ORIGINAL ARTICLE

Association and risk of hypercholesterolemia among patients with prediabetes from a medical center in Villa El Salvador, Lima, Peru

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ABSTRACT

Objective: To evaluate the association and risk of hypercholesterolemia among adult patients with prediabetes treated at a medical center in the district of Villa El Salvador in Lima, Peru.
Materials and methods: An analytical, prospective and cross-sectional study conducted with data from medical consultation records of 749 patients treated at a polyclinic in the district of Villa El Salvador in Lima, Peru. Asymptomatic adult patients who had routine and preventive checkups were included in the research. Patients with endocrine and metabolic disorders or being treated with hypoglycemic or hyperglycemic drugs were excluded. The study variables were sex, hypercholesterolemia and prediabetes. The association analysis was performed using the chi-square test and the risk was evaluated by means of the odds ratio. In addition, the multivariate analysis was conducted through a binary logistic regression, and an alpha value of 0.05 and a 95 % confidence interval were considered as the cut-off point to determine the statistical significance.
Results: There was a statistically significant association between prediabetes and hypercholesterolemia. Females with prediabetes were 1.66 times more likely to develop hypercholesterolemia than females with normal baseline glucose levels, while males with prediabetes were 2.37 times more likely to have high cholesterol than males with normal baseline blood glucose levels.
Conclusions: Prediabetes is associated with hypercholesterolemia, thus increasing its risk. It is justifiable to carry out the joint measurement of fasting total cholesterol and baseline glucose in disease prevention and health promotion campaigns, regular checkups and follow-up of patients with risk factors for diabetes, prediabetes and hypercholesterolemia. This helps reduce the hemodynamic and cardiovascular consequences of high cholesterol levels and the worsening of the joint morbidity and mortality of chronic hyperglycemia.

Keywords: Hyperglycemia; Hypercholesterolemia; Odds Ratio; Blood Glucose; Chi-Square Distribution (Source: MeSH NLM).

INTRODUCTION

Prediabetes is the metabolic state in which blood glucose levels are elevated above normal but remain below the threshold for diabetes [1]. It is characterized by insulin resistance, where the body's cells do not respond effectively to such hormone, resulting in insufficient glucose uptake and increased circulation of this macromolecule in plasma. Consequently, the pancreas produces more insulin [2]. This condition is of growing concern due to its high prevalence and underestimation by both patients and physicians, despite its significant association with cardiovascular disease and other high-comorbidity complications [3]. Individuals with prediabetes face an elevated risk of developing microvascular and macrovascular complications such as diabetic retinopathy, diabetic neuropathy and chronic kidney disease [4]. Prediabetes is typically asymptomatic [5], but those at higher risk include individuals who are overweight, are over 45 years of age [6], have parents or siblings with diabetes mellitus, engage in physical activity less than three times a week, or have a history of gestational diabetes or birth under such conditions [7].

Approximately 25 % of patients with prediabetes progress to diabetes mellitus within three to five years of diagnosis, and 70 % do so eventually [8]. In 2017, a global prevalence among adults was reported at 7.30 % (587 million people), with similar rates in males and females, and this trend is expected to rise [9].

Hypercholesterolemia, a form of hyperlipidemia and dyslipidemia, is characterized by elevated blood cholesterol levels [10]. Primary causes are often monogenic or polygenic mutations leading to excessive cholesterol production or defects that decrease the production or increase the elimination of high-density lipoproteins [11]. Secondary causes include a sedentary lifestyle and high consumption of high-calorie, saturated fat-rich, cholesterol-laden

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and trans-fatty foods. Other contributing factors include diabetes mellitus, chronic renal insufficiency, hypothyroidism, liver disease, alcohol consumption and certain medications, including thiazides, antiretrovirals, estrogens, progestins and immunosuppressants such as cyclosporine and tacrolimus [12].

Though usually asymptomatic, its cumulative effect can have deleterious consequences on the body years or even decades after the onset of the disorder, primarily due to the formation of atheromatous plaques in the intimal layer of the arteries [13]. This condition disrupts circulation by causing hemodynamic imbalances, generating free radicals and producing inflammatory cytokines [14]. Consequently, it damages organs and tissues, including the brain, heart, kidney and eyes [15]. Globally, hypercholesterolemia is highly prevalent, with an estimated 30 million people over the age of 20 having high cholesterol levels [16].

