It indicates an unfavorable ratio of triglycerides to HDL cholesterol, with higher levels of triglycerides and lower levels of HDL cholesterol. In conclusion, a higher AIP score, particularly when it lies within the "high AIP" range, is linked to an increased risk of coronary heart disease. It indicates the balance of blood lipoproteins may not be appropriate for cardiac health.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this quantitative, cross-sectional study was to examine the correlation between AIP as direct variable (DV) and indirect variable (IV's) Coronary risk factors, age at menopause, duration of menopause, and physical activity while controlling for age at menarche, OCP, education level, income, smoking, and DM. I obtained the dataset from one study conducted by Barua et al. (2019), in which they collected the data in a town in Bangladesh (formerly known as east Pakistan) Sub-continent between 2016–17. There existed a significant need for empirical data regarding the atherogenic index of plasma (AIP) and its correlation with cardiovascular disease (CVD) risk factors among postmenopausal women in Bangladesh. The absence of this information motivated Barua et al.(2019) to explore the relationship between AIP and CVD risk factors among postmenopausal women residing in a rural locale. Among the respondents, 35.5% exhibited a high-risk level of AIP, with a mean value of 0.16 ± 0.25. Upon adjusting for confounding variables, several cardiovascular disease (CVD) risk factors demonstrated a statistically significant association with AIP. These factors included the duration of menopause ($b = 0.606$, $p = 0.043$), total cholesterol ($b = 1.082$, $p < 0.001$), low-density lipoprotein cholesterol ($b = 1.044$, $p < 0.001$).

Interpretation of the Findings

I run multiple linear regression analyses using SPSS Version 28.1 to address the research inquiries. My research and findings mentioned earlier can be analyzed and interpreted within the socio-ecological framework, which considers multiple levels of influence on health and well-being, from individual characteristics to broader societal factors. My study examined the relationship between the Atherogenic Index of Plasma (AIP) and various elements in the context of coronary risk. Here's an analysis and interpretation of the socio-ecological framework: The tier is limited to the community level, is the scope of the research

Individual Level (Microsystem)

I assessed the impact of personal characteristics such as age at menopause, duration of menopause, and physical activity on AIP levels. These factors are part of the individual's microsystem, affecting their health and disease risk. Controlling for variables like age at menarche, oral contraceptive pill (OCP) use, and smoking habits acknowledge the importance of these individual-level factors in understanding AIP and its implications for coronary risk.

Interpersonal Level (Microsystem)

Menopause, as one of my independent variables, represents a biological transition that varies among individuals. This reflects the interplay between personal experiences and their impact on health. The sociodemographic variables (educational attainment and income) are also individual-level factors that can be seen as influenced by interpersonal interactions and access to resources.

Community and Organizational Level (Exosystem)

I did not explicitly mention community or organizational factors in my study, but these elements can indirectly influence the variables I examined. For instance, the availability of healthcare resources and programs for postmenopausal women might affect their health behaviors and access to preventive measures.

Societal and Cultural Level (Macrosystem)

The follow-up of my study could benefit from considering broader societal and cultural factors that affect women's health. These could include cultural norms, healthcare policies, and public health initiatives for preventing women's health and heart disease.

Temporal Level (Chronosystem)

I have examined the effect of age, particularly in the context of menopause. The timing of events in one's life is a crucial aspect of the socio-ecological framework, as it recognizes that health and disease risks can change over time.

Controlling for Covariates

I employed controlled variables such as diabetes mellitus (DM) and smoking habits acknowledges the potential confounding influence of these variables on the relationship between AIP and coronary risk factors. This reflects the recognition that health outcomes are influenced by the interaction of numerous factors. In summary, my research findings demonstrated that AIP levels significantly affect the odds of developing Coronary Heart Disease (CHD) among postmenopausal women. Nonetheless, within the socio-ecological framework, it is imperative to acknowledge that AIP represents only a single component of the comprehensive picture.. Multiple individuals, interpersonal, community, societal, and temporal factors interact to influence health outcomes. In future researchers may explore how these elements interact and how interventions at various levels can reduce CHD risk among postmenopausal women.

My primary objective was to establish the relationship between the Atherogenic Index of Plasma (AIP), serving as the dependent variable (DV), and a set of independent variables (IVs) encompassing coronary risk factors, age at menopause, duration of menopause, and physical activity. These analyses were conducted while controlling for other covariates: age at menarche, oral contraceptive pill (OCP) use, educational attainment, income, smoking habits, and diabetes mellitus (DM).

In the initial analysis, an examination was made regarding the likelihood of AIP elevation among postmenopausal women aged between 40 and 70 years. Specifically, my analysis was used to assess the probability of these women developing Coronary Heart Disease (CHD) compared to those without elevated AIP levels. The statistical findings revealed a significant effect, concluding that the odds of developing CHD were notably higher among individuals with elevated AIP values.

Moreover, the results of this investigation indicated compelling evidence of a significant association between AIP and various risk factors, including hypertension (HTN), total cholesterol (TC), triglycerides (Trig), low-density lipoprotein (LDL), and high-density lipoprotein (HDL). In the research, the lipid profile and HTN were associated with AIP, with a high-risk index for CHD. Among various similar research studies conducted by Nansseu et al. (2016) failed to establish a direct link between AIP and CHD. However, subsequent studies, such as those conducted by Cai et al. (2017), Barua et al. (2019), and Wu et al. (2018), unequivocally revealed a significant association between AIP values ranging from 0.24 to 1.1 and CHD, which continues to be a leading global cause of mortality. (CDC, 2021).

A review of related literature underscores the constant pursuit of significant effects of risk factors on CHD, as recent studies consistently reveal substantial correlations between AIP and CHD. Cai et al. (2017) reported significantly lower AIP values in the control group compared to the CHD group. Moreover, an observational study demonstrated a significant relationship between AIP scores and CHD severity (Li et al., 2023).

The regression analysis results for the second research question provided insights into the associations between age at menopause and duration of menopause with AIP in Pakistani women while controlling for age at menarche, OCP use, education level, income, smoking, and DM (see Table 4). A significant negative association was observed between age at menopause and AIP. An unknown mechanism is believed to operate postestrogen cycle cessation, seemingly exerting an endothelial protective effect on coronary health, AIP is raised and risk of coronary heart disease increases (Ruberti et al., 2020).

The third research question was investigated particularly, the effect of physical activity on AIP, explicitly focusing on predicting AIP levels based on physical activity. I designed to determine whether individuals with increased AIP levels were more likely to be associated with CHD risk factors than those with low AIP levels. The multiple linear regression analysis, incorporating multiple risk factors including physical activity, yielded statistically significant effects of physical activity on AIP. The AIP is inversely associated with physical activity with the increased physical activity, AIP levels decreases and lessens the risk of coronary heart disease. This led to the conclusion that sufficient evidence supports the alternative hypothesis, even while controlling for age at menarche, OCP use, education level, income, smoking, and Diabetes Mellitus (DM).

