

## Research Article

# Association between body mass index and blood pressure among children age group 5 to 15 years in a tertiary care centre: a descriptive study

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## ABSTRACT

**Background:** The growing prevalence of obesity is increasingly recognized as one of the most important risk factors for the development of hypertension. Today the problem has started appearing even in developing countries like India. Tackling this epidemic of obesity and obesity-related hypertension requires studies specific for the local population as these vary according to ethnicity, lifestyles and dietary habits which differ among areas in India, for this reason a study was done in our hospital.

**Methods:** The pediatric unit of Kerala Institute of Medical Science (KIMS), which is a referral multispecialty tertiary care hospital in private sector in south India catering to a population of 100 to 200 outpatient/day, children attending OPD between 5-15 years were included in the study.

**Results:** Pre-hypertension and hypertension was seen in 1% (2 out of 195) of normal and 0% (0 out of 30) of overweight and 60.9% (9 out of 14 obese children). P value was statistically significant indicating that there is strong association between BMI and blood pressure.

**Conclusions:** There is strong association between BMI and blood pressure. Prevalence of obesity in children aged 5 to 15 years attending to the outpatient department in Kerala Institute of Medical Sciences, Trivandrum is 9.2%. Prevalence of essential hypertension in children aged 5 to 15 years attending to the outpatient department in Kerala Institute of Medical Sciences, Trivandrum is 2%.

**Keywords:** BMI, SBP, DBP, Hypertension, WHO-

## INTRODUCTION

The relevance of both hypertension and obesity, as important public health challenges, is increasing worldwide. Compared with the year 2000, the number of adults with hypertension is predicted to increase by 60% to a total of 1.56 billion by the year 2025.<sup>1</sup> The growing prevalence of obesity is increasingly recognized as one of the most important risk factors for the development of hypertension. Childhood obesity, now emerging as a global health problem, was previously considered a problem of affluent countries. Today the problem has

started appearing even in developing countries like India, where it was basically under-nutrition which attracted the focus of health workers in the past. Tackling this epidemic of obesity and obesity-related hypertension requires studies specific for the local population as these vary according to ethnicity, lifestyles and dietary habits which differ among areas in India.<sup>1</sup>

Obesity is an excessive accumulation of fat in the body resulting in increase in weight beyond that considered desirable with regard to age, height and bone structure and is a state of excess body weight. This fat deposition

may be generalized, or may occur preferentially in different adipose tissue compartments. The issue of overweight and obesity has become a serious public health concern throughout the world during the last few decades. The prevalence of overweight and obesity is increasing, and obesity is estimated to be a major leading cause of mortality and morbidity, causing an estimated 2.6 million deaths worldwide and 2.3% of the global burdens of disease.<sup>2</sup> In the USA, 30% of adults are obese, and an additional 35% of adults are overweight. The National Health and Nutrition Examination Survey (NHANES) IV, 1999-2002, found 31% of children older than 2 years to be overweight or obese, and 16% of children and adolescents 6-19 years were obese. In Iran obesity rates vary from rural to urban populations rising to 30% among women in Tehran. Adult obesity in Japan averages 20%, rising to 30% in men over 30 years old, and in women over 40 years old, representing a 3 to 4 fold increase over the last 40 years. Childhood obesity was rarely seen in the past. But over the past few years this entity is increasingly being observed. Globally the prevalence of childhood obesity varies from over 30% in USA to less than 2% in sub-Saharan Africa. Currently the prevalence of obese school children is 20% in UK and Australia, 15.8% in Saudi Arabia, 15.65% in Thailand, 10% in Japan and 7.8% in Iran.<sup>3</sup> National representative data for childhood obesity in India is unavailable; however available studies from Chennai and Delhi have shown a prevalence of 6.2% and 7.4% respectively.<sup>4,5</sup>

Despite a growing burden of obesity and hypertension in developing countries, there is limited information on the contribution of body mass index to blood pressure among the populations.

