Original Research Article

Waist-To-Height Ratio in Assessing Cardiometabolic Risk Factors in Affluent School Going Children

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Abstract

Introduction: Childhood obesity is one of the most prevalent chronic diseases among children and adolescents, and is responsible for a growing proportion of global health burden. It will lead to drastic complications if left unattended and waist to height ratio is simple and easily performable procedure even by non-medical staff in early detection of cardiometabolic risk. To study Waist circumference to height ratio (WHtR) in early detection of cardiometabolic risk factors in school children and educating parents about cardiometabolic risk in obesity. **Materials and Methods:** This cross-sectional study was conducted in children aged between 11 to 17 years in affluent schools of Bangalore from January 2018 to May 2019. Weight, Height, BMI, waist circumference was measured as per the standard protocol and those with WHtR >0.5 were investigated for cardiometabolic risk factors. The parameters recorded were Blood pressure, FBS, HbA1c, HDL, LDL, Cholesterol, VLDL by standard methods. The results were analyzed and correlation of WHtR along with altered biochemical parameters were studied.**Results:** A total of 1577 children were included in the study, out of which 702 (44.5%) were boys and 875(55.5%) were girls. The mean age was 14.4±0.2 years. 280(17.8%) children had abnormal WHtR (>0.5). Area under the ROC curve for waist to height ratio among the children who had WHtR >0.5 was 78.4% which is good predictor of obesity and many of the children had abnormal biochemical parameters.**Conclusion:** Waist to height ratio is a significant anthropometric screening parameter that can be used in early identification of cardiometabolic risk factor in affluent school children and for those with WHtR >0.5 needs parental education and proper lifestyle modification and periodic cardiometabolic assessment.

Keywords: WHtR in children; Cardiometabolic risk; HbA1c; lipid profile, RBS

Introduction

Obesity prevalence has been in increasing trend worldwide over the last few decades and has reached alarming rates in low middle-income countries. Childhood has been affected by this pandemic, leading to early dramatic health problems in younger age group.

Cardiovascular disease is the most common cause of death among affluent and sedentary children and to be the leading cause of death worldwide by 2030[1].Waist circumference to height in assessing the status of the abdominal obesity and related cardiometabolic risk profile among overweight/obese children, has been classified in accordance to the accepted BMI threshold values[2].Cardiovascular disease (CVD) in comparison to the European ancestry, CVD affects Indians at least a decade earlier and in their most productive midlife years. WHO has estimated that, with the current burden of CVD, India would lose 237 billion dollars of productivity and spending on healthcare over a 10-year period[3]hence India being a developing country with minimal allotment of GDP share towards healthcare system, which will require an effective management and preventive strategies to limit the cost by modification of lifestyle and early detection of the disease. In the past twenty to thirty years the prevalence of overweight and obesity increased almost four times from 4% to 15% in India,[4] while type 2 diabetes among Indian adults increased from 5.9% to 9.1% and hypertension prevalence increased from 17.2% to 29.2%, with significant urban-rural differences[5]Some trials have shown that waist-to-height ratio is a better long-term and promising marker in diagnosing cardiometabolic diseases in children and it will halt the usage of unnecessary investigations and early diagnosis with minimal investigations[6]. Hence, we intend to assess the overall effectiveness of waist-to-height ratio in children between 11 years to 17 years of age in affluent school going children in early detection of CVD.

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Materials and Methods

Source of Data: The study group includes affluent school going children in the city of Bangalore,India who are studying in7th, 8th, 9th and 10th standard with age between 11 years to 17 years.

Study Period: This study was school based study involving affluent school going children, from 1/1/2018 to 30/05/19.

Type of Study: It is an observational, cross-sectional study of affluent school going children

Inclusion Criteria: All Children studying in 7th, 8th, 9th and 10th standard with age between 11 years to 17 years.

Exclusion Criteria: History of drug intake which will cause obesity like steroids.

