Original Article

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Paediatrics Section

Pattern of Lipid Profile among Asthmatic versus Non-asthmatic Children Aged 5-12 years: A Cross-sectional Study from Coastal Kerala, India

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ABSTRACT

Introduction: Hypercholesterolemia and asthma are associated with skewing of adaptive immune system towards a TH2 (T Helper cell 2). Literature has examined the relationship between blood lipid profile and asthma with ambiguous results. Hence, it is important to look for pattern of lipid profile in asthmatic children.

Aim: To compare the Total Cholesterol (TC), Low Density Lipoprotein-Cholesterol (LDL-C) and High Density Lipoprotein-Cholesterol (HDL-C), triglyceride in asthmatic and non-asthmatic children.

Materials and Method: A total of 180 children aged 5–12 years were enrolled in this cross-sectional study, including 90 children with asthma attending the asthma clinic and 90 non-asthmatic children serving as controls. The study was conducted at Government TD Medical College, Alappuzha, in the paediatric asthma clinic and paediatric ward from April 2021 to April 2022. Data was collected using questionnaire and anthropometric measurement. Fasting lipid profile was done in the hospital laboratory by enzymatic colorimetric method. Data was analysed and compared using Statistical Package of Social Sciences (SPSS) software version 20.

Results: Mean Total Cholesterol (TC)- 172.73 mg/dL, LDL-C- 104.11 mg/dL, HDL-C- 47.98 mg/dL, triglyceride- 77.63 mg/dL (5-9.9 years) and 81.20 mg/dL (10-12 years). Girls with asthma had significantly higher TC than control group with p-value 0.022. TC, LDL-C and HDL-C were high compared to studies in general paediatric population of India. Prevalence of dyslipidemia among the whole study population was as high as 51.1%.

Conclusion: There was no statistically significant difference in TC, LDL-C, HDL-C or Triglycerides among asthmatic and non-asthmatic children. However, girls with asthma had significantly higher TC than control group.

Keywords: Body mass index, High density lipoprotein cholesterol, Inhalational corticosteroids, Low density lipoprotein cholesterol, Total cholesterol, Triglyceride

INTRODUCTION

Asthma affects people of all age groups and its prevalence is increasing in many countries, especially among children [1]. Asthma is a common chronic disease in children. It is a cause of emergency department visits, hospitalisation and missed school days. There is chronic inflammation of airways resulting in recurrent episodes of airflow obstruction due to oedema, bronchospasm and increased mucus production. It occurs as recurrent wheezing of early childhood or chronic asthma persisting into late childhood [2].

It is defined by the symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and intensity. There is variable expiratory airflow limitation with airway hyper-responsiveness and airway inflammation [1]. It is caused by allergies, air pollution, cigarette smoke, diesel exhaust particle, aspirin, exercise and obesity. Although the underlying mechanisms are not fully understood asthma exhibits two different disease entities: atopic asthma and non-atopic asthma. Regarding non-atopic asthma metabolic syndrome and dyslipidemia which are known to contribute to a proinflammatory state have attracted interest as a potential cause in recent year [3].

Several longitudinal epidemiological studies show that obesity or increased adiposity often precedes incident asthma [4]. Multiple cytokines (e.g., tumour necrosis factor-a, Interleukin-1, Interleukin-6), hormones (e.g., leptin, adiponectin), and acute-phase reactants (e.g., Creactive protein) participate to both metabolic and inflammatory pathways and are overexpressed in both asthma and obesity resulting in a chronic, low-grade inflammatory state [5,6]. Hypercholesterolemia has also been associated with skewing of adaptive immune system towards a TH2 (T helper cell type 2) response which could mediate other diseases such as asthma [7].

The role of HDL and several cholesterol trafficking regulators were studied in animal model of asthma. Mice sensitised with ovalbumin while taking high cholesterol diet had significantly increased airspace eosinophils and Interleukin-5 (IL-5) [8]. COPSAC2000 (Copenhagen Prospective Studies on Asthma in Childhood 2000) cohort study obtained high LDL cholesterol associated with concurrent asthma with an adjusted Odds Ratio (aOR) 1.93; 95% confidence interval, 1.06-3.55; p=0.03) high levels of HDL cholesterol were associated with improved specific airway resistance [7].

Studies of children's blood lipid profiles in relation to asthma are few, and the results are ambiguous [9-12]. More prevalence of asthma and dyslipidemia in obese children was reported in a study [12]. Two cohort studies showed abnormal LDL and HDL in asthmatic children than controls [7,9]. Dyslipidemia is a trigger in the initiation and progression of endothelial dysfunction, considered the earliest atherosclerotic lesion and to be managed aggressively to prevent further disease progression to cardiac disease, a leading cause of mortality in adults [13]. If dyslipidemia is associated with asthma, all asthmatic children need to be screened and appropriate intervention needed. The aim of the study is to compare the total, LDL and HDL cholesterol, triglyceride in asthmatic and non-asthmatic children. The Primary objective of the study was to find mean of TC, LDL-C, HDL-C and triglyceride in asthmatic and

non-asthmatic children and compare. The secondary objective of the study was to determine prevalence of unacceptable lipid levels/dyslipidemia in study population and to find any relation with gender or Body Mass Index (BMI).