The prevalence of obesity-related elevation in blood pressure varies with age, race, and sex of the population studied. Studies have shown that approximately 30% of cases of hypertension may be attributable to obesity in men under the age of 45 years. This figure, however, in some cases may be as high as 60%.<sup>6</sup> Ghosh et al demonstrated that Hindu men from West Bengal with average age of 37.5 years, obesity measures in the form of Waist Stature Ratio and BMI explained that the greater risk of developing hypertension was associated with increasing BMI.<sup>7</sup>

Much of the information about the prevalence of obesity and trends in obesity and blood pressure comes from studies conducted on national or state level. Less is known about the prevalence of obesity and BP in smaller geopolitical units such as states or cities. India, being multi-ethnic, there is a pressing need to have data on overweight and obesity specific to each state. At least this knowledge about the local standards for population groups will help to develop early measures for mollifying the potential burden. Hence we did this study to find the association between body mass index and blood pressure in children aged 5 to 15 years.

### **Primary objective**

- To find the association between BMI and blood pressure in children aged 5 to 15 years attending the Out Patient department in Kerala Institute of Medical Sciences, Trivandrum, Kerala, India.

### **Secondary objective**

- To determine the prevalence of obesity in children aged 5 to 15 years attending the Out Patient department in Kerala Institute of Medical Sciences, Trivandrum.
- To determine the prevalence of essential hypertension in children aged 5 to 15 years attending the Out Patient department in Kerala Institute of Medical Sciences, Trivandrum, Kerala, India..

## **METHODS**

A prospective descriptive study was carried out at pediatric unit of Kerala Institute of Medical Science (KIMS), which is a referral multispecialty tertiary care hospital in private sector in south India catering to a population of 100 to 200 outpatient/day for 1 year from January 2014 to December 2014.

### **Inclusion criteria**

Children aged 5 to 15 years attending outpatient clinic.

### **Exclusion criteria**

Patients with systemic diseases or conditions associated with variation in blood pressure like:

- Chronic Kidney disease
- Nephrotic syndrome/nephritis
- Pheochromocytoma
- Heart diseases, cardiac failure
- Vascular diseases-SLE
- Other collagen vascular diseases
- Cushing's syndrome
- Hypothyroidism
- Genetic conditions like Bardet-Biedl syndrome, Carpenter syndrome, Prader-Willi syndrome etc. are excluded from the study.

### **Sample size**

Sample size was calculated based on the correlation between BMI and blood pressure.

With probability of type 1 error 5% (0.05) and power of the test 80% (0.8) and correlation coefficient from previous studies 0.23, a sample size 115 was calculated.

### Study intervention

After taking a written consent, a bio-data about the life style habits, food habits, exercise and television viewing etc. was taken. Following this, the weight and height were measured. Weight and height were measured with participants standing without footwear and wearing light clothing. For measurement of height a measuring tape affixed to the wall was used. The child was asked to stand upright, barefoot on the ground with heels, buttocks, upper back, and back of head making firm contact with the wall, with the head in Frankfort plane. A cardboard was pressed firmly onto the child's head to form a right angle to the wall. Weight was recorded using standard weighing machine (Libra India Ltd.). Measurement of weight was done with same instrument and to the same degree of accuracy to the nearest of 0.5 kg.

From this data, the body mass index was calculated as:

Body mass index ( $\text{kg/m}^2$ ) = Weight/ Height.

The children were then grouped according to BMI percentile chart<sup>8</sup>.

BMI < 85<sup>th</sup> percentile: Normal

BMI 85-95<sup>th</sup> percentile: Overweight

BMI > 95<sup>th</sup> percentile: Obese

Blood pressure was then measured using a mercury sphygmomanometer with cuff sizes appropriate for the age of the child. After seating the child quietly for 5 minutes, the blood pressure was measured. All efforts were made to eliminate factors which might affect the blood pressure such as anxiety, fear, crying, laughing etc. Blood pressure was recorded only after the child gets accustomed to the surroundings in the room. Right arm was used for measurement for consistency. The blood pressure cuff was placed such that 40% of the circumference of the arm at the mid-point between the acromion and olecranon was overlapped by the bladder. The point of appearance of Korotkoff sounds was taken to represent systolic blood pressure and the point of disappearance as the diastolic blood pressure.

Blood pressure was categorized based on WHO percentile chart with reference to age, sex and height.