Already having pre-existing diseases like DM, HTN

Method of Data Collection

The study was approved by the institutional ethical committee. Informed written consent was obtained from parents of each child before enrollment. Written informed consent was be taken from parents/guardians of all children and children aged more than 12 years before enrolment. This study was school based study involving affluent school going children of Bangalore,India city. Demographic profile and clinical data were collected using a pretested pre-structured proforma, Anthropometry and blood pressure was recorded using standard protocol. Based on anthropometry, BMI, WHtR will be calculated and Waist circumference was measured at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest with non-stretchable measuring tape with minimal clothing without affecting child privacy and height was measured to the nearest 0.1cm using stadiometer as per WHO guidelines with barefoot advised to stand in upright position, with shoulders and arms relaxed and head in Frankfort horizontal plane. Females waist circumference was measured by female doctor. Blood pressure was measured in the right arm with the child at the sitting position, at rest, with the mercury sphygmomanometer. The first Korotkoff phase was used to determine systolic blood pressure (SBP) and the fifth Korotkoff phase to determine diastolic blood pressure (DBP).

Weight was determined to the nearest 0.1kg using a calibrated mechanical column scale.Among all children and those with altered WHtR (>0.5) and will be labelled as cardiometabolic risk children will undergo biochemical tests like fasting lipid profile, insulin levels, RBS, HbA1c and abnormal values will be classified according to the TABLE 2 in the discussion as per international diabetes federation criteria where Cholesterol >200mg/dl, LDL >110mg/dl, HDL <40mg/dl, Triglycerides >75mg/dl, HbA1c >5.7 %, RBS >140mg/dl will be considered abnormal. Mothers will be interviewed as per pretested proforma. Affluent were be defined as upper class (1) in accordance with modified kuppuswamy classification.

Sample Size Estimation

Based on the published literature the prevalence of obesity in children in India is 19.3% (epidemiology of childhood overweight and obesity in India/ncbi.nlm.nih.gov) assuming 90% power and 5% level of significance and 10% relative precision, the required sample size is 1577(n=1577)

$$n = \frac{Z^2 (1-\alpha/2) \times P (1-P)}{d^2}$$

P = Percentage of children with obesity (1.93)
Z = Standard normal value at 5% level of significance (1.96)
d = Absolute precision (0.10)

Method of Statistical Analysis: The following methods of statistical analysis have been used in this study. The Excel and SPSS (SPSS Inc, Chicago v 18.5) software packages were used for data entry and analysis respectively. The results were averaged (mean ± standard deviation) for each parameter for continuous data in Table and Figure.

Results

Total of 1577 children were screened from affluent schools of Bangalore of which 121(17%) males and 159(18.7%) females were found to have waist to height ratio >0.5

Table 1: Mean Age of presentation of children in the study population

	N	Mean	SD	Min.	Max.	't' value*	P value
Without CMR	1297	14.3	1.067	11	18	5.202	***0.023***
CMR	280	14.5	1.170	12	18		
Total	1577	14.4	1.088	11	18		

*Student 't' test

The mean age of presentation for Cardiometabolic risk is at around 14 years hence, screening for the cardiometabolic risk should be done early to prevent further complications.

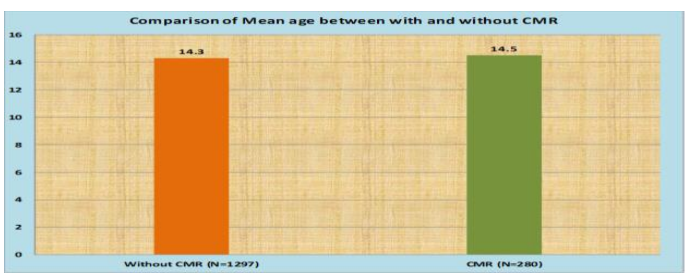

Fig 1: Mean age of presentation of cardiometabolic risk

Out of 702 males 121 had waist to height ratio >0.5 which is 17%

Out of 875 females 159 had waist to height ratio >0.5 which is 18.7%

Table 2: Sex wise comparison of cardiometabolic risk in affluent school going children

	Sex		Total	χ^2 value	P value
	Male	Female			
Without CMR	581	716	1297	0.233	0.629
	44.8%	55.2%	100.0%		
CMR	121	159	280		
	43.2%	56.8%	100.0%		
Total	702	875	1577		
	44.5%	55.5%	100.0%		

*Chi Square Test

According to the present study, there is not much difference in cardio metabolic risk between different sex.