Hypothesis

Research hypothesis: TC, LDL-C and triglycerides are high and HDL-C is low among asthmatic children.

Null hypothesis: Lipid profile is not related to asthma in children.

MATERIALS AND METHODS

This study was structured to compare lipid profile among asthmatic and non-asthmatic children. Conducted in Government TD medical college, Alappuzha situated in the coastal Kerala during the period April 2021 to April 2022. Ethics committee clearance was obtained (Reg no: ECR/12/Inst/KL/2013/RR-19, EC: 20/2021 on 29/03/2021).

Sample size: Using Nmaster software taking reference of Yiallouros PK et al., study "asthma- role of HDL-C in childhood and adolescence" [9] which concluded significant association of low HDL-C and adolescent asthma in those with high baseline HDL-C (OR 2.40, 95% CI 1.03-5.20)

Sample size of 176 calculated (88 in each asthmatic and non-asthmatic group).

n=m/p e.

where,

n: Number of required pairs to detect m discordant pairs in the exposure group.

m: Minimum number of required discordant pairs.

p e: Prevalence of exposed.

$$m = \frac{\left\{\left\{\frac{z_\alpha}{2}+\left(z_{1-\beta}\sqrt{P\,(1-P)}\right)\right\}\right\}^2}{\left(P-\frac{1}{2}\right)^2}$$

$$P_e = \{P_2 * (1-P_1)\} + \{P_1 * (1-P_2)\}$$

$$P = \left(\frac{OR}{1+OR}\right);\ P1 = \frac{(OR)P_2}{1+(OR-1)\,P2}$$

P1: Calculated proportion in the case group.

P2: Expected proportion exposed in the control group.

OR: Estimated Odds ratio.

n: Number of required pairs to detect m discordant pairs in the exposure group.

m: Minimum number of required discordant pairs.

α: Significance level

1-β: Power

Epidemiology methods- Matched case control studies single control per case

proportion exposed in the control group= 0.5

Anticipated odds ratio= 2.4

Proportion exposed in case group=0.71

Power (%)=80

Alpha Error (%)=5

Sided=2

Minimum no. of required discordant pairs 'm'= 44;

No. of required pairs to detect 'm' discordant pairs in the exposure group=88;

Means sample size of 88 in each case and control groups;

Total sample size=176;

Hence, 90 children with asthma were selected according to the operational definition.

Operational Definition of Asthma

Children aged 5-12 years were registered in the asthma clinic. They were fulfilling the clinical criteria as per GINA guidelines [1].

Features of wheeze, shortness of breath, cough and/or chest tightness:

- Patients experience more than one of these symptoms;
- Worse at night or early morning;
- Vary over time and in intensity;
- Symptoms are triggered by infections (colds), exercise, allergen exposure, changes in weather, laughter or irritant);
- Symptomatic improvement with asthma medications.

Cooperative children have also undergone spirometry.

Height, weight and BMI calculated by standard procedures. BMI plotted in IAP growth charts and classified into four groups [14].

- **Undernourished/underweight:** <3rd centile is thinness.
- **Normal weight:** 3rd centile to 23 adult equivalent
- **Over weight:** BMI between 23-27 adult equivalent for age and gender on BMI chart.
- **Obesity:** Body Mass Index (BMI) >27 adult equivalent for age and gender.

Additionally 90 children were selected from the paediatric ward. They were of similar age group 5-9 years and 10-12 years as triglyceride reference is different for these two groups) and matched for gender and BMI groups.

Inclusion criteria:

Case- Asthmatic children of 5-12 yr age group presenting in asthma clinic TD Medical College Alappuzha after getting informed consent

Control- Non-asthmatic children of similar age group and BMI presenting in T D Medical College Alappuzha after getting consent.

Exclusion criteria:

Cases:

- Co-existent nephrotic syndrome;
- Familial dyslipidemia;
- Child with hypothyroidism;
- Hormonal drugs.

Controls: Diseases as nephrotic syndrome, hypothyroidism, familial dyslipidemia or on drugs as hormones or steroids.

Procedure

Total sample size was 180 (90 in each group) matched in terms of age group, BMI group and gender. Participants were selected using non-probability convenience sampling within the study period.

Data collection tools:

1. **Anthropometry**
   - Weight: digital weighing machine (OMRON HN289, measured with accuracy ±100g)
   - Height: stadiometer (PRESTIGE height measuring scale, measured height with footwear removed, looking forward, shoulder in relaxed position to the nearest 0.1 cm)
   - IAP BMI chart [14], BMI calculated {weight in kg/(height in m)^2} and plotted in chart and categorised into underweight, normal, overweight or obese.
2. **Fasting lipid profile report** [Table/Fig-1] [15].