In alignment with the literature, I found that AIP was a compelling predictor for CHD across various settings. Wu et al. (2018) established AIP as a risk factor for CHD in patients diagnosed with CHD. I selected a total of 265 participants while controlling for age at menarche, OCP use, education level, income, smoking, and Diabetes Mellitus (DM). As in previous analyses, the results were statistically significant ($p < .05$), indicating a compelling effect of all predictors on AIP.

The analysis also provided ample evidence to conclude that a combination of risk factors and higher levels of each predicting variable increased the likelihood of elevated AIP levels. Notably, these findings were consistent with previous research results. Overall, this study's findings align with those presented in the literature review, including with Barua et al. (2019) concluding that a substantial proportion of postmenopausal women exhibited a 'high-risk' level of AIP, significantly associated with various CHD risk factors.

Hypertension emerged as a prominent predicting variable in this study, carrying a high risk for CHD, particularly when combined with other risk factors, including AIP. HTN is a condition with potential repercussions on the health and well-being of community members, demanding immediate attention from healthcare stakeholders.

In comparison to research on postmenopausal Indian women (Barua et al. (2019), I found that the proportion of smokeless tobacco use was eleven times greater (4% vs. 45%), although physical inactivity was similar (55% vs. 58.1%). Notably, some rural women exhibited dietary intakes exceeding calorie requirements, consistent with findings from a study conducted in a rural setting (Coleman et al., 2023). Uncontrolled and untreated behavioral risk factors contribute to the development of intermediate CHD risk factors such as obesity, hypertension, diabetes, and an aberrant lipid profile (Hayden, 2023) . These risk variables were proportionately distributed in three questions in this study and matched with earlier studies for postmenopausal women with central obesity, hypertension, diabetes, hypercholesterolemia, and hypertriglyceridemia (Khakurel et al., 2018; Wu et al., 2018).

Limitations of the Study

Upon completing the analysis of this study, I have identified a few limitations. Although the research study boasted an ample sample size, enhancing the generalizability of the findings, it is imperative to note the study's distinct focus on postmenopausal women and their susceptibility to coronary artery disease (CAD). Furthermore, one must acknowledge the potential vulnerability to diminished reliability stemming from the possibility of inadequate recall amongst study participants (Barua et al., 2019). Recent investigations have indicated a burgeoning interest in the examination of the potential impact of the atherogenic index of plasma (AIP) on coronary heart disease (CHD) across various stages of the aging process (Guo et al., 2020). However, it is incumbent upon me to acknowledge the potential constraints imposed on research outcomes by cultural and social factors, which may, in turn, influence the dependability of the findings of CHD when amalgamated (Barua et al., 2019).

Additionally, it is pertinent to underscore that the study's findings were derived exclusively from responses obtained within the South Asian region of the subcontinent. Respondents' sociodemographic and behavioral information was collected using a modified version of the World Health Organization's (WHO) Surveillance of Non-communicable Diseases Risk Factors (STEPS) questionnaire. A Microsoft Excel spreadsheet template measured physical activity (PA) levels.

I selected this research methodology due to the inherent constraints of relying solely on secondary sources for data collection. Moreover, it is imperative to acknowledge the potential influence exerted on the gathered responses by the respondent's familial or social milieu, thereby introducing the conceivable presence of inherent bias within the dataset. Consequently, the applicability of the findings derived from this study is not sufficiently representative; even though the sample size was adequately substantial, I still need to consider this not to be generalized. An even larger sample size encompassing a broader geographic scope would enhance the robustness and external validity of the study's outcomes.

In this pioneering research endeavor, due to these enumerated reasons, it is imperative to acknowledge potential challenges that may have impacted the reliability of the collected and archived data, thereby potentially introducing subtle perturbations capable of influencing the measured data. Another noteworthy factor deserving scrutiny was the methodology employed in this study, which is inherently cross-sectional, thus constraining the capacity to draw robust causal inferences. Moreover, as I contemplate future research directions, I must recognize the forthcoming limitations. One such challenge entails the endeavor of persuading policymakers to take cognizance of the findings. This task may prove formidable due to the need for more comprehensive data concerning Coronary Heart Diseases, owing to the limited extant research on this subject matter.

Recommendations

Based on the research conducted on the atherogenic index of plasma among postmenopausal Pakistani women, several recommendations are made to promote cardiovascular health/coronary health and further research in this area:

- Regular Cardiovascular Screening: Encourage regular cardiovascular health screenings, especially for postmenopausal women with higher atherogenic index values. Early detection of potential cardiovascular risk factors can lead to more effective prevention and management.
- Dietary Modifications: Promote dietary interventions aimed at reducing the atherogenic index. Encourage the consumption of heart-healthy foods rich in fruits, vegetables, whole grains, and lean proteins while limiting the intake of saturated fats, trans fats, and excessive dietary cholesterol.
- Physical Activity: Encourage regular physical activity among postmenopausal women. Exercise has been shown to improve lipid profiles and reduce cardiovascular risk. I recommend a combination of aerobic exercises and strength training for optimal results.
- Lifestyle Modifications: I do advocate for overall lifestyle modifications, including smoking cessation and moderation in alcohol and fat consumption, as smoking and excessive alcohol intake can adversely affect lipid profiles and increase cardiovascular risk. A subjective, qualitative methodology could help researchers understand how Pakistani women view their sedentary behavior concerning obesity, HTN, and lack of physical activity.
- Hormone Replacement Therapy (HRT): As a physician I would go for multidisciplinary discussion with cardiologist and endocrinologist for hormone replacement therapy's potential benefits and risks among postmenopausal women, considering individual health histories and preferences. HRT can positively and negatively affect cardiovascular health, so decisions should be personalized.
- Medication Management: Consider pharmacological interventions appropriate for individuals with elevated atherogenic index values and other cardiovascular risk factors. Statins

and other lipid-lowering medications may be recommended in consultation with a healthcare provider.

- Patient Education: Develop educational programs and materials targeting these women to raise awareness about the importance of cardiovascular health, risk factors, and preventive measures.
- Further Research: Encourage further research to explore the mechanisms behind atherogenic index alterations in postmenopausal women. Investigate potential gender-specific factors and interventions tailored to this population. Qualitative study designs are suggested for future research on this subject. Cardio metabolic risk factors at a young age pose a significant risk for developing atherosclerotic cardiovascular disease in adulthood. Atherogenic dyslipidemia is highly associated with obesity and metabolic syndrome already in young age. I do recommend of conducting longitudinal studies to track changes in the atherogenic index of plasma in postmenopausal women over time. This could provide valuable insights into the progression of cardiovascular risk. It will help in more specific findings, pattern of increasing and decreasing of AIP along with hormonal changes during aging process.
- A mixed methods approach will allow participants to answer subjectively and objectively about how they communicate their perception of CHD risk and their trust in healthcare facility medical staff.
- Multidisciplinary Care: Promote multidisciplinary healthcare approaches that collaborate with primary care providers, cardiologists, nutritionists, and other specialists to provide comprehensive cardiovascular care for postmenopausal women.