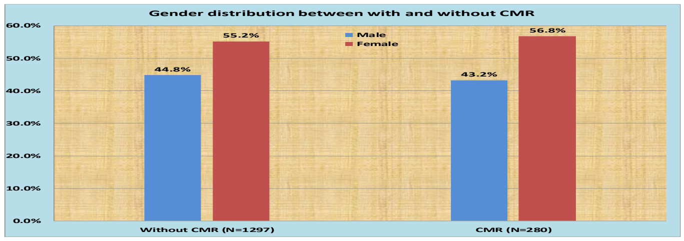

Fig 2: Sex wise distribution of cases

Table 3: Age wise distribution of Cardiometabolic risk in affluent school going children

	Age								Total	χ^2 value	P value
	11	12	13	14	15	16	17	18			
Without CMR	3	22	322	291	519	120	18	2	1297	33.888	***<0.001***
	.2%	1.7%	24.8%	22.4%	40.0%	9.3%	1.4%	.2%	100.0%		
CMR	0	13	42	75	102	39	6	3	280		
	.0%	4.6%	15.0%	26.8%	36.4%	13.9%	2.1%	1.1%	100.0%		
Total	3	35	364	366	621	159	24	5	1577		
	.2%	2.2%	23.1%	23.2%	39.4%	10.1%	1.5%	.3%	100.0%		

According to the present study age is significant risk factor for cardiometabolic risk and the mean age of presentation is 14.4 ± 0.2y in both sex and hence high-risk children should be screened earlier for cardiometabolic risk.

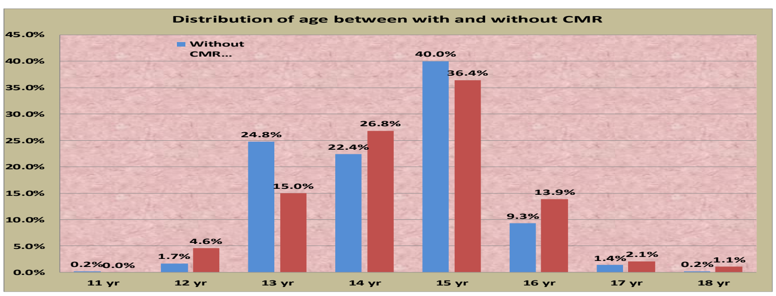

Fig 3: Age wise distribution of cases with and without cardiometabolic risk in affluent school going children

Table 4: Correlation of family history of children with cardiometabolic risk factors

	Family History				Total	χ^2 value	P value
	No	Father-DM	Mother-DM	Mother-HTN & DM			
Without CMR	1215	30	48	4	1297	51.115	***<0.001***
	93.7%	2.3%	3.7%	.3%	100.0%		
CMR	227	20	33	0	280		
	81.1%	7.1%	11.8%	.0%	100.0%		
Total	1442	50	81	4	1577		
	91.4%	3.2%	5.1%	.3%	100.0%		

According to the present study family history itself as an individual risk factor (p value <0.001) in early identification of cardiometabolic risk and those with positive family history should be screened for cardiometabolic risk.

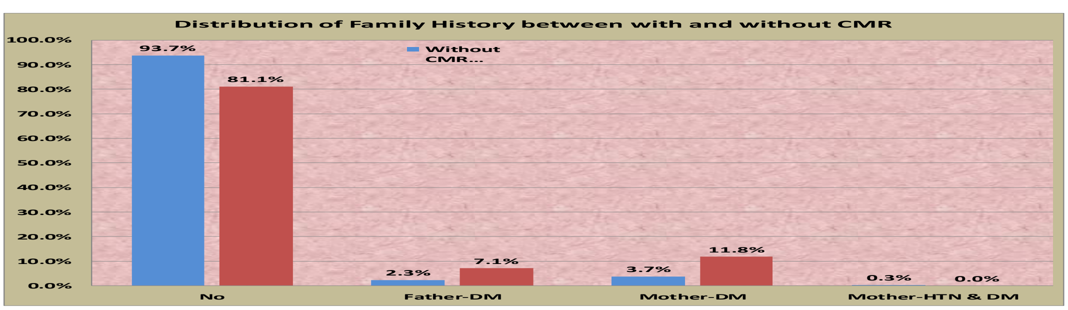

Fig 4: Family history of children with and without cardiometabolic risk

Table 5: Comparison of waist circumference and waist to height ratio in children with and without cardiometabolic risks