The National Heart, Lung, and Blood Institute (NHLBI) guidelines [15] were used for interpreting the laboratory findings. Questionnaire was filled, anthropometry measurements were done and fasting

Category		Acceptable	High/low
TC (mg/dL)		<170	≥200
LDL-C (mg/dL)		<110	≥130
TG (mg/dL)	0-9	<75	≥100
	10-19	<90	≥130
HDL-C (mg/dL)		>45	<40

[Table/Fig-1]: Lipid profile in children [15].
TC: Total cholesterol, LDL-C: Low density lipoprotein cholesterol; TG: Triglycerides; HDL-C: High density lipoprotein cholestero

lipid profile was done by enzymatic colorimetric method. Details were collected with consent and kept confidential IEC number: (Reg no: ECR/12/Inst/KL/2013/RR-19, EC:20/2021 on 29/03/2021). In 2011, NHLBI (National Heart Lung and Blood Institute) [15] published guidelines endorsed by AAP (American Academy of Paediatrics) recommending selective cholesterol screening in children of age 2-21 with risk factors and universal screening at ages 9-11 and 17-21 years [16]. Blood samples were collected after obtaining informed consent.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS software version 20. Quantitative variables were expressed as mean ± standard deviation (SD), while qualitative variables were presented as frequencies and percentages. The Chi-square test was used to compare categorical variables. A p-value <0.05 was considered statistically significant.

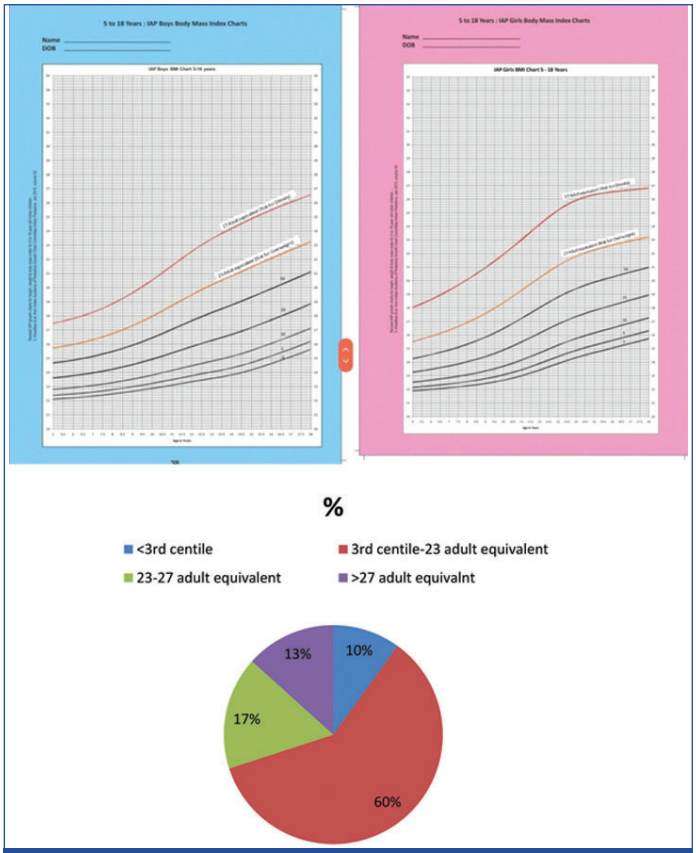
RESULTS

The children included in the study were aged 5–12 years which were further divided into 5-9.9 years and ≥10 years. Both the case group and control group had 64 children (71.1%) in 5-9.9 years age group and 26 children (28.9%) in ≥10 years of age group. Sample was selected such that age, gender and BMI were evenly distributed among case and control groups. Of the total children 52 (57.8%) were boys and 38 (42.2%) were girls in both the groups.

The BMI was homogeneously distributed among cases and controls which means among the 90 children of case group 52 were boys and 38 were girls. BMI was calculated and compared with respective gender IAP BMI chart and categorised as underweight (9 children- 5 boys and 4 girls)), normal (54 children- 28 boys and 26 girls), overweight (15 children-10 boys and 5 girls) and obese (12 children- 9 boys and 3 girls) groups. Control group was selected later with same gender and BMI distribution (5 underweight boys, 4 underweight girls, 28 normal weight boys and 26 normal weight girls, 10 overweight boys, 5 overweight girls, 9 obese boys and 3 obese girls). Pie-chart was prepared on basis of BMI category regardless of the gender [Table/Fig-2].

In this study, both asthma and control groups had equal number of girls and boys of similar age group with mean 8.0 (SD=2.2, range=5-12 years) and 8.1 (SD=2.16, range=5-12 years) in respective groups. Mean BMI in asthmatics was 16.5 kg/m2 (SD=3.3, Range=10.36-31.25) and in control group was 16.30 kg/m2 (SD=3.3, Range=10.60-26.40), thus minimising the confounding effects. The results came as slightly high mean TC of 172.73mg/dL (SD=30.18) in asthmatics than control group, mean 164.08 mg/dL (SD=36.14). Mean LDL cholesterol and HDL cholesterol were similar in both groups 104.11 mg/dL (SD=26.26) and 103.34 mg/dL (SD=32.98) for LDL-C, 47.98 mg/dL (SD=12.92) and 46.17 mg/dL (SD=16.55) for HDL-C. Mean triglyceride in below 10 years was 77.63 mg/dL (SD= 28.42) and 85.38 mg/dL (SD=40.28), in ≥10 years 81.20 mg/dL (SD=35.96) and 80.06 mg/dL (SD=29.73) in these groups [Table/Fig-3].