- Public Health Initiatives: Advocate for public health initiatives that address cardiovascular risk factors at a community level. This may include policies promoting healthy eating, physical activity, and access to healthcare services for postmenopausal women.

These recommendations should be implemented holistically, considering individual health profiles and preferences. Consultation with healthcare professionals is essential to develop personalized cardiovascular health plans for postmenopausal women based on their specific risk factors and needs.

Implications

The study's findings could help public health, social change, and multidisciplinary professionals create case-specific and diagnosis-specific services to address the variables under study, individually and together, to reduce CHD morbidity due to AIP, HTN, dyslipidemia, and sedentary living.

These findings permit personalized risk stratification and the implementation of individualized interventions and lifestyle changes to enhance cardiovascular health in this population.

This study could be used to raise awareness and promote positive social change at the individual, community, and national levels. Despite limitations, public health practitioners could continue to educate the public and community interventionists about the health risks of these variables. The women mostly have sedentary lifestyles in Pakistan. The residents have a very high consumption of trans-fatty acids; TFA was responsible for 7.7% of coronary heart disease mortality despite accounting for only 1.4% of global energy intake. The elimination of TFA from diets has been deemed a straightforward public health intervention for reducing the risk of noncommunicable diseases (NCDs) (Rashid et al., 2020). Public health experts could continue to address the problems of this study by striving to find significant effects of these variables on public health in future investigations. Past research has shown postmenopausal women have risk variables such as AIP levels connected with HTN, lipid levels, and physical activity (Khakurel et al., 2019). The coronary risk factors included in my research questions, affecting the community and individuals, increasing heart disease mortality and morbidity. Unfortunately, disparities in accessing healthcare affect their ability to get care and adherence to treatment; these observations were also mentioned by (Barua et al.,2019). Future research should also focus on the finances and access to healthcare to reduce the morbidity and mortality from a combination of behavioral and personal risk factors in menopausal women with increased AIP.

In conclusion, the overall health implications for menopausal women who may not be fully aware of the effects of hormonal changes and are at risk of experiencing adverse outcomes leading to elevated AIP, which may result in more severe health events, are significant. The utilization of evidence-based practices has the potential to enhance individuals' health and quality of life through early detection and tailored treatments targeting the risk factors identified in this study. The results of this research have the potential to offer valuable insights into risk assessment, strategies for early intervention, and personalized healthcare approaches aimed at reducing cardiovascular risk among postmenopausal Pakistani women. This can enhance the well-being of individuals, families, and communities.

Methodological Implications:

Data Sources and Collection: The Study datasets was selected focusing on the requirements.

Methodological implications can move researchers to carefully consider their study objectives and criteria when selecting datasets, ensuring they align with the research goals.

Future researchers should consider broadening such groups' inclusivity to enhance the study population's comprehensiveness. Utilizing a case-control study design among postmenopausal women suggests that researchers should be mindful of selecting study designs best suited for their target population. This methodology choice can be a reference for future studies focusing on similar demographic groups.

Identifying an implication to include women from the postmenopausal group in future studies related to coronary heart disease signifies the importance of extending the research scope to cover specific subpopulations. This implies that future studies should consider diverse demographic subgroups to gain a comprehensive understanding of the subject matter. Quantitative research methods for generalizing the results underline the significance of choosing appropriate research methods to draw robust and generalized conclusions. Researchers should consider quantitative approaches to extrapolate findings to larger populations or contexts.

Theoretical Implications:

Integration of Socioecological Model in Quantitative Research

Using the Socio-ecological model in quantitative research has theoretical implications for understanding complex interactions empirically. This model emphasizes the intricate interplay between social, economic, and ecological factors and underscores the interdependence between individuals and their environments. The theoretical implication is that this model offers a holistic framework to investigate multifaceted issues by considering various layers of influence.

Novelty and Motivation for Future Research

The absence of prior utilization of this theoretical model in dissertations and related articles implies a gap in existing research. The theoretical implication lies in the potential to motivate researchers and scholars to embrace the Socioecological model more frequently in their studies. This model's comprehensive perspective, which encompasses individual behaviors, social networks, community characteristics, and environmental factors, may encourage future researchers to explore new dimensions in their investigations.

Study of Complex System Interactions in Public Health

The incorporation of the Socioecological model in future research within the field of public health has theoretical implications. This model's application provides a theoretical foundation for studying intricate interactions within complex systems. It offers a way to delve deeper into how individual behaviors, social networks, community features, and environmental elements collectively influence health outcomes. Theoretical implications here pertain to the potential for advancing the understanding of intricate relationships within public health contexts.

Comprehensive Consideration of the Person and Their Environment

The Socioecological model implies a broader perspective on the individual by encompassing health outcomes, environmental sustainability, and community factors. This theoretical implication suggests that future quantitative research can address a more comprehensive spectrum of influences on individuals' health and well-being by adopting this model. It encourages researchers to examine health more holistically, incorporating individual factors and their larger environment.

In summary, the use of the Socioecological model in quantitative research carries theoretical implications related to its potential to enhance the understanding of complex interactions, motivate further research, expand the study of complex systems in public health, and promote a more comprehensive consideration of individuals and their environmental development in research endeavors.

Empirical Implications

The results of this study involving postmenopausal women have significant empirical implications for future research and clinical practice. The atherogenic index of plasma (AIP) has been identified as a valuable clinical indicator for assessing cardiovascular disease risk, aligning with the findings of previous research conducted by Barua et al. in 2019. This study's implications extend to high-risk postmenopausal women in Pakistan, as such research has yet to be previously undertaken in this population. Future investigations may build upon these findings by exploring the relationship between high AIP levels and the risk of atherosclerosis and cardiovascular events, as demonstrated by Wu et al. in 2018.The positive association identified between AIP and various risk factors suggests the potential for raising awareness within the postmenopausal women population in the region. It may serve as a motivation to inform and educate individuals about the implications of elevated AIP levels. Furthermore, longitudinal studies may be conducted to establish a more robust link between AIP and heart disease in this specific cohort, enabling improved risk classification and prevention strategies. To address the practical implications of these findings, future research could investigate the impact of interventions such as hormone replacement therapy or lifestyle modifications, including dietary and exercise changes, on AIP levels and cardiovascular outcomes in postmenopausal women.

Understanding the empirical consequences of these interventions can significantly enhance the quality of cardiovascular disease care and prevention for this population. Overall, the insights gained from this study provide a foundation for further research and potential improvements in healthcare practices for postmenopausal women in Pakistan and similar folks.

Conclusion

In summary, this research has yielded valuable insights into the correlations between diverse independent variables and the Atherogenic Index of Plasma (AIP) scores within a cohort of Pakistani women. The regression analysis (MLR) has unveiled statistically significant relationships between various risk factors and AIP values, underscoring their pivotal role in forecasting cardiovascular health outcomes within this demographic. The results of this investigation have contributed significantly to my understanding of the determinants influencing AIP levels and provide valuable groundwork for prospective studies and interventions aimed at mitigating the risk of cardiovascular disease among postmenopausal women.