		N	Mean	SD	Min.	Max.	't' value	'p' value
Waist Circumference	Without CMR	1297	32.62	8.115	20.0	73.0	1394.363	*<0.001*
	CMR	280	53.83	10.652	25.0	93.0		
	Total	1577	36.39	11.831	20.0	93.0		
Waist- Height Ratio	Without CMR	1297	0.22	0.056	0.14	0.55	1714.720	*0.003*
	CMR	280	0.50	0.071	0.19	0.59		
	Total	1577	0.25	0.085	0.14	0.59		

In the present study, waist circumference (75th centiles according to the IAP) and waist-to-height ratio >0.5 are significant risk factors in early identification of cardiometabolic children and they are simple ways that can be adopted even by non-medical staff as screening tool for early identification of cardiometabolic risk in high risk group

Fig 5: Comparison of waist circumference and waist-to-height ratio in children with and without cardiometabolic risk

Table 6: Comparison of waist circumference in children with and without cardiometabolic risk

		N	Mean	SD	Min.	Max.	't' value	'p' value
Waist Circumference	Without CMR	1297	32.62	8.115	20	73	1394.363	***<0.001***
	CMR	280	53.83	10.652	25	93		
	Total	1577	36.39	11.831	20	93		

In the present study, waist circumference (75th centiles according to the IAP)is significant risk factor (p value<0.001) in early identification of cardiometabolic children.

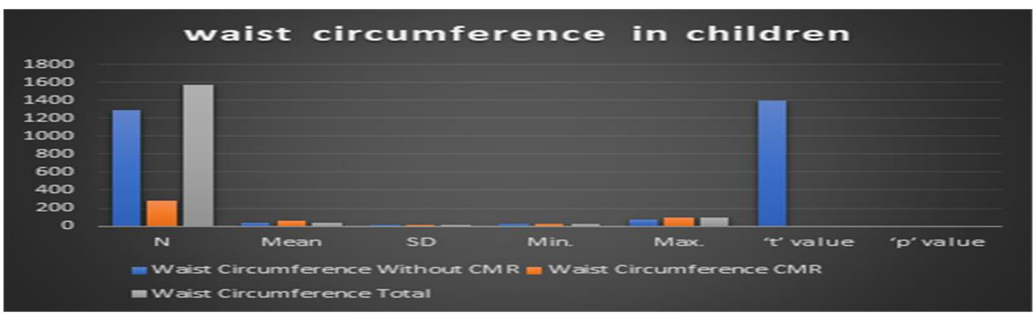

Fig 6: Comparison of waist circumference in children with and without cardiometabolic risk

Table 7: Comparison of waist-to-height ratio in children with and without cardiometabolic risk

		N	Mean	SD	Min.	Max.	't' value	'p' value
Waist-height ratio	Without CMR	1297	0.22	0.056	0.14	0.55	1714.72	***0.003***
	CMR	280	0.50	0.071	0.19	0.59		
	Total	1577	0.25	0.085	0.14	0.59		

In the present study, waist-to-height ratio >0.5 is significant risk factor (p value <0.003) in early identification of cardiometabolic children and they are simple ways that can be adopted even by non-medical staff as screening tool for early identification of cardiometabolic risk in high risk group.