Prediabetes, driven by insulin resistance and persistent elevation of plasma glucose levels [17], is associated with increased visceral obesity, hypertension, dyslipidemia, atherosclerosis, among other conditions [18]. Previous studies have recommended the use of statins and lifestyle changes to reduce the risks of microvascular and macrovascular complications stemming from underlying dyslipidemias [19]. However, the impact of statins and fibrates on insulin resistance and the subsequent development of diabetes remains uncertain [20]. Research on the relationship between prediabetes and hypercholesterolemia has primarily focused on populations in North America, Asia and Europe [21], whereas studies conducted on the Peruvian population to evaluate the association and risk of hypercholesterolemia among patients with prediabetes have been limited, as prevalence studies are more common [22]. Therefore, the objective of this study was to determine the association and risk of hypercholesterolemia among patients with prediabetes treated at a medical center in the district of Villa El Salvador in Lima, Peru. Additionally, it aimed to assess the importance of systematically—not incidentally—measuring cholesterol levels among patients with prediabetes and implementing pharmacological and lifestyle interventions in this population.

MATERIALS AND METHODS

Study design and population

This was an observational, analytical and cross-sectional study using data from medical records of consultations conducted at a general medicine and physical therapy polyclinic in the district of Villa El Salvador in Lima, Peru, from June 2021 to December 2022. A non-probability convenience sampling method was used, and the sample consisted of the total population eligible according to the inclusion and exclusion criteria (749 patients: 502 females and 247 males).

The inclusion criteria targeted patients aged 18 years or older who were asymptomatic, had undergone a fasting blood glucose and total cholesterol test, and had attended preventive checkups. Patients being treated with hypoglycemic or hyperglycemic drugs (corticosteroids, antipsychotics, statins, diuretics, contraceptives, antivirals), patients with endocrinopathies (diabetes mellitus, hyperthyroidism or hypothyroidism, hypercortisolism, neoplasms) and patients who had visited the polyclinic for medical emergencies or consultation due to non-specific symptoms of discomfort or pain were excluded.

Variables and measurements

The qualitative variables were sex (male, female), impaired fasting glucose (yes, no) and hypercholesterolemia (yes, no). Normal and impaired fasting blood glucose levels were defined according to the American Diabetes Association (ADA) criteria [23], which classify fasting glucose levels between 100 and 125 mg/dL as prediabetes. Cholesterol levels were assessed based on the World Health Organization (WHO) criteria, with normal cholesterol defined as less than 200 mg/dL.

Data were collected and selected from medical records to ensure compliance with the inclusion and exclusion criteria. The collection occurred during medical consultations and during health campaigns carried out every third Thursday from June 2021 to December 2022. The information was recorded and sorted in Excel 2016 for subsequent statistical analysis using IBM SPSS Statistics V25.

Statistical analysis

The variables were dichotomized in 2 x 2 tables. In the bivariate analysis, the chi-square test was used to determine associations between the variables; the odds ratio was also calculated with a 95 % confidence interval. In addition, the multivariate analysis was conducted through a binary logistic regression.

An alpha value of 0.05 was considered as the cut-off point to determine the statistical significance.

Ethical considerations

The polyclinic's ethics committee approved the research. Data were recorded in an anonymous database that only included quantifiable information, so informed consent was not required. Only the researcher had access to the data.

RESULTS

Out of the 749 patients, 184 had prediabetes, and 67.90 % of these were found to have hypercholesterolemia. Among patients with prediabetes, hypercholesterolemia was equally prevalent in both females and males, at 67.50 % and 68.80 %, respectively (Table 1).

Table 1. Frequency of patients with and without prediabetes and hypercholesterolemia

Sex				Hypercholesterolemia		Total
				Yes	No	
Female	Prediabetes	Yes	*n*	81	39	120
			%	67.50	32.50	100
		No	*n*	214	168	382
			%	56	44	100
	Total		*n*	295	207	502
			%	58.80	41.20	100
Male	Prediabetes	Yes	*n*	44	20	64
			%	68.80	31.30	100
		No	*n*	88	95	183
			%	48.10	51.90	100
	Total		*n*	132	115	247
			%	53.40	46.60	100
Total	Prediabetes	Yes	*n*	125	59	184
			%	67.90	32.10	100
		No	*n*	302	263	565
			%	53.50	46.50	100
	Total		*n*	427	322	749
			%	57	43	100

A significant association was found, leading to the rejection of the null hypothesis of independence of variables and the acceptance of the hypothesis that prediabetes is associated with hypercholesterolemia.