It is noteworthy that the 2018 guidelines issued by the American College of Cardiology and ACC/AHA concerning hypercholesterolemia, as well as the 2019 ACC/AHA guidelines about primary prevention, acknowledge pre-eclampsia, early onset of menopause, and autoimmune diseases as factors that heighten the susceptibility to cardiovascular disease. These guidelines posit that in cases where these risk factors coexist in patients who fall within the borderline or intermediate risk category, it may be judicious to contemplate initiating statin therapy. Additionally, dietary modifications and increased physical activity should be strongly advocated among postmenopausal women, primarily when additional risk factors manifest. Therefore, the utilization of AIP as a tool for assessing the risk of atherosclerosis development within a community-based population emerges as a viable strategy for preventing and managing cardiovascular diseases. Pakistani postmenopausal women exhibiting elevated AIP levels, which indicate a strong association with coronary heart disease (CHD) risk factors, necessitate targeted lifestyle interventions.

References

Aggarwal, N. R., Patel, H. N., Mehta, L. S., Sanghani, R. M., Lundberg, G. P., Lewis, S. J., Mendelson, M. A., Wood, M. J., Volgman, A. S., & Mieres, J. H. (2018). Sex differences in ischemic heart disease. *Circulation: Cardiovascular Quality and Outcomes*, *11*(2). https://doi.org/10.1161/circoutcomes.117.004437

Agarwala, A., Michos, E. D., Samad, Z., Ballantyne, C. M., & Virani, S. S. (2020). The use of sex-specific factors in the assessment of women's cardiovascular risk. *Circulation*, *141*(7), 592–599. https://doi.org/10.1161/circulationaha.119.043429

Allabadi, H., Probst-Hensch, N., Alkaiyat, A., Haj-Yahia, S., Schindler, C., Kwiatkowski, M., & Zemp, E. (2019). Mediators of gender effects on depression among cardiovascular disease patients in Palestine. *BMC psychiatry*, *19*(1), 284. https://doi.org/10.1186/s12888-019-2267-4

Ambikairajah, A., Walsh, E., & Cherbuin, N. (2019). Lipid profile differences during menopause: a review with meta-analysis. *Menopause; 26*(11), 1327–1333. https://doi.org/10.1097/GME.0000000000001403

Arora, S., Stouffer, G. A., Kucharska-Newton, A., Vaduganathan, M., Qamar, A., Matsushita, K., Kolte, D., Reynolds, H. R., Bangalore, S., Rosamond, W. D., Bhatt, D. L., & Caughey, M. C. (2018). Fifteen-year trends in management and outcomes of non–st-segment–elevation myocardial infarction among black and white patients: the aric community surveillance study, 2000–2014. *Journal of the American Heart Association*, *7*(19). https://doi.org/10.1161/jaha.118.010203

Alsayed, I., Maguire-Wright, K., & Flickinger, K. (2016). Utilizing secondary data sources in combination with primary clinical data to optimize data collection in prospective study designs. *Value in Health, 19*(3), A108. https://doi.org/10.1016/j.jval.2016.03.1699

Awotidebe, T. (2014). Cardiovascular risk profile of post-menopausal women in a semi-urban community in Nigeria. *British Journal of Medicine and Medical Research, 4*(29), 4780–4790. https://doi.org/10.9734/bjmmr/2014/8108

Bakshi, A., Bavikar, J., & Asegaonkar, S. (2019). Comparative study of calculated lipid indices viz atherogenic index of plasma, atherogenic coefficient and lipid accumulation product over conventional lipid profile parameters as better predictors of atherosclerosis in obesity: A cross sectional study. *International Journal of Clinical Biochemistry and Research, 6*(1), 2–6. https://doi.org/10.18231/2394-6377.2019.0002

Barua, L., Faruque, M., Chandra Banik, P., & Ali, L. (2018). Physical activity levels and associated cardiovascular disease risk factors among postmenopausal rural women of Bangladesh. *Indian Heart Journal, 70,* S161–S166. https://doi.org/10.1016/j.ihj.2018.09.002

Barua, L., Faruque, M., Banik, P. C., & Ali, L. (2019). Atherogenic index of plasma and its association with cardiovascular disease risk factors among postmenopausal rural women of Bangladesh. *Indian Heart Journal, 71*(2), 155–160. https://doi.org/10.1016/j.ihj.2019.04.012

Bo, M. S., Cheah, W. L., Lwin, S., Moe Nwe, T., Win, T. T., & Aung, M. (2018). Understanding the relationship between atherogenic index of plasma and cardiovascular disease risk factors among staff of an university in Malaysia. *Journal of Nutrition and Metabolism, 2018,* 1–6. https://doi.org/10.1155/2018/7027624

Bots, S. H., Peters, S. A. E., & Woodward, M. (2017). Sex differences in coronary heart disease and stroke mortality: a global assessment of the effect of ageing between 1980 and 2010. *BMJ Global Health, 2*(2), e000298. https://doi.org/10.1136/bmjgh-2017-000298

CDC. (2019, April 30). National Center for Chronic Disease Prevention and Health Promotion. Centers for Disease Control and Prevention. https://www.cdc.gov/chronicdisease/index.htm

Chobanian, A. V., Bakris, G. L., & Black, H. R. (2003). The seventh report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure. The JNC 7 report. *ACC Current Journal Review, 12*(4), 31–32. https://doi.org/10.1016/s1062-1458(03)00270-8

Coleman, F., Ahmed, A. U., Quisumbing, A. R., Roy, S., & Hoddinott, J. (2023). Diets of men and women in rural Bangladesh are equitable but suboptimal. *Current Developments in Nutrition, 7*(7), 100107–100107. https://doi.org/10.1016/j.cdnut.2023.100107

Creswell, J. W., Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods (5th ed.). Sage.

Dal Canto, E., Ceriello, A., Rydén, L., Ferrini, M., Hansen, T. B., Schnell, O., Standl, E., & Beulens, J. W. (2019). Diabetes as a cardiovascular risk factor: An overview of global trends of macro and microvascular complications. European Journal of Preventive Cardiology, 26(2_suppl), 25–32. https://doi.org/10.1177/2047487319878371

Dam, V., van der Schouw, Y. T., Onland-Moret, N. C., Groenwold, R., Peters, S., Burgess, S., Wood, A. M., Chirlaque, M. D., Moons, K., Oliver-Williams, C., Schuit, E., Tikk, K., Weiderpass, E., Holm, M., Tjønneland, A., Kühn, T., Fortner, R. T., Trichopoulou, A., Karakatsani, A., La Vecchia, C., … Butterworth, A. (2019). Association of menopausal characteristics and risk of coronary heart disease: a pan-European case-cohort analysis. International journal of epidemiology, 48(4), 1275–1285. https://doi.org/10.1093/ije/dyz016

Daley, L. K., Fish, A. F., Frid, D. J., & Mitchell, G. L. (2009). Stage-specific education/counseling intervention in women with elevated blood pressure. Progress in cardiovascular nursing, 24(2), 45–52. https://doi.org/10.1111/j.1751-7117.2009.00031.x