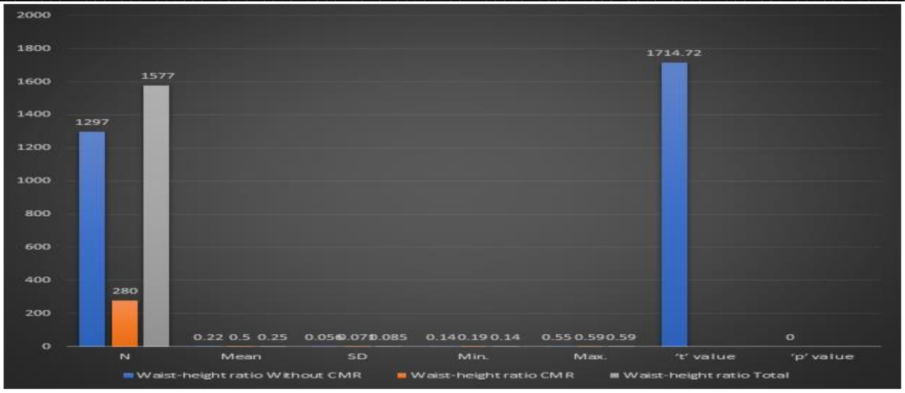

Fig 7: Comparison of waist-to-height ratio in children with and without cardiometabolic risk

Table 8: Classification of obesity based on BMI

Obesity	**Frequency**	**Percent**
Normal	844	53.5
Overweight	456	28.9
Obesity 1	239	15.2
Obesity 2	22	1.4
Obesity 3	16	1.0
Total	1577	100.0

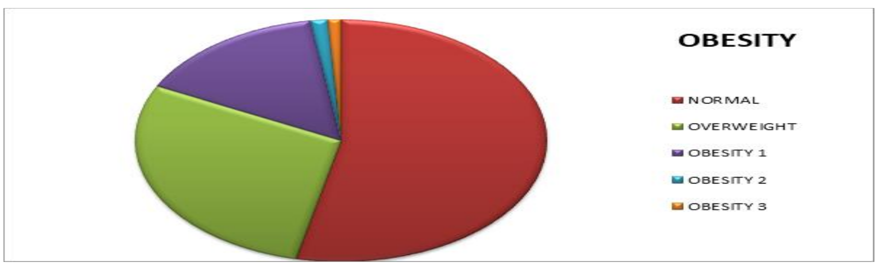

Fig 8: Classification of obesity based on BMI

In the present study, children screened predominantly will fall under normal criteria and 17.6% will fall under obesity criteria and 28.9% will fall under overweight criteria.

Table 9: ROC curve for OVERWEIGHT (BMI 23-27)

Area Under the Curve-Overweight					
Test Result Variable(s)	**Area**	**Std. Error**[a]	**Asymptotic Sig.**[b]	**Asymptotic 95% Confidence Interval**	
				Lower Bound	**Upper Bound**
Body Mass Index	.753	.013	.000	.728	.778
Weight in Kg	.631	.015	.000	.602	.661
Waist Circumference (CM)	.524	.016	.128	.492	.556
Height (CM)	.440	.016	.000	.409	.471
Waist To Height Ratio	.538	.016	.017	.507	.570

Waist to height ratio has 53% area under curve which is unsatisfactory in estimation of overweight.

Table 10: ROC table for OBESITY 1 (BMI: 23-35)

Area Under the Curve-Obesity 1					
Test Result Variable (s)	**Area**	**Std. Error**[a]	**Asymptotic Sig.**[b]	**Asymptotic 95% Confidence Interval**	
				Lower Bound	**Upper Bound**
Body Mass Index	.972	.005	.000	.963	.980
Weight in Kg	.699	.017	.000	.666	.731
Waist Circumference (CM)	.530	.022	.138	.487	.574
Height (CM)	.253	.019	.000	.215	.290
Waist To Height Ratio	.628	.019	.000	.590	.666

In the present study, waist to height ratio has area under curve with 63.8% hence it is satisfactory in early identification of obesity.