The p-value for TC (0.18), LDL-C (0.64), HDL-C (0.07), Triglyceride (0.76) proved no statistically significant difference among cases and controls as such in terms of lipid profile [Table/Fig-4].



[Table/Fig-2]: BMI distribution among both groups (Indian Academy of Paediatrics-IAP chart [14].

Mean of	Asthma group		Control group	
	Mean (Standard Deviation/ SD)	Range (min - max)	Mean (SD)	Range (max - min)
Age (years)	8.0 (2.2)	5 - 12	8.1 (2.16)	5 - 12
BMI (kg/m2)	16.50 (3.3)	10.36 - 31.25	16.30 (3.3)	10.60 - 26.40
Total Cholesterol (TC) (mg/dL)	172.73 (30.18)	103 - 242	164.08 (36.14)	92 - 267
LDL-C (mg/dL)	104.11 (26.26)	35 - 162	103.34 (32.98)	33 - 191
HDL-C (mg/dL)	47.98 (12.92)	23 - 90	46.17 (16.55)	14 - 147
Triglyceride (mg/dL)				
5 years- 9 year 11 month	77.63 (28.42)	36 - 170	85.38 (40.28)	27 - 244
10-12 years	81.20 (35.96)	35 - 195	80.06 (29.73)	27 - 147

[Table/Fig-3]: Comparison of case and control groups.
BMI: Body mass index; LDL-C: Low density lipoprotein cholesterol; HDL-C: High density lipoprotein cholesterol; SD: Standard deviation

TC >200 mg/dL is present in 26.6% cases and 16.6% controls; LDL-C >110 mg/dL in 20% cases and 17.7% controls; HDL-C <40 mg/dL in 30% cases and 35.5% controls; Triglyceride is high (>100 mg/dL in <10 years and > 130 mg/dL in > 10 years) in 16.6% cases and 21.1% controls. However, dyslipidemia (any one component deranged according to the values given) is as high as 51.1% in cases and 50% in controls [Table/Fig-5]. And there was no statistically significant difference among asthma group and control.

Total Cholesterol (TC) in Cases and Controls

A total of 23 (44.2%) of boys with asthma and 24 (46.2%) boys without asthma had unacceptable TC (p-value 0.84). Among girls 24 (63.2%) asthmatics and 14 (36.8%) non-asthmatics had unacceptable TC (p-value 0.02, significant). But in boys there was no such significant difference between asthmatics and non-asthmatics {23(44.2%)

Lipid component	Group	Acceptable	Unacceptable	p-value
Total cholesterol (TC)	Case	43	47	0.18
		47.7%	52.3%	
	Control	52	38	
		57.7%	42.3%	
LDL-C	Case	57	33	0.64
		63.3%	36.7%	
	Control	60	30	
		66.6%	33.4%	
HDL-C	Case	50	40	0.07
		55.5%	44.5%	
	Control	38	52	
		42.2%	57.8%	
Triglyceride	Case	49	41	0.76
		54.4%	45.6%	
	Control	51	39	
		56.6%	43.4%	

[Table/Fig-4]: Unacceptable lipid profile in cases and controls.
Chi-square test is used. (LDL-C: Low density lipoprotein cholesterol, HDL-C: High density lipoprotein cholesterol)

Lipid profile		Dyslipidemia		p-value
		Yes	No	
Total Cholesterol (TC) (>200 mg/dL)	Case	24	60	0.103
		26.6%	73.4%	
	Control	15	75	
		16.6%	83.4%	
LDL-C (>110 mg/dL)	Case	18	72	0.703
		20%	80%	
	Control	16	74	
		17.7%	82.3%	
HDL-C (<40 mg/dL)	Case	27	63	0.427
		30%	70%	
	Control	32	58	
		35.5%	64.5%	
Triglyceride (>100 mg/dL or >130 mg/dL agewise)	Case	15	75	0.446
		16.6%	83.4%	
	Control	19	71	
		21.1%	78.9%	
Dyslipidemia	Case	46	44	0.881
		51.1%	48.9%	
	Control	45	45	
		50%	50%	

[Table/Fig-5]: Distribution of dyslipidemia in cases and controls.

		Total Cholesterol (TC)		p-value
		Acceptable	Unacceptable	
Male (n=52)	Case	29	23	0.844
		55.8%	44.2%	
	Control	28	24	
		53.8%	46.2%	
Female (n=38)	Case	14	24	0.022*
		36.8%	63.2%	
	Control	24	14	
		63.2%	36.8%	

[Table/Fig-6]: Total Cholesterol (TC) distribution among males and females.

asthmatic and 24(46.2%) non-asthmatic boys had unacceptable TC with p-value 0.844}. as given in [Table/Fig-6].

In normal BMI and overweight group asthmatics had high TC than controls- 46.3% and 46.7% against 40.7% and 33.3%, respectively. But prevalence of high cholesterol was same in obese children of both categories (66.7%). The p-value for categories normal weight=0.56, overweight=0.45 and obese=1.0 proved no statistically significant difference among cases and controls as such in terms of lipid profile. The p-value for underweight category 0.05 which gives evidence that asthmatic children of underweight category has high TC compared to control group of same BMI category [Table/Fig-7].