Dressel, S., Ericsson, G., & Sandström, C. (2018). Mapping social-ecological systems to understand the challenges underlying wildlife management. *Environmental Science & Policy*, *84*, 105–112. https://doi.org/10.1016/j.envsci.2018.03.007

Elgendy, I. Y., Mansoor, H., Li, Q., Guo, Y., Handberg, E. M., Bairey Merz, C. N., & Pepine, C. J. (2018). Long-term mortality and estimated functional capacity among women with symptoms of ischemic heart disease: From the NHLBI-sponsored Women's Ischemia Syndrome Evaluation. *American Heart Journal*, *206*, 123–126. https://doi.org/10.1016/j.ahj.2018.08.010

Elder, P., Sharma, G., Gulati, M., & Michos, E. D. (2020). Identification of female-specific risk enhancers throughout the lifespan of women to improve cardiovascular disease prevention. *American Journal of Preventive Cardiology*, *2*, 100028. https://doi.org/10.1016/j.ajpc.2020.100028

El Khoudary, S. R., & Thurston, R. C. (2018). Cardiovascular Implications of the Menopause Transition. *Obstetrics and Gynecology Clinics of North America*, *45*(4), 641–661. https://doi.org/10.1016/j.ogc.2018.07.006

Evenson, K. R., Ridenour, T., Bagwell, J., & Furberg, R. (2021). *Sustaining Physical Activity Following Cardiac Rehabilitation Discharge*. https://doi.org/10.3768/rtipress.2021.rr.0043.2102

Prabakaran, S., Schwartz, A., & Lundberg, G. (2021). Cardiovascular risk in menopausal women and our evolving understanding of menopausal hormone therapy: risks, benefits, and current guidelines for use. *Therapeutic Advances in Endocrinology and Metabolism*, *12*, 204201882110139. https://doi.org/10.1177/20420188211013917

Fawwad, A., Mahmood, Y., Askari, S., Butt, A., Basit, A., Rehman Abro, M. U., Ahmed, K. I., Ahmed, K., Ali, S. S., Bilal, A., Butt, A., Devrajani, B. R., Hayder, I., Humayun, Y., Irshad, R., Khan, R. A., Khan, A., Khowaja, A. A., Khowaja, R., & Masroor, Q. (2023). NDSP 12: Atherogenic index of plasma as a useful marker of cardiovascular disease risk among Pakistani individuals; a study from the second National Diabetes Survey of Pakistan (NDSP) 2016–2017. *Clinical Epidemiology and Global Health*, *19*, 101202. https://doi.org/10.1016/j.cegh.2022.101202

Freaney, P. M., Khan, S. S., Lloyd-Jones, D. M., & Stone, N. J. (2020). The Role of Sex-Specific Risk Factors in the Risk Assessment of Atherosclerotic Cardiovascular Disease for Primary Prevention in Women. *Current Atherosclerosis Reports*, *22*(9). https://doi.org/10.1007/s11883-020-00864-6

Garcia, M., Mulvagh, S. L., Bairey Merz, C. N., Buring, J. E., & Manson, J. E. (2016). Cardiovascular Disease in Women. *Circulation Research*, *118*(8), 1273–1293. https://doi.org/10.1161/circresaha.116.307547

Garg, R., Knox, N., Prasad, S., Zinzuwadia, S., & Rech, M. A. (2020). The Atherogenic Index of Plasma is Independently Associated with Symptomatic Carotid Artery Stenosis. *Journal of Stroke and Cerebrovascular Diseases*, *29*(12), 105351. https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.105351

Greenhalgh, T., & Fahy, N. (2015). Research impact in the community-based health sciences: an analysis of 162 case studies from the 2014 UK Research Excellence Framework. *BMC Medicine*, *13*(1). https://doi.org/10.1186/s12916-015-0467-4

Gong, I. Y., Tan, N. S., Ali, S. H., Lebovic, G., Mamdani, M., Goodman, S. G., Ko, D. T., Laupacis, A., & Yan, A. T. (2019). Temporal Trends of Women Enrollment in Major Cardiovascular Randomized Clinical Trials. *Canadian Journal of Cardiology*, 35(5), 653–660. https://doi.org/10.1016/j.cjca.2019.01.010

Gould, D. J., Moralejo, D., Drey, N., Chudleigh, J. H., & Taljaard, M. (2017). Interventions to improve hand hygiene compliance in patient care. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.cd005186.pub4

Guo, Q., Zhou, S., Feng, X., Yang, J., Qiao, J., Zhao, Y., Shi, D., & Zhou, Y. (2020). The sensibility of the new blood lipid indicator atherogenic index of plasma (AIP) in menopausal women with coronary artery disease. *Lipids in Health and Disease*, 19(1). https://doi.org/10.1186/s12944-020-01208-8

Garcia, M., Mulvagh, S. L., Merz, C. N., Buring, J. E., & Manson, J. E. (2016). Cardiovascular Disease in Women: Clinical Perspectives. *Circulation research*, 118(8), 1273–1293. https://doi.org/10.1161/CIRCRESAHA.116.307547

Grant, C., & Osanloo, A. (2014). Understanding, selecting, and integrating a theoretical framework in the dissertation research; creating a blueprint for your house" *Administrative Issues Journal Education Practice and Research*, 4(2). https://doi.org/10.5929/2014.4.2.9

Gulati, M., & Noel Bairey Merz, C. (2015). New cholesterol guidelines and primary prevention in women. *Trends in Cardiovascular Medicine*, 25(2), 84–94.

https://doi.org/10.1016/j.tcm.2014.08.007

Hallström, S., Wijkman, M. O., Ludvigsson, J., Ekman, P., Pfeffer, M. A., Wedel, H., Rosengren, A., & Lind, M. (2022). Risk factors, mortality trends, and cardiovascular diseases in people with Type 1 diabetes and controls in Sweden: An observational cohort study. *The Lancet Regional Health - Europe*, *21*, 100469. https://doi.org/10.1016/j.lanepe.2022.100469

Hayden, M. R. (2023). Overview and New Insights into the Metabolic Syndrome: Risk Factors and Emerging Variables in the Development of Type 2 Diabetes and Cerebrocardiovascular Disease. *Medicina*, *59*(3), 561. https://doi.org/10.3390/medicina59030561

Honigberg, Michael C., et al. "Association of Premature Natural and Surgical Menopause with Incident Cardiovascular Disease." *JAMA*, vol. 322, no. 24, 24 Dec. 2019, pp. 2411–2421, jamanetwork.com/journals/jama/article-abstract/2755841, https://doi.org/10.1001/jama.2019.19191. Accessed 17 Jan. 2022.

Isakadze, Nino, et al. "Addressing the Gap in Physician Preparedness to Assess Cardiovascular Risk in Women: A Comprehensive Approach to Cardiovascular Risk Assessment in Women." *Current Treatment Options in Cardiovascular Medicine*, vol. 21, no. 9, 29 July 2019, https://doi.org/10.1007/s11936-019-0753-0. Accessed 13 July 2020.