Table 11: ROC table for obesity 2

Area Under the Curve-Obesity 2					
Test Result Variable(s)	**Area**	**Std. Error[a]**	**Asymptotic Sig.[b]**	**Asymptotic 95% Confidence Interval**	
				Lower Bound	**Upper Bound**
Body Mass Index	.990	.003	.000	.985	.995
Weight in Kg	.791	.031	.000	.731	.851
Waist Circumference (CM)	.688	.063	.002	.564	.812
Height (CM)	.100	.032	.000	.037	.163
Waist To Height Ratio	.784	.053	.000	.680	.889

In the present study, waist to height ratio has area under curve with 78.4% hence it is good result in early identification of obesity category 2

Table 12: ROC table for obesity 3

Area under the curve					
Test result variable(s)	**Area**	**Std. Error[a]**	**Asymptotic sig.[b]**	**Asymptotic 95% confidence interval**	
				Lower bound	**Upper bound**
Body Mass Index	1.000	.000	.000	1.000	1.000
Weight in Kg	.926	.014	.000	.899	.953
Waist Circumference (CM)	.795	.052	.000	.693	.896
Height (CM)	.080	.021	.000	.040	.120
Waist To Height Ratio	.870	.037	.000	.797	.942

In the present study, waist to height ratio has area under curve with 87% hence it is very good result in early identification of obesity category 3 hence as the obesity increase in weight waist to height ratio is has increased specificity in identifying the risk.

Table 13: Significance of individual and combined parameters in assessing cardiometabolic risk in school going children

Abnormal Value	Frequency	Percent
HbA1c+SBP	6	2.1
LDL	194	69.3
FBS+LDL	1	.4
HbA1c+LDL	19	6.8
Chol+LDL	16	5.7
HbA1c+Chol+LDL	28	10.0
HbA1c+HDL+LDL	1	.4
Chol+HDL+LDL	3	1.1
FBS+HbA1c+Chol+LDL	1	.4
FBS+Chol+HDL+LDL	1	.4
HbA1c+Chol+HDL+LDL	5	1.8
FBS+HbA1c+Chol+HDL+LDL	5	1.8
Total	280	100.0

Table 14: Comparison of clinical parameters with cardiometabolic risk and among one another in affluent school children

Group			N	Mean	SD	Min.	Max.	't' value	P value
CMR	AGE	Male	121	14.1	1.202	12	17	21.455	***<0.001***
		Female	159	14.8	1.071	13	18		
		Total	280	14.5	1.170	12	18		
	Waist Circumference	Male	121	56.9	11.685	36.0	93.0	18.734	***<0.001***
		Female	159	51.5	9.165	25.0	78.4		
		Total	280	53.8	10.652	25.0	93.0		
	Waist- Height Ratio	Male	121	0.40	0.077	0.22	0.58	8.961	***0.003***
		Female	159	0.50	0.065	0.19	0.59		
		Total	280	0.38	0.071	0.19	0.59		

In the present study, Age, waist circumference and waist-to-height ratio are all risk factors for future development of cardiometabolic risk as the p value is significant.

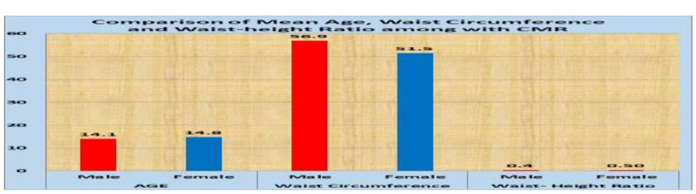

Fig 9: Waist circumference, waist-to-height ratio and age wise distribution of cases

Table 15: Comparison of clinical parameters with cardiometabolic risk and among one another in affluent school children

Group			N	Mean	SD	Min.	Max.	't' value	'p' value
CMR	FBS	Male	121	83.8	12.642	59	137	0.007	0.931
		Female	159	83.9	11.247	59	113		
		Total	280	83.9	11.849	59	137		
	HbA1c	Male	121	6.1	0.316	5.1	6.9	5.025	***0.026***
		Female	159	6.0	0.264	4.9	6.9		
		Total	280	6.0	0.290	4.9	6.9		
	Cholesterol	Male	121	157.4	20.028	103	201	9.532	***0.002***
		Female	159	149.8	20.889	98	222		
		Total	280	153.1	20.833	98	222		
	HDL	Male	121	65.9	9.305	38	88	2.435	0.120
		Female	159	67.6	8.361	41	91		
		Total	280	66.9	8.803	38	91		
	LDL	Male	121	146.4	24.224	91	221	2.799	0.095
		Female	159	141.8	20.889	89	231		
		Total	280	143.8	22.462	89	231		
	VLDL	Male	121	32.5	5.750	20	51	11.603	***0.001***
		Female	159	30.4	4.455	19	45		
		Total	280	31.3	5.150	19	51		

FBS alone has no statistical significance (p value is 0.931) in identifying cardiometabolic risk.