		Total Cholesterol (TC)		p-value
		Acceptable	Unacceptable	
Underweight (n=9)	Case	2	7	0.05
		22.2%	77.8%	
	Control	6	3	
		66.7%	33.3%	
Normal weight (n=54)	Case	29	25	0.56
		53.7%	46.3%	
	Control	32	22	
		59.3%	40.7%	
Overweight (n=15)	Case	8	7	0.456
		53.3%	46.7%	
	Control	10	5	
		66.7%	33.3%	
Obese (n=12)	Case	4	8	1.0
		33.3%	66.7%	
	Control	4	8	
		33.3%	66.7%	

[Table/Fig-7]: Total Cholesterol (TC) distribution among BMI groups.
Chi-square test is used

LDL Cholesterol (LDL-C) in Cases and Controls

The p-value of acceptable and unacceptable LDL-C among asthmatic and non-asthmatic boys was 1.0 (19 asthmatics and 19 non-asthmatics had unacceptable values) and among girls 0.46, 14 (36.8%) asthmatics and 11 (28.9%) had unacceptable values [Table/Fig-8].

		LDL		p-value
		Acceptable	Unacceptable	
Male (n=52)	Case	33	19	1.0
		63.5%	36.5%	
	Control	33	19	
		63.5%	36.5%	
Female (n=38)	Case	24	14	0.464
		63.2%	36.8%	
	Control	27	11	
		71.1%	28.9%	

[Table/Fig-8]: LDL-C distribution among males and females.

Distribution of LDL-C among BMI groups was p-value 0.04 in underweight category, 0.83 in normal weight, 0.69 in overweight and 0.68 in obese comparing cases and controls [Table/Fig-9].

HDL cholesterol (HDL-C) in cases and controls

A 20 (38.5%) asthmatic boys and 30 (57.7%) control boys had unacceptable HDL-C (p-value 0.07). among girls p-value was 0.64 {20(52.6%) asthmatics and 22(57.9%) non-asthmatics had unacceptable values} [Table/Fig-10].

[Table/Fig-11] shows the distribution of HDL levels across different BMI groups among case and control participants. Acceptable HDL levels were comparatively higher among cases in the underweight and normal-weight groups, while unacceptable HDL levels were more common in overweight and obese participants. However,

		LDL		p-value
		Acceptable	Unacceptable	
Underweight (n=9)	Case	4	5	0.04*
		44.4%	55.6%	
	Control	8	1	
		88.9%	11.1%	
Normal weight (n=54)	Case	36	18	0.83
		66.7%	33.3%	
	Control	37	17	
		68.5%	31.5%	
Overweight (n=15)	Case	11	4	0.69
		73.3%	26.7%	
	Control	10	5	
		66.7%	33.3%	
Obese (n=12)	Case	6	6	0.68
		50.0%	50.0%	
	Control	5	7	
		41.7%	58.3%	

[Table/Fig-9]: LDL-C distribution among BMI groups.

		HDL		p-value
		Acceptable	Unacceptable	
Male (n=52)	Case	32	20	0.077
		61.5%	38.5%	
	Control	22	30	
		42.3%	57.7%	
Female (n=38)	Case	18	20	0.645
		47.4%	52.6%	
	Control	16	22	
		42.1%	57.9%	

[Table/Fig-10]: HDL-C distribution among males and females.

		HDL		p-value
		Acceptable	Unacceptable	
Underweight (n=9)	Case	6	3	0.058
		66.7%	33.3%	
	Control	2	7	
		22.2%	77.8%	
Normal weight (n=54)	Case	34	20	0.121
		63.0%	37.0%	
	Control	26	28	
		48.1%	51.9%	
Overweight (n=15)	Case	5	10	0.456
		33.3%	66.7%	
	Control	7	8	
		46.7%	53.3%	
Obese (n=12)	Case	5	7	0.386
		41.7%	58.3%	
	Control	3	9	
		25.0%	75.0%	

[Table/Fig-11]: HDL-C distribution among BMI groups.

the differences between cases and controls were not statistically significant in any BMI category (p>0.05).

Triglyceride in Cases and Controls

Boys with and without asthma had p-value of 0.43 {23(44.2%) asthmatics and 27(52%) non-asthmatics and girls 0.15 (18(47.4%) asthmatics and 12(31.6%) non-asthmatics} on comparing unacceptable triglyceride [Table/Fig-12].