Normal BP: SBP and DBP <90<sup>th</sup> percentile

Prehypertension: SBP or DBP 90<sup>th</sup> to <95<sup>th</sup> percentile

Or BP >120/80 mmHg to <95<sup>th</sup> percentile

Stage 1 Hypertension: SBP and/or DBP 95<sup>th</sup> to 99<sup>th</sup> percentile plus 5 mmHg

Stage 2 Hypertension: SBP and/or DBP >99<sup>th</sup> percentile plus 5 mmHg

Systemic examination was done to exclude cardiovascular, renal or other diseases and such children found to have such diseases were excluded from the study.

The BMI percentile and the blood pressure category was then compared and association was looked into.

### Method of measurements of outcome of interest

1. Obesity and overweight are defined using CDC BMI percentiles charts.<sup>8</sup>
2. Blood pressure was being categorized based on percentile chart.<sup>9</sup>

### Data collection methods

There was a structured proforma which was be filled by the principal investigator. This proforma contains essential demographic and clinical data, BMI and BP charts to measure the outcome of the study.

### Statistical methods

Mean or median and standard deviation of the BP and BMI values of the children were computed by age group and gender. A multiple linear regression was applied to examine whether BP was associated with BMI. Degree of correlation was calculated using correlation coefficient. The level of significance was fixed at 95% and a p- value less than 0.05 was considered as significant.

## RESULTS

The present study was a descriptive study done in KIMS hospital Trivandrum city, Kerala, India and included 250 children in the age group of 5-15 years. The results of the study are detailed as follows:

### Baseline characteristics of the study population

#### Age and sex wise distribution of the study population

**Table 1: Percentage distribution of the sample according to age.**

Age	Count	%
5 – 10	172	68.8
11 – 15	78	31.2
Mean $\pm$ SD	9.5 $\pm$ 2.4	

Mean age of children was 9.5  $\pm$  2.4 and around two third (68.8%) patients belong to age group of 5-10years. There was equal distribution of boys and girls in our study population.

**Table 2: Percentage distribution of the sample according to sex.**

Sex	Count	%
Female	114	45.6
Male	136	54.4

### Primary out come

*Association between body mass index and hypertension*

**Table 3: Comparison of BMI based on blood pressure.**

BMI	Normal		Hypertension		P
	Count	%	Count	%	
Normal	195	99.0	2	1.0	0.000
Over weight	30	100.0	0	0.0	
Obesity	14	60.9	9	39.1	

\*\*Significant at 0.01 level

Pre-hypertension and hypertension was significantly more in obese children (60.9%) as compared to normal children. So strong association was demonstrated between BMI and hypertension (p value <0.000).

### Secondary out come

*Prevalence of overweight and obesity in the study population*

**Table 4: Percentage distribution of the sample according to BMI.**

BMI	Count	%
Normal	197	78.8
Over weight	30	12.0
Obesity	23	9.2

Table 4 shows the prevalence of overweight and obesity. Out of 250 children included in the study 197 (78.8%) had normal BMI. 30 (12%) children were overweight and 23 (9.2%) children were obese. The overall prevalence of obesity and overweight combined was 21.1% (53 out of 250).

*Age wise distribution of prevalence of overweight and obesity in the study population*

Overall prevalence of obesity and overweight combined was almost equal in 5-10 year (20.9%) and 11 to 15 year (21.8%) population.

*Sex-wise distribution of the prevalence of overweight and obesity in the study population*

14% and 7% of girls were overweight and obese respectively. 10.3% and 11% of boys were overweight and obese respectively. Over weight and obesity was equally distributed among both sexes.

**Table 5: Percentage distribution of the overweight and obesity according to sex.**

Sex	Count	Overweight and obese	%
Female	114	24	21.05
Male	136	29	21.32

*Prevalence of hypertension in study population*

**Table 6: Percentage distribution of the sample according to blood pressure.**

BMI	Count	%
Normal	239	95.6
Prehypertension	6	2.4
Stage 1 hypertension	5	2.0

Out of 250 children included in the study 239 (95.6%) had normal blood pressure 6 (2.4%) children had prehypertension and 5 (2%) children had stage 1 hypertension. The overall prevalence of prehypertension and stage 1 hypertension combined was 4.4% (11 out of 250).

*Age wise distribution of prevalence of prehypertension and hypertension in the study population*

**Table 7: Percentage distribution of the prevalence of prehypertension and hypertension in the study population according to age.**

Age (years)	Count	Prehypertension and hypertension	%
5 to 10	172	2	1.1%
10 to 15	78	9	14.1%

Out of 11 hypertensive children in the study 18.1% of children (2 out of 11) belong to age group of 5 to 10. And 81.9% (9 out of 11) belong to 10 to 15 age group.