Joseph, Philip, et al. "Reducing the Global Burden of Cardiovascular Disease, Part 1." *Circulation Research*, vol. 121, no. 6, Sept. 2017, pp. 677–694, https://doi.org/10.1161/circresaha.117.308903. Accessed 15 Apr. 2020.

Khakurel, G., Kayastha, R., Chalise, S., & Karki, P. K. (2018). Atherogenic Index of Plasma in Postmenopausal Women. *Journal of Nepal Health Research Council*, 16(2), 175–177.

Khanal, Mahesh Kumar, et al. “Prevalence, Associated Factors, Awareness, Treatment, and Control of Hypertension: Findings from a Cross Sectional Study Conducted as a Part of a Community Based Intervention Trial in Surkhet, Mid-Western Region of Nepal.” *PLOS ONE*, vol. 12, no. 10, 5 Oct. 2017, p. e0185806, https://doi.org/10.1371/journal.pone.0185806. Accessed 26 Aug. 2019.

Khosravi, A., Sadeghi, M., Farsani, E. S., Danesh, M., Heshmat-Ghahdarijani, K., Roohafza, H., & Safaei, A. (2022). Atherogenic index of plasma: A valuable novel index to distinguish patients with unstable atherogenic plaques. *Journal of research in medical sciences : the official journal of Isfahan University of Medical Sciences*, *27*, 45. https://doi.org/10.4103/jrms.jrms_590_21

Kim, J. J., Yoon, J., Lee, Y.-J., Park, B., & Jung, D.-H. (2021). Predictive Value of the Atherogenic Index of Plasma (AIP) for the Risk of Incident Ischemic Heart Disease among Non-Diabetic Koreans. *Nutrients*, *13*(9), 3231. https://doi.org/10.3390/nu13093231

Kolovou, G. D., Kolovou, V., Kostakou, P. M., & Mavrogeni, S. (2014). Body Mass Index, Lipid Metabolism, and Estrogens: Their Impact on Coronary Heart Disease. *Current Medicinal Chemistry*, *21*(30), 3455–3465. https://doi.org/10.2174/0929867321666140901114515

Kim, S. H., Cho, Y. K., Kim, Y.-J., Jung, C. H., Lee, W. J., Park, J.-Y., Huh, J. H., Kang, J. G., Lee, S. J., & Ihm, S.-H. (2022). Association of the atherogenic index of plasma with cardiovascular risk beyond the traditional risk factors: a nationwide population-based cohort study. *Cardiovascular Diabetology*, *21*(1). https://doi.org/10.1186/s12933-022-01522-8

Kokaua, J., Jensen, S., Ruhe, T., Camp, J., Jensen, W., Sorensen, D., Lucas, A., & Richards, R. (2020). An Application of a Tivaivai Research framework to a quantitative Pacific health research project using New Zealand's Integrated Data Infrastructure. *Pacific Health Dialog*, *21*(5), 206–215. https://doi.org/10.26635/phd.2020.621

Kozela, M., Polak, M., Stepaniak, U., Bobak, M., & Pająk, A. (2022). Changes in Socioeconomic Status as Predictors of Cardiovascular Disease Incidence and Mortality: A 10-Year Follow-Up of a Polish-Population-Based HAPIEE Cohort. *International Journal of Environmental Research and Public Health*, *19*(22), 15411. https://doi.org/10.3390/ijerph192215411

Lee, J. J., & Shufelt, C. L. (2020). After *menopause*, is an enlarging middle an enlarging cardiovascular risk factor? *Menopause*, *27*(9), 974–975. https://doi.org/10.1097/gme.0000000000001620

Lee, W. W. M., *Choi*, K. C., Yum, R. W. Y., Yu, D. S. F., & Chair, S. Y. (2016). Effectiveness of motivational interviewing on lifestyle modification and health outcomes of clients at risk or diagnosed with cardiovascular diseases: A systematic review. *International Journal of Nursing Studies*, *53*, 331–341. https://doi.org/10.1016/j.ijnurstu.2015.09.010

Li, Ya, et al. "The Atherogenic Index of Plasma (AIP) Is a Predictor for the Severity of Coronary Artery Disease." *Frontiers in Cardiovascular Medicine*, vol. 10, 27 June 2023, https://doi.org/10.3389/fcvm.2023.1140215.

Li, X., Yang, S., Wang, Y., Yang, B., & Zhang, J. (2020). Effects of a transtheoretical model - based intervention and motivational interviewing on the management of depression in hospitalized patients with coronary heart disease: a randomized controlled trial. *BMC Public Health*, *20*(1). https://doi.org/10.1186/s12889-020-08568-x

Liaquat, A., & Javed, Q. (2018). Current Trends of Cardiovascular Risk Determinants in Pakistan. *Cureus*, *10*(10), e3409. https://doi.org/10.7759/cureus.3409

Liu, T., Liu, J., Wu, Z., Lv, Y., & Li, W. (2021). Predictive value of the atherogenic index of plasma for chronic total occlusion before coronary angiography. *Clinical Cardiology,44*(4),518–525. https://doi.org/10.1002/clc.23565

Mandrup, C. M., Egelund, J., Nyberg, M., Lundberg Slingsby, M. H., Andersen, C. B., Løgstrup, S., Bangsbo, J., Suetta, C., Stallknecht, B., & Hellsten, Y. (2017). Effects of high-intensity training on cardiovascular risk factors in premenopausal and postmenopausal women. *American journal of obstetrics and gynecology*, *216*(4), 384.e1–384.e11. https://doi.org/10.1016/j.ajog.2016.12.017

McSweeney, J. C., Rosenfeld, A. G., Abel, W. M., Braun, L. T., Burke, L. E., Daugherty, S. L., Fletcher, G. F., Gulati, M., Mehta, L. S., Pettey, C., Reckelhoff, J. F., & American Heart Association Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, Council on Epidemiology and Prevention, *Council on Hypertension, Council on Lifestyle and Cardiometabolic Health, and Council on Quality of Care and Outcomes Research* . doi.org/10.1161/CIR.0000000000000381Circulation. 2016;133:1302–1331

Preiser, R., Biggs, R., De Vos, A., & Folke, C. (2018). Social-ecological systems as complex adaptive systems: organizing principles for advancing research methods and approaches. *Ecology and Society*, *23*(4). https://doi.org/10.5751/es-10558-230446

Preventing and Experiencing Ischemic Heart Disease as a Woman: State of the Science: A Scientific Statement From the American Heart Association. *Circulation*, *133*(13), 1302–1331. https://doi.org/10.1161/CIR.0000000000000381

Mehta, P. K., Johnson, B. D., Kenkre, T. S., Eteiba, W., Sharaf, B., Pepine, C. J., Reis, S. E., Rogers, W. J., Kelsey, S. F., Thompson, D. V., Bittner, V., Sopko, G., Shaw, L. J., & Bairey Merz, C.