		Triglyceride		p-value
		Acceptable	Unacceptable	
Male (n=52)	Case	29	23	0.432
		55.8%	44.2%	
	Control	25	27	
		48%	52%	
Female (n=38)	Case	20	18	0.159
		52.6%	47.4%	
	Control	26	12	
		68.4%	31.6%	

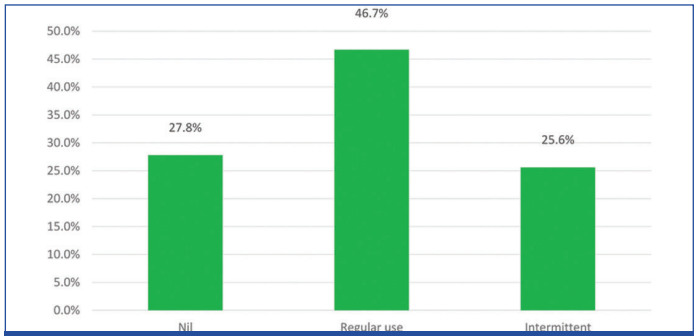
[Table/Fig-12]: Triglyceride distribution among males and females.

The table shows the distribution of acceptable and unacceptable triglyceride levels among different BMI groups in both case and control participants. Statistical analysis revealed no significant association between triglyceride levels and BMI categories among cases and controls, as all p-values were greater than 0.05 [Table/Fig-13].

A 46.7% of children used Inhalational Corticosteroids (ICS) regularly and 25.6% used them intermittently [Table/Fig-14].

		Triglyceride		p-value
		Acceptable	Unacceptable	
Underweight (n=9)	Case	4	5	1.0
		44.4%	55.6%	
	Control	4	5	
		44.4%	55.6%	
Normal weight (n=54)	Case	31	23	0.695
		57.4%	42.6%	
	Control	33	21	
		61.1%	38.9%	
Overweight (n=15)	Case	8	7	1.0
		53.3%	46.7%	
	Control	8	7	
		53.3%	46.7%	
Obese (n=12)	Case	6	6	0.682
		50.0%	50.0%	
	Control	8	4	
		41.7%	58.3%	

[Table/Fig-13]: Triglyceride distribution among BMI groups.



[Table/Fig-14]: Use of Inhalational Corticosteroids (ICS) among asthmatic children.

Unacceptable TC was found in 44% of asthmatics who are not on ICS, 50% with regular ICS and 65.2% who are intermittent user. Similarly unacceptable LDL cholesterol was found in 32% 35.7% and 43.5% of these groups respectively. Values were 40%, 47.6% and 43.5% for unacceptable HDL cholesterol in those not using ICS, using regularly and on intermittent use, respectively. On considering triglycerides 57.1% regular users and 39.1% intermittent users showed unacceptable values compared to 32% of those who are not on ICS. However, statistical values show no significant difference [Table/Fig-15].

Treatment	Total Cholesterol (TC)		LDL		HDL		Triglyceride	
	Acceptable	Unacceptable	Acceptable	Unacceptable	Acceptable	Unacceptable	Acceptable	Unacceptable
Nil	14	11	17	8	15	10	17	8
	56.0%	44.0%	68.0%	32.0%	60.0%	40.0%	68.0%	32.0%
Regular use	21	21	27	15	22	20	18	24
	50.0%	50.0%	64.3%	35.7%	52.4%	47.6%	42.9%	57.1%
Intermittent	8	15	13	10	13	10	14	9
	34.8%	65.2%	56.5%	43.5%	56.5%	43.5%	60.9%	39.1%
P value	0.31		0.70		0.82		0.10	

[Table/Fig-15]: Inhalational Corticosteroids (ICS) use and lipid profile comparison.

Among the 65 asthmatic children using ICS regularly or intermittently 21 children (32.3%) were having BMI ≥ 23 adult equivalent(overweight or obese). Among the 25 not using ICS, six were overweight/obese. No statistically significant relation was found [Table/Fig-16].

ICS use	Overweight/obese		p-value
	Yes	No	
Yes	21	44	0.441
	32.3%	67.7%	
No	6	19	
	24%	76%	

[Table/Fig-16]: Inhalational Corticosteroids (ICS) use and obesity.

DISCUSSION

In this study 90 cases of asthma and equal number of control-children were evaluated. Average BMI of asthmatic group was 16.5 kg/m2 and control group was 16.3 kg/m2. Among the population 60% were normal weight, 16.7% overweight, 13.3% obese and 10% underweight in both groups. A 46.7% asthmatics were using ICS regularly.

According to Khalil A et al., mean TC in Indian children was 134.5 mg/dL(17).And in our study mean cholesterol value among asthmatic and non-asthmatic were 172.73 mg/dL and 164.08 mg/dL respectively. The p-value of acceptable and unacceptable TC levels among asthmatics and controls is 0.179 and not significant. No statistically significant difference in unacceptable TC was found among different BMI groups. Comparing sex difference female asthmatics had unacceptable TC than control girls with p-value 0.022.

In Khalil A et al., study mean LDL was 80.1 mg/dL [17] According to Ford ES et al., mean concentration for low-density lipoprotein cholesterol for participants 12 to 17 years of age was 90.2 mg/dL (n=27240) [11]. But in this study we got average LDL 104.11 and 103.34 mg/dL in asthmatic and non-asthmatic children. Copenhagen Prospective Studies on Asthma in Childhood 2000 was a cohort study and obtained high LDL cholesterol associated with concurrent asthma with an aOR 1.93; 95% confidence interval, 1.06-3.55; p=0.03) [7].