There was significance increase in prevalence of hypertension in 10 to 15 year age group 14.1% (11 out of 78) when compared to 5 to 10 year age group 1.1% (2 out of 172).

**Table 8: Sex wise distribution of prevalence of prehypertension and hypertension in the study population.**

Sex	Count	Prehypertension and hypertension	%
Female	114	5	4.3%
Male	136	6	4.4%

There is equal prevalence of prehypertension and hypertension in the study population among boys and girls.

## DISCUSSION

The price we are paying for an affluent and developed society is a sedentary life style and faulty dietary habits which result in an imbalance between energy intake and energy expenditure, which, in turn leads to obesity.

Overweight and obesity represent a rapidly growing threat to the healthy populations in an increasing number of countries. Obesity and overweight among children have significant long term health consequences such as adult obesity, higher levels of cholesterol, higher future incidence of hypertension and coronary artery disease.

**Table 9: Comparison of association between blood pressure and obesity among various studies.**

Study	Year	Area	Conclusion	Comparison
Present study	2013-2014	Trivandrum, Kerala	Strong association between BMI and blood pressure.	
Dyson et al <sup>10</sup>	2013	China, India and Mexico	Significant association between overweight and obesity and rates of hypertension	Comparable
Sharma, et al <sup>11</sup>	2005 -2006	Shimla	Elevated blood pressures were significantly higher among those with high BMI	Comparable
Shivaprakash et al <sup>12</sup>	2014	Karnataka, South India	A strong correlation between the Body mass index and the blood pressure profiles in children	Comparable
Krishna, et al <sup>13</sup>	2001 -2002	South India Karnataka	Blood pressure is found to be associated with BMI both in normal and obese Children	Comparable

**Table 10: Comparison of prevalence of obesity in children.**

Study	Year	Area	Conclusion	Comparison
Present study	2013-2014	Trivandrum Kerala	12% children were overweight and 9.2% children were obese	High compared to other studies
Dyson et al <sup>10</sup>	2013	China, India and Mexico	3.7% were over weight 0.4% were obese	Low when compared to present study
Keerthan Kumar et al <sup>14</sup>	2011	Mangalore, south India	3.0 % of children were overweight and 2.6% were obese	Low when compared to present study
Raj M et al <sup>15</sup>	2005-06	Ernakulum district, in central Kerala, South India	4.8% children were overweight and 1.7% were obese respectively	Low when compared to present study
Cherian AT et al <sup>16</sup> in 2009-10	2009-10	Kochi, Kerala, India	Boys 10.2% were overweight and 3% were obese and Girls 12.1% were overweight 5.3% were obese	Low when compared to present study but shows increasing trend when compared to older studies in same state

There are studies done previously on overweight hypertension and relationship between them in various parts of the world and the country. The study design varies regarding size of population, age, racial, regional

differences etc. India is a vast country with divergent customs, dietary habits and socioeconomic background. Data on blood pressure profile in Indian children are inadequate.



In this contest, study of association between body mass index and blood pressure among children group 5 to 15 years in a tertiary care centre was undertaken which would scientifically contribute to identify at-risk population well in advance and would also help to implement necessary action to obtain desired physical fitness in the form of optimum body composition and thereby prevent/delay future health hazards.

### Demographic chart of study population

The present study was a cross descriptive study done in KIMS hospital Trivandrum city, Kerala and included 250 children in the age group of 5-15 years. Out of 250 children 136 were boys and 114 were girls with male to female ratio of 1.1:1 (Table 2).

**Table 11: Comparison of prevalence of hypertension in children.**

Study	Year	Area	Conclusion	Comparison
Present study	2014	Trivandrum Kerala	2.4% children had prehypertension and 2% children had hypertension	
Sharma A et al <sup>11</sup>	2005 -06	Shimla, Himachal Pradesh	12.3% children had and 5.9% had hypertension	Higher when compared to present study*
Patil RR et al <sup>17</sup>	2010-2012	Wardha, Maharashtra, India	8.4% children had prehypertension and 3% children had hypertension.	Higher when compared to present study*
Buch et al <sup>18</sup>	2011	Surat city, south Gujarat, India.	Total prevalence of hypertension of 6.48%.	Higher when compared to present study*
Sundar JS et al <sup>19</sup>	2013	Chennai, Tamilnadu	Prevalence of Adolescent hypertension was 21.5%	Higher when compared to present study*

\*Prevalence depends on the age group analysed hence may not be comparable.