N. (2017). Sudden Cardiac Death in Women With Suspected Ischemic Heart Disease, Preserved Ejection Fraction, and No Obstructive Coronary Artery Disease: A Report From the Women's Ischemia Syndrome Evaluation Study. *Journal of the American Heart Association*, *6*(8). https://doi.org/10.1161/jaha.117.005501

Mensah, G., Roth, G., Sampson, U., Moran, A., Feigin, V., Forouzanfar, M., Naghavi, M., & Murray, C. (2015). Mortality from cardiovascular diseases in sub-Saharan Africa, 1990–2013: a systematic analysis of data from the Global Burden of Disease Study 2013: cardiovascular topic. *Cardiovascular Journal Of Africa*, *26*(2), S6–S10. https://doi.org/10.5830/cvja-2015-036

Mitchell, A., & Rich, M. (2020). Business School Teaching of Research Methods A Review of Literature and Initial Data Collection for Undergraduate Business School Students. *Electronic Journal of Business Research Methods*, *18*(2). https://doi.org/10.34190/jbrm.18.2.003

Muka, T., Oliver-Williams, C., Kunutsor, S., Laven, J. S. E., Fauser, B. C. J. M., Chowdhury, R., Kavousi, M., & le Franco, O. H. (2016). Association of Age at Onset of Menopause and Time Since Onset of Menopause With Cardiovascular Outcomes, Intermediate Vascular Traits, and All-Cause Mortality. *JAMA Cardiology*, *1*(7), 767. https://doi.org/10.1001/jamacardio.2016.2415

Näher, A.-F., Vorisek, C. N., Klopfenstein, S. A. I., Lehne, M., Thun, S., Alsalamah, S., Pujari, S., Heider, D., Ahrens, W., Pigeot, I., Marckmann, G., Jenny, M. A., Renard, B. Y., Kleist, M. von, Wieler, L. H., Balzer, F., & Grabenhenrich, L. (2023). Secondary data for global health digitalisation. *The Lancet Digital Health*, *5*(2), e93–e101. https://doi.org/10.1016/S2589-

7500(22)00195-9

Nansseu, J. R. N., Ama Moor, V. J., Nouaga, M. E. D., Zing-Awona, B., Tchanana, G., & Ketcha, A. (2016). Atherogenic index of plasma and risk of cardiovascular disease among Cameroonian postmenopausal women. *Lipids in Health and Disease*, *15*(1). https://doi.org/10.1186/s12944-016-0222-7

Nishimura, R. A., Otto, C. M., Bonow, R. O., Carabello, B. A., Erwin, J. P., Fleisher, L. A., Thompson, A. (2017). 2017 AHA/ACC focused update of the 2014 AHA/ACC guideline for the management of patients with valvular heart disease. *Journal of the American College of Cardiology*, *70*(2), 252-289. doi:10.3928/24748307-20170427-01

NDSP 12: Atherogenic *index* of plasma as a useful marker of cardiovascular disease risk among Pakistani individuals; a study from the second National Diabetes Survey of Pakistan (NDSP) 2016–2017

Asher Fawwad, Yasir Mahmood, Saima Askari , Anum Butt , Abdul Basit Otto, C. M. (2017). Heartbeat: Ischemic heart disease risk factors in women. *Heart*, *103*(20), 1559–1561. https://doi.org/10.1136/heartjnl-2017-312328

Pagidipati, N. J., & Peterson, E. D. (2016). Acute coronary syndromes in women and men. *Nature Reviews. Cardiology*, *13*(8), 471–480. https://doi.org/10.1038/nrcardio.2016.89

Pathak, L. A., Shirodkar, S., Ruparelia, R., & Rajebahadur, J. (2017). Coronary artery disease in women. *Indian heart journal*, *69*(4), 532–538. https://doi.org/10.1016/j.ihj.2017.05.023

Pathak E. B. (2016). Is Heart Disease or Cancer the Leading Cause of Death in United States Women? *Women's health issues: official publication of the Jacobs Institute of Women's Health*, *26*(6), 589–594. https://doi.org/10.1016/j.whi.2016.08.002

Permanyer-Miralda, G., Hinrichs-Krapels, S., & Adam, P. (2016). The Social Impact of Cardiology Research: Beyond Management. *Revista Espanola de cardiologia (English ed.), 69*(7), 639–643. https://doi.org/10.1016/j.rec.2016.03.018

POP, D., DĂDÂRLAT-POP, A., CISMARU, G., & ZDRENGHEA, D. (2020). The control of cardiovascular risk factors – an essential component of the rehabilitation of patients with ischemic heart disease. What are the current targets? *Balneo Research Journal*, *Vol.11*, *No1*, 20–23. https://doi.org/10.12680/balneo.2020.310

Prochaska, J. O., & DiClemente, C. C. (1982). Transtheoretical therapy: Toward a more integrative model of change. *Psychotherapy: Theory, Research & Practice*, *19*(3), 276–288. https://doi.org/10.1037/h0088437

Prabakaran, S., Schwartz, A., & Lundberg, G. (2021). Cardiovascular risk in menopausal women and our evolving understanding of menopausal hormone therapy: risks, benefits, and current guidelines for use. *Therapeutic Advances in Endocrinology and Metabolism*, *12*, 204201882110139. https://doi.org/10.1177/20420188211013917

Rehman, S., Li, X., Wang, C., Ikram, M., Rehman, E., & Liu, M. (2019). Quality of Care for Patients with Acute Myocardial Infarction (AMI) in Pakistan: A Retrospective Study. *International Journal of Environmental Research and Public Health*, *16*(20), 3890. https://doi.org/10.3390/ijerph16203890

Rashid, A., Amjad, S., Nishtar, M. K., & Nishtar, N. A. (2020). Trans-Fatty Acid (TFA) elimination in Pakistan: A situational analysis. *JPMA. The Journal of the Pakistan Medical Association*, *70(Suppl 2)*(5), S1–S30.

Rashid, N. A., Nawi, A. M., & Khadijah, S. (2019). Exploratory analysis of traditional risk factors of ischemic heart disease (IHD) among predominantly Malay Malaysian women. *BMC Public Health*, *19*(S4). https://doi.org/10.1186/s12889-019-6855-5

Ra, J. S., Kim, H. S., & Jeong, Y.-H. (2019). Associated Factors of Ischemic Heart Disease Identified Among Post-Menopausal Women. *Osong Public Health and Research Perspectives*, *10*(2), 56–63. https://doi.org/10.24171/j.phrp.2019.10.2.03

Richards, S. H., Anderson, L., Jenkinson, C. E., Whalley, B., Rees, K., Davies, P., Bennett, P., Liu, Z., West, R., Thompson, D. R., & Taylor, R. S. (2017). Psychological interventions for coronary heart disease. *The Cochrane database of systematic reviews*, *4*(4), CD002902. https://doi.org/10.1002/14651858.CD002902.pub4

Roa-Díaz, Z. M., Raguindin, P. F., Bano, A., Laine, J. E., Muka, T., & Glisic, M. (2021). Menopause and cardiometabolic diseases: What we (don't) know and why it matters. *Maturitas*, *152*, 48–56. https://doi.org/10.1016/j.maturitas.2021.06.013

Ruberti OM, Rodrigues B. Estrogen Deprivation and Myocardial Infarction: Role of Aerobic Exercise Training, Inflammation and Metabolomics. *Curr Cardiol Rev.* 2020;16(4):292-305. doi: 10.2174/1573403X15666190729153026. PMID: 31362678; PMCID: PMC7903506.