On comparing LDL underweight category of asthma children had high prevalence of unacceptable LDL with p-value= 0.046.In normal BMI and overweight categories of asthma and control groups 66.7% and 68.5 % respectively had normal LDL. No much difference in LDL of obese children in both groups. Almost equal number had normal and high LDL. No significant difference in lipid profile of cases and controls with respect to gender.

According to Khalil A et al., mean HDL in Indian children was 34.15 mg/dL. With regard to HDL in a follow up cohort study done in Cyprus mean HDL-C levels in asthmatic and current wheezing patients were significantly lower than in the controls (47.9 and 49.7 vs. 53.4 mg/dL; p=0.001 and p=0.011)(9). But such a relation was not found in our study as 47.98 vs 46.17 with a p-value 0.073. However it is more comparing Khalil A et al., study [17].

In this study, 66.7% of underweight asthmatics had acceptable level of HDL while it was unacceptable in 77.8% non-asthmatic underweight children (however p-value is 0.058 and not statistically significant). But as sample size is only nine in the underweight category so this finding need to be confirmed in a larger population. In normal BMI category also 63% asthmatic had acceptable HDL and 51.9% controls had low HDL. In obese and overweight categories majority of both cases and controls had low HDL with no statistically significant difference. No significant difference in lipid profile of cases and controls with respect to gender.

Triglyceride mean value among Indian children was 91.1 mg/dL according to Khalil A et al., [17]. Here, it was 77.63 mg/dL and 85.38 mg/dL in asthmatic and control group of 5-9.9 years. Mean triglyceride ≥10 years as 81.2 mg/dL and 80.06 mg/dL in cases and controls. No significant difference in lipid profile of cases and controls with respect to gender.

In Yavuz O et al., cholesterol concentration decreased slightly (p=0.03) and HDL-cholesterol concentrations increased after ICS therapy for four weeks (p=0.01) [18]. No significant association use or duration of use and lipid profile was found [18].

According to Chen YC et al., TC and LDL-C levels increased progressively in the group order obese asthmatics > non-obese asthmatics > obese controls > non-obese controls. In boys, LDL-C levels were significantly higher in obese asthmatics compared to obese non-asthmatics [3].

Dyslipidemia was present in 51.1% of cases and 50% of controls. In U.S. national health survey of prevalence of dyslipidemia in children was 22.9%. Elevated triglyceride in 14.2% and elevated TC in 9.6% children.

AHA and AAP recommend lipid screening for all children 9-11 years. Selective screening based on family history alone could potentially miss 30-50% of children and adolescents with substantial increase of lipid profile. This is very slowly being taken up to the practice [19]. Findings of the present study also recommend routine screening of lipid profile for children.

Limitation(s)

Dietary habits, physical activity and other conditions affecting lipid status are not considered which may act as confounding factors.

CONCLUSION(S)

This study has found significantly high TC in asthmatic females compared to non-asthmatic females. Mean TC was high in cases than controls. Both values were high compared to previous studies. Underweight category of asthmatic children found to have significantly high LDL compared to same category control children. Mean LDL values were comparable between cases and controls, but both were high comparing previous studies. Mean HDL values were also comparable between cases and controls. These values were slightly high comparing previous study. However, mean triglyceride of both groups were slightly low than previous studies.

Prevalence of dyslipidemia was found to be high in both groups than values from previous studies. Since dyslipidemia is associated with increased coronary artery disease, cardiovascular death, MI, stroke etc., the finding of high proportion of unacceptable lipid profile need

attention not only in asthmatic but in entire child population. The study found no significant overall difference in lipid profile between asthmatic and non-asthmatic children, except for: Higher TC in girls with asthma Higher LDL-C in underweight asthmatic children Therefore, the statement recommending attention to the entire child population is somewhat stronger than the study findings and should be interpreted cautiously.