Out of 250 children included in the study, 136 (54.4%) children were boys and 114 (45.6%) children were girls with male to female ratio 1.1:1. 68.8% of our sample group belong to 5 to 10 year's age group and 31% belong to 11 to 15 years age group and mean age of the study population was 9.5±2.4.

Our sample age group mainly included children's between age group of 5 to 10 (68.8%) and 31% of age group between 11 to 15 (Table 1).

Dyson et al did a similar larger study which included 12,730 school children aged 12-18 years in China, India and Mexico as part of the Community Interventions for Health programme.<sup>10</sup> Krishna et al studied blood pressure data of 5,208 children out of which 2278 (43.7%) were boys and 2930 (65.2) girls in the age group of 3-18 years and analysed to study the distribution pattern of systolic blood pressure and diastolic blood pressure.<sup>10</sup> The survey was carried out in 20 randomly selected government schools and Anganwadi centers of Bangalore. Shivaprakesh et al did a cross-sectional observational study in 2014 which included 300 school going children between the age groups of 10 to 12years out of which 42.3% (127) were boys and 57.6% (173) were girls.

Compared to other studies our study included children of lower age group (5-10years).<sup>12</sup>

### Primary outcome

#### Association between body mass index and hypertension

Pre-hypertension and hypertension was seen in 1% (2 out of 195) of normal and 0% (0 out of 30) of overweight and 60.9% (9 out of 14 obese children). P value was statistically significant indicating that there is strong association between BMI and blood pressure (Table 9). Among the overweight and obese children, obese children were more prone for development of hypertension. The association between elevated blood pressure and high BMI observed by us has been noted by various workers including few from this part of the world.

Similar study done by Sharma et al in Shimla noted that rates of elevated blood pressure (prehypertension and hypertension) were significantly higher ( $P<0.001$ ) among those with high BMI (overweight and obese) compared to those with normal BMI.<sup>11</sup>

Study done by Dyson et al analysed Anthropometric data collected from 12,730 school children aged 12-18 years in China, India and Mexico as part of the Community Interventions for Health programme, an international study evaluating community interventions to reduce non-communicable disease.<sup>10</sup>

They came to similar conclusion that there was a significant association between overweight and obesity and rates of hypertension and overweight children were 1.7-2.3 times more likely to be hypertensive and obese children 3.5-5.5 more likely to show hypertension than those of normal weight. In both boys and girls in all three countries, the odds for hypertension increased incrementally with each BMI category.

Study done by Krishna et al at Bangalore and Haveri in 2001-02 have showed that undernourished children have significantly reduced ( $P < 0.05$ ) levels of systolic and diastolic blood Pressure and that blood pressure was found to be associated with BMI both in normal and obese children.<sup>13</sup>

It is important to determine the prevalence of hypertension and pre-hypertension in children, not only because it varies from one community to the other, but also because it is essential to identify the population at risk. Early identification translates into early interventions and possibly prevention of later morbidity and mortality. In the studied children we found a strong association between BMI and blood pressure.

As indicated in the study, weight gain is almost invariably associated with an increase in BP. Thus prevention of weight gain should be a primary therapeutic target for reducing the problem of hypertension. Regular physical activity and healthy eating habits to prevent weight gain in normal weight subjects. If successful, lifestyle modification may have important implications for the prevention of obesity-associated hypertension.

## Secondary outcome

### Prevalence of obesity in children aged 5 to 15 years

Out of 250 children included in the study 197 (78.8%) had normal BMI. 30 (12%) children were overweight and 23 (9.2%) children were obese. The overall prevalence of obesity and overweight combined was 21.1% (53 out of 250). Overall prevalence of obesity and overweight combined was almost equal in 5-10 years (20.9%) and 11 to 15 years (21.8%) population (Table 4).

We found that 14% and 7% of girls were overweight and obese respectively. 10.3 % and 11% of boys were overweight and obese respectively (Table 5). Although the prevalence of overweight and obesity put together was equal among both sexes, we noted that prevalence of overweight was higher in girls and prevalence of obesity was higher in boys.