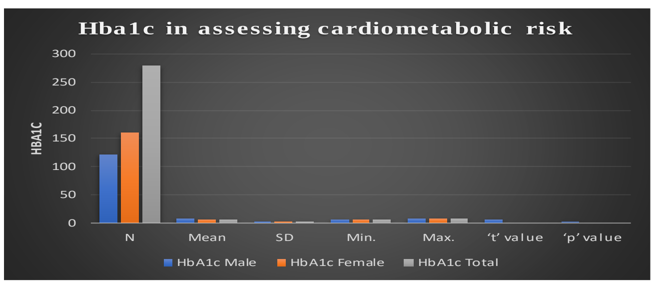

Fig 10: HbA1c values in assessing cardiometabolic risk factors in affluent school going children

HbA1c as an individual parameter can be used in identifying cardiometabolic risk as the p value in our study is 0.026

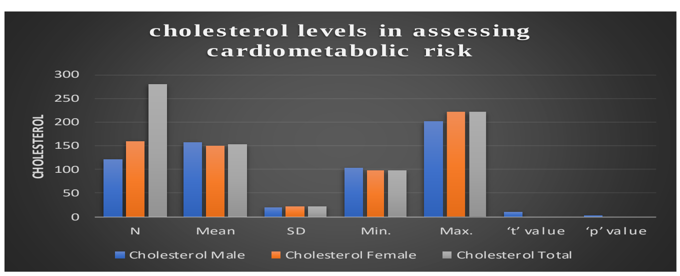

Fig 11: Cholesterol values in assessing cardiometabolic risk factors in affluent school going children

Cholesterol alone can indicate the risk of future cardiometabolic risk according to the present study as the p value is 0.002.

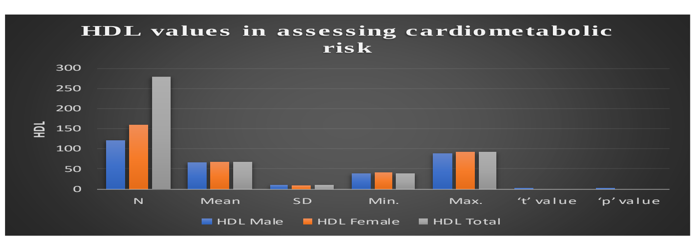

Fig 12: HDL values in assessing cardiometabolic risk factors in affluent school going children

Among children's, HDL-C ≤ 40 mg/dl and HDL is significant risk factor in assessing cardiometabolic risk as the p value is 0.120 in our study.

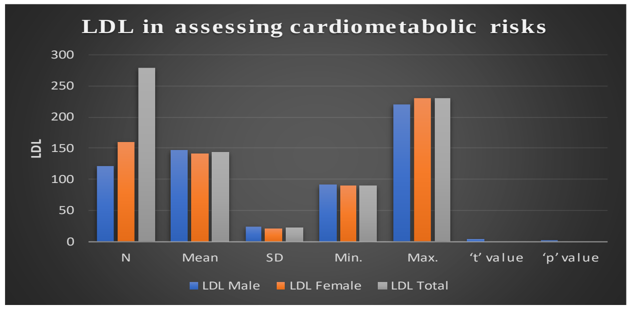

Fig 13: LDL values in assessing cardiometabolic risk factors in affluent school going children

In the present study LDL is not a significant risk factor for identification of cardiometabolic risk as the p value is 0.095.