Samad, F. (2017). Ischemic Heart Disease in Women: Under-recognized and Under- treated! *International Journal of Medicine and Public Health*, *7*(2), 72–72. https://doi.org/10.5530/ijmedph.2017.2.14

Sharma, S. K., Makkar, J. S., Bana, A., Sharma, K., Kasliwal, A., Sidana, S. K., Degawat, P. R., Bhagat, K. K., Chaurasia, A. K., Natani, V., Sharma, S. K., & Gupta, R. (2022). Premature coronary artery disease, risk factors, clinical presentation, angiography, and interventions: Hospital based registry. *Indian heart journal*, *74*(5), 391–397.

https://doi.org/10.1016/j.ihj.2022.08.003

Scott, N. A., & Siltanen, J. (2016). Intersectionality and quantitative methods: assessing regression from a feminist perspective. *International Journal of Social Research Methodology*, *20*(4), 373–385. https://doi.org/10.1080/13645579.2016.1201328

Scott, P. E., Unger, E. F., Jenkins, M. R., Southworth, M. R., McDowell, T.-Y., Geller, R. J., Elahi, M., Temple, R. J., & Woodcock, J. (2018). Participation of Women in Clinical Trials Supporting FDA Approval of Cardiovascular Drugs. *Journal of the American College of Cardiology*, *71*(18), 1960–1969. https://doi.org/10.1016/j.jacc.2018.02.070

Shaman, A. A. (2015). Metabolic syndrome and cardiovascular risk assessment among women with polycystic ovary syndrome attending King Khalid Hospital in Tabuk. *Endocrinology & Metabolic Syndrome*, *04*(04). https://doi.org/10.4172/2161-1017.c1.012

Shen, S., Lu, Y., Qi, H., Li, F., Shen, Z., Wu, L., Yang, C., Wang, L., Shui, K., Wang, Y., Qiang, D., Yun, J., & Weng, X. (2016). Association between ideal cardiovascular health and the atherogenic index of plasma. *Medicine*, *95*(24), e3866. https://doi.org/10.1097/MD.0000000000003866

Shin, H. R., Song, S., Cho, J. A., & Ly, S. Y. (2022). Atherogenic Index of Plasma and Its Association with Risk Factors of Coronary Artery Disease and Nutrient Intake in Korean Adult Men: The 2013-2014 KNHANES. *Nutrients, 14*(5), 1071. https://doi.org/10.3390/nu14051071

Stanhewicz, A. E., Wenner, M. M., & Stachenfeld, N. S. (2018). Sex differences in endothelial function important to vascular health and overall cardiovascular disease risk across the lifespan. *American journal of physiology. Heart and circulatory physiology*, *315*(6), H1569–

H1588. https://doi.org/10.1152/ajpheart.00396.2018

Stepwise Approach to Chronic Disease Risk Factor Surveillance. World Health Organization. http://www.who.int/chp/steps/bangladesh/en/ Accessed 04.08.17

Taqueti, V. R., & Di Carli, M. F. (2018). Coronary Microvascular Disease Pathogenic Mechanisms and Therapeutic Options: JACC State-of-the-Art Review. *Journal of the American College of Cardiology*, *72*(21), 2625–2641. https://doi.org/10.1016/j.jacc.2018.09.042

Twenty-Year Trends and Sex Differences in Young Adults Hospitalized With Acute Myocardial Infarction. *Circulation*, *139*(8), 1047–1056. https://doi.org/10.1161/circulationaha.118.037137

Vaccarino, V., Badimon, L., Bremner, J. D., Cenko, E., Cubedo, J., Dorobantu, M., Duncker, D. J., Koller, A., Manfrini, O., Milicic, D., Padro, T., Pries, A. R., Quyyumi, A. A., Tousoulis, D., Trifunovic, D., Vasiljevic, Z., de Wit, C., Bugiardini, R., Lancellotti, P., & Carneiro, A. V. (2019). Depression and coronary heart disease: 2018 position paper of the ESC working group on coronary pathophysiology and microcirculation. *European Heart Journal*. https://doi.org/10.1093/eurheartj/ehy913

Vaduganathan, M., Mensah, G. A., Turco, J. V., Fuster, V., & Roth, G. A. (2022). The Global Burden of Cardiovascular Diseases and Risk: A Compass for Future Health. *Journal of the American College of Cardiology*. https://doi.org/10.1016/j.jacc.2022.11.005

Van Nes, M., & Sawatzky, J.-A. V. (2010). Improving cardiovascular health with motivational interviewing: A nurse practitioner perspective. *Journal of the American Academy of Nurse Practitioners*, *22*(12), 654–660. https://doi.org/10.1111/j.1745-7599.2010.00561.x

Waheed, N., Elias-Smale, S., Malas, W., Maas, A. H., Sedlak, T. L., Tremmel, J., & Mehta, P. K.

(2020). Sex differences in non-obstructive coronary artery disease. *Cardiovascular Research*, *116*(4), 829–840. https://doi.org/10.1093/cvr/cvaa001

Wei, J., Cheng, S., & Bairey Merz, C. N. (2019). Coronary Microvascular Dysfunction Causing Cardiac Ischemia in Women. *JAMA*, *322*(23), 2334. https://doi.org/10.1001/jama.2019.15736

Waist Circumference and Waist-Hip Ratio. World Health Organization; Geneva: 2011. http://apps.who.int/iris/bitstream/10665/44583/1/9789241501491_eng.pdf

Williams, B., Mancia, G., Spiering, W., Agabiti Rosei, E., Azizi, M., Burnier, M., Kahan, T. (2018). ESC/ESH guidelines for the management of arterial hypertension: The task force for the management of arterial hypertension of the European Society of Cardiology (ESC) and the European Society of Hypertension (ESH). *European Heart Journal*, 39(33), 3021-3104

World Health Organisation (WHO). *Cardiovascular Diseases (CVDs) Fact Sheet Number 137* 2017. https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases

Wu, T. T., Gao, Y., Zheng, Y. Y., Ma, Y. T., & Xie, X. (2018). Atherogenic index of plasma (AIP): a novel predictive indicator for the coronary artery disease in postmenopausal women. *Lipids in health and disease*, *17*(1), 197. https://doi.org/10.1186/s12944-018-0828-z

Young, L., & Cho, L. (2019). Unique cardiovascular risk factors in women. *Heart*, *105*(21), 1656–1660. https://doi.org/10.1136/heartjnl-2018-314268