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REFERENCES

[1] Global Initiative for Asthma (GINA). Global Strategy for Asthma Management and Prevention. 2022. Available from: https://ginasthma.org/gina-reports/. Assessed on 27/12/2022.
[2] Kliegman RM, St Geme JW, Blum NJ, Shah SS, Tasker RC, Wilson KM, editors. Nelson Textbook of Pediatrics. 22nd ed. Philadelphia: Elsevier; 2023. Available from: https://shop.elsevier.com /books/nelson-textbook-of-pediatrics-2-volume-set/kliegman/978-0-323-88305-4. Assessed on 18/12/2022.
[3] Chen YC, Tung KY, Tsai CH, Su MW, Wang PC, Chen CH, et al. Lipid profiles in children with and without asthma: Interaction of asthma and obesity on hyperlipidemia. Diabetes Metab Syndr. 2013;7(1):20-25. Available from: https://pubmed.ncbi.nlm.nih.gov/23517791/ Assessed on 6/2/2021.
[4] Gilliland FD, Berhane K, Islam T, McConnell R, Gauderman WJ, Gilliland SS, et al. Obesity and the risk of newly diagnosed asthma in school-age children. Am J Epidemiol. 2003;158:406-15. Available from: https://pubmed.ncbi.nlm.nih.gov/12936895/. Assessed on 1/3/21.
[5] Hotamisligil GS, Shargill NS, Spiegelman BM. Adipose expression of tumour necrosis factor-alpha: Direct role in obesity-linked insulin resistance. Science. 1993;259:87-91. Available from: https://pubmed.ncbi.nlm.nih.gov/7678183/. assessed on 19/1/2021.
[6] Perseghin G, Petersen K, Shulman GI. Cellular mechanism of insulin resistance: Potential links with inflammation. Int J Obes Relat Metab Disord. 2003;27:S6-S11. Available from: https://pubmed.ncbi.nlm.nih.gov/14704736/. Assessed on 19/1/2021.
[7] Vinding RK, Stokholm J, Chawes BLK, Bisgaard H. Blood lipid levels associate with childhood asthma, airway obstruction, bronchial hyperresponsiveness, and aeroallergen sensitization. J Allergy Clin Immunol. 2016;137(1):68-74.e4. Available from: https://pubmed.ncbi.nlm.nih. gov/26148797/. Assessed on 6/2/2021.
[8] Zhu LP, Yan CJ, Wu QJ, Zhang CX, Yuan XT, Fang TK. Assessment of changes in lipid profile and related enzymes in children with asthma. Trop J Pharm Res. 2017;16(7):1711-16. Available from: https://www.researchgate.net/publication/318974957_Assessment_of_changes_in_lipid_profile_ and_related_enzymes_in_children_with_asthma. Assessed on 19/1/2023.
[9] Yiallouros PK, Savva SC, Kolokotroni O, Dima K, Zerva A, Kouis P, et al. Asthma: The role of low high-density-lipoprotein cholesterol in childhood and adolescence. Int Arch Allergy Immunol. 2014;165(2):91-99. Available from: https://pubmed.ncbi.nlm.nih.gov/25377880/. Assessed on 4/1/2021.
[10] Bolton CH, Mulloy E, Harvey J, Downs LG, Hartog M. Plasma and lipoprotein lipids and apolipoproteins AI, AII and B in patients with chronic airflow limitation. J R Soc Med. 1989 Feb;82(2):91-2. Doi: 10.1177/014107688908200212. PMID: 2494326; PMCID: PMC1292001. Available from: https://pubmed.ncbi.nlm.nih.gov/2494326/. Assessed on 2/2/2021.
[11] Ford ES, Li C, Zhao G, Mokdad AH. Concentrations of low-density lipoprotein cholesterol and total cholesterol among children and adolescents in the United States. Circulation. 2009;119(8):1108-15. Available from: https://pubmed.ncbi.nlm.nih.gov/19221218/. Assessed on 7/1/2023.
[12] C ottrell L, Neal WA, Ice C, Perez MK, Piedimonte G. Metabolic abnormalities in children with asthma. Am J Respir Crit Care Med. 2011;183(4):441-48. Available from: https://pubmed.ncbi.nlm.nih.gov/20851922/ assessed on 9/2/2021.
[13] Pires A, Sena C, Seiça R. Dyslipidemia and cardiovascular changes in children. Curr Opin Cardiol. 2016;31(1):95-100. Available from: https://pubmed.ncbi.nlm.nih.gov/26599060/ Assessed on 19/1/2023.
[14] Indian Academy of Pediatrics Growth Charts Committee, Khadilkar V, Yadav S, Agrawal KK, Tamboli S, Banerjee M, et al. Revised IAP growth charts for height, weight and body mass index for 5- to 18-year-old Indian children. Indian Pediatr. 2015;52(1):47-55. Available from: https://pubmed.ncbi.nlm.nih.gov/25638185/ Assessed on 9/2/2021.
[15] Zachariah JP. Lipid Screening in Youth. [Updated 2023 Mar 9]. In: Feingold KR, Anawalt B, Blackman MR, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. Table 3. [NHLBI Guideline Lipid Thresholds by Age (mg/dL)]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK395583/table/lipid_youth-screen.T.nhlbi_guideline_lip/. Assessed on 21/2/2022.
[16] Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents, National Heart, Lung, and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: Summary report. Pediatrics. 2011;128(Suppl 5):S213-S256 Available from: https://pubmed.ncbi.nlm.nih.gov/22084329/. Assessed on 21/2/2021.
[17] Khalil A, Gupta S, Madan A, Venkatesan M. Lipid profile norms in Indian children. Indian Pediatr. 1995;32(11):1177-80. Available from: https://pubmed.ncbi.nlm.nih.gov/8772866/. Assessed on 6/1/2022.
[18] Yavuz O, Türktas¸ I, Cevik C. The effect of high-dose inhaled budesonide on lipid profile in asthmatic patients. Gen Pharmacol. 1996;27(1):89-90. Available from: https://pubmed.ncbi.nlm.nih.gov/8742500/. Assessed on 7/1/2022.
[19] Ritchie SK, Murphy ECS, Ice C, Cottrell LA, Minor V, Elliott E, et al. Universal versus targeted blood cholesterol screening among youth: The CARDIAC project. Pediatrics. 2010;126(2):260-65. Available from: https://pubmed.ncbi.nlm.nih.gov/20624798/ Assessed on 7/1/2023.

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