A larger study involving 3 countries done by Dyson et al showed that prevalence of obesity was 3.2% in China, 0.4% in India and 8.4% in Mexico, and the prevalence of overweight children was 13.4% in China, 3.7% in India and 28.7% in Mexico.

Similar studies done in other parts of south India by Kumar K et al and Manu Raj et al showed that prevalence of obesity and overweight were 2.6%, 3.0% and 4.8%, 1.7% respectively.<sup>14,15</sup>

Another study by Cherian AT et al showed that among boys 3% were obese and 10.2% were overweight and among girls 5.3% were obese and 12.1% were overweight.<sup>16</sup>

The prevalence of overweight and obesity in our study population was significantly high when compared to national as well as regional data. Even study done by Cherian AT et al in the same state yielded similar results of high prevalence of obesity when compared to rest of the countries data.<sup>16</sup>

It is alarming to note that even in the same region prevalence of obesity and overweight is increasing as compared to data from previous studies. The escalation of overweight population is visible in the study. The exponential nature of this transition appears to be due to differences in socioeconomic levels as well as varying grades of urbanization.

### Prevalence of essential hypertension in children aged 5 to 15 years

Out of 250 children included in the study 239 (95.6%) had normal blood pressure, 6 (2.4%) children had prehypertension and 5 (2%) children had stage 1 hypertension. The overall prevalence of prehypertension and stage 1 hypertension combined was 4.4% (11 out of 250).

Out of 11 hypertensive children in the study 18.1% of children (2 out of 11) belong to age group of 5 to 10 years. And 81.9% (9 out of 11) belong to 10 to 15 years age group. There was significance increase in prevalence of hypertension in 10 to 15 years age group 14.1% (11 out of 78) when compared to 5 to 10 years age group 1.1% (2 out of 172) (Table 13).

There is equal prevalence of prehypertension and hypertension in the study population among boys and girls. Overall, prevalence of prehypertension and hypertension was found to be 4.4% among males and was 4.3% among females (Table 14).

Studies done by Ret PR et al showed overall, prevalence of prehypertension and hypertension was found to be 8.4% and 3.0% respectively.<sup>17</sup> The proportion of hypertension among males was 2.8% against 3.2% in females which is comparable to our results.

Similar study done by Sharma A et al, hypertension was identified in 62 (5.9%) children and prehypertension in 130 (12.3%).

Prehypertension or hypertension was found in nearly 20% school children in Shimla.

Another study done by Buch et al showed a total prevalence of hypertension of 6.48%.<sup>18</sup> Hypertension in males was 6.74% (<10 yrs: 5.88%, 10-13yrs: 6.04%, >13yrs: 9.19%) and in females was 6.13% (<10yrs: 0.62%, 10-13yrs: 8.67%, 13yrs: 8.48%).

Over all prevalence of hypertension may be low in our study because our study population mainly included children between age group of 5 to 10 years. (68.8%) however prevalence in age group of 10 to 15 years is comparable to other studies.

Studies done by Sundar JS et al which concentrated mainly on adolescents revealed that prevalence of adolescent hypertension was 21.5% which is alarming.<sup>17</sup> He also noted that prevalence of hypertension was increasing with the class of study, it was the lowest among students of VIII standard and highest among X, XI and XII students.

Both the above studies noted that there is increase in prevalence of hypertension among adolescents.

Early diagnosis of hypertension is necessary to initiate preventive measures but this seems difficult due to the lack of symptoms. Even though, it is proved that even asymptomatic adolescents with high blood pressure (BP) elevation can have evidence of target organ damage.

Early identification of hypertension and prehypertension translates into early interventions and possibly prevention of later morbidity and mortality. Periodic surveys should be done in schools to identify the “at risk” group of children and adolescents who can develop hypertension in future, so that preventive care can be provided.

## CONCLUSION

### Primary outcome

There is strong association between BMI and blood pressure.

### Secondary outcome

Prevalence of obesity in children aged 5 to 15 years attending to the outpatient department in Kerala Institute of Medical Sciences, Trivandrum is 9.2%.

Prevalence of essential hypertension in children aged 5 to 15 years attending to the outpatient department in Kerala Institute of Medical Sciences, Trivandrum is 2%.

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