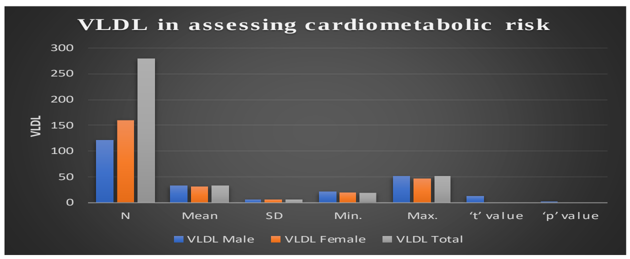

Fig 14: VLDL values in assessing cardiometabolic risk factors in affluent school going children

In the present study VLDL is significant risk factor in early identification of cardiometabolic risk as the p value is 0.001

Table 16: Incidence of cardiometabolic risk in affluent school going children

Group	Frequency	Percent
Without CMR	1297	82.2
CMR	280	17.8
Total	1577	100.0

According to the present study the incidence of cardiometabolic risk in affluent school children's is 17.8% which is higher than the incidence according to the National center for biotechnology information (ncbi/2017) data base.

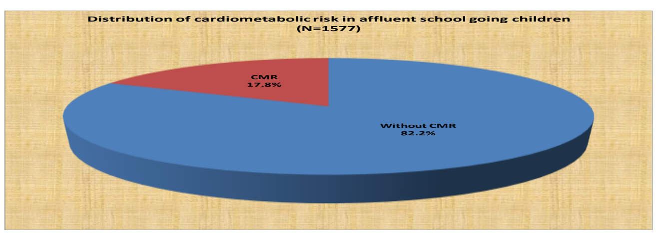

Fig 15: Incidence of cardiometabolic risk in affluent school children

Discussion

Waist circumference correlates well with visceral adipose tissue in adults but not in children. Waist circumference and WHtR have been used as useful predictors for cardiovascular disease risk factors and coronary heart disease mainly in adults[7].Body weight, height and waist circumference are all simple measurements that most paediatricians can precisely measure, while the same does not apply to other measurements such as the skin fold measurements[8].The results of the study indicate that obese children have higher risk for the presence of cardiovascular disease risk factors. Children who exceed the 75thfor waist circumference and waist-to-height ratio have significantly higher mean values for all cardiovascular risk factors.

These results are in agreement with other studies that have shown that obesity, by means of increased waist-to-height ratio is associated with increased risk for the presence of cardiovascular disease risk factors in children .A possible explanation is that why BMI is poor predictor of cardio metabolic risk factor in children is that children and adolescents with similar BMI have large differences in total body fat and percentage body fat.The accumulation of visceral fat has been proven a better predictor for adult morbidity than obesity itself hence the use, therefore, of indices that correlate to visceral fat would be more justified. There is a correlation of adult changes in adiposity by means of BMI, total body fat and percentage body fat with serum lipids and lipoprotein levels.In particular, in our study children in the highest WHtR percentile group had higher mean values for most of the cardiovascular disease risk factors for both sexes.Children in the highest percentile groups for waist-to-height ratio were at significantly greater risk (p value) of having pathological values of cardiovascular disease risk factors[8]Waist circumference and waist-to height ratio were proven to be better predictors for cardio metabolic risk factors in affluent school going children. Although waist circumference has been validated as a useful predictor for cardiovascular disease risk factors in children, we also validated waist-to height ratio in this study, since it takes into account a child's height, whereas a single cut-off point cannot be specified for waist measurement in children as is the case in adults. Expanding these observations further in other age groups could possibly define a single cut-off value for WHtR, which will highlight children in high risk groups for cardiovascular disease risk factors.A total of 1577 affluent school children were enrolled in the study of which 702 were males and 875 were females and the mean age of presentation is 14.4 ± 0.2y and of which 121 males and 159 females were found to have high risk for cardiometabolic risk factors which is in comparison with the study done by SC Savva et al and L.L-Y.Lim et al.

As per the present study, Indian children are more prone for cardio metabolic risk at lower anthropometric values and most of the values are in comparison with the other study.

There is a difference in LDL cholesterol between the present and the other study

Conclusion

In conclusion, waist to height ratio is a simple, easy to use, age/sex independent cut off value which identifies the child with high cardiometabolic risk.Hence, waist to height ratio can be used in clinical practice for obesity screening, Parental counselling and lifestyle modification and regular health check-up is must for all the children whose ratio is >0.5.

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