Females with prediabetes were 1.66 times more likely to develop hypercholesterolemia than females with normal baseline glucose levels, with a risk increase to 1.68 times in the binary logistic regression analysis. Similarly, males with prediabetes were 2.37 times more likely to develop hypercholesterolemia than males with normal baseline glucose levels, with a risk increase to 2.24 times in the binary logistic regression analysis. Overall, prediabetes represented a risk factor for the development of hypercholesterolemia in both groups (Table 2).

Table 2. Association and risk of hypercholesterolemia among patients with prediabetes according to simple and multivariate analyses

Simple analysis	Sex	*n*	*OR*	95 % CI	X^2	*p*
Prediabetes-hypercholesterolemia	Female	502	1.66	1.07-2.55	5.36	0.021
	Male	247	2.37	1.30-4.34	8.13	0.004
	Total	749	1.86	1.31-2.65	12.37	0.000
Multivariate analysis	**Sex**	***n***	***OR***	**95 % CI**	**X^2**	***p***
Prediabetes-hypercholesterolemia	Female	502	1.68	1.08-2.59	5.65	0.019
	Male	247	2.24	1.23-4.07	7.92	0.008
	Total	749	1.85	1.30-2.64	12.74	0.001

OR: odds ratio, CI: confidence interval, X^2: chi-square, $p < 0.005$.

DISCUSSION

Prediabetes is associated with hypercholesterolemia and represents a risk factor for both males and females. This finding is consistent with studies such as that of Bello de García et al. [24] on the frequency of risk factors for prediabetes among healthcare personnel at a hospital in Paraguay, which observed that elevated lipid and glucose levels are common in this population. Similarly, Al Amri et al. [25] reported a significant association between prediabetes and dyslipidemia among patients at primary care health centers in a Saudi Arabian city, noting an increased risk of lipid metabolism disorders. Arranz-Martínez et al. [26], in their study on the prevalence of prediabetes and its association with cardiometabolic and renal factors according to the Sociedad Española de Diabetes (SED - Spanish Diabetes Society) and the ADA criteria, identified an association between hyperlipidemia and prediabetes, with a particular focus on triglycerides and very low-density lipoproteins. Kansal et al. [27] evaluated the lipid profile among patients with prediabetes in India and found alterations compared to healthy subjects. Bhowmik et al. [28], in an article on the lipid profile and its association with diabetes and prediabetes in a rural Bangladesh population, found that patients with prediabetes were at risk of dyslipidemia, though the risk was higher among patients with diabetes.

Mechanisms increasing lipid levels in insulin resistance conditions include direct effects of insulin on apolipoproteins, dysregulation of lipoprotein lipase and alterations in cholesteryl ester transport protein, contributing to both hypertriglyceridemia and hypercholesterolemia [29]. Prediabetic states, such as glucose intolerance and metabolic syndrome, independently increase cardiovascular disease risk up to threefold [30]. Therefore, hypercholesterolemia should be suspected, assessed and managed in patients with prediabetes in our population due to its potential health consequences, which would increase morbidity and mortality, regardless of whether or not they subsequently develop diabetes mellitus.

The limitations of this study included the sample size, absence of randomization—as the total eligible population was included—and lack of control over additional variables such as body mass index, abdominal circumference and blood pressure levels. Efforts were made to address these limitations through the inclusion and exclusion criteria, which focused on patients without morbid obesity who were asymptomatic and participated in disease prevention and health promotion campaigns. However, the main limitation was that, as a cross-sectional study, it could only suggest associations. Cohort studies are needed to determine the long-term effects of detecting these cases.

In conclusion, prediabetes is associated with hypercholesterolemia and represents a risk factor for its development in asymptomatic patients attending a medical center in the district of Villa El Salvador in Lima, Peru. Routine monitoring of total cholesterol levels among patients with prediabetes with or without metabolic syndrome is recommended.

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