The descriptive cross-sectional study was done to screen the children attending paediatric OPD of Saveetha Medical College and Hospital for colour vision deficiency and to find out the overall prevalence of CVD and compare the prevalence rate among males and females. One hundred seventy-five children in the age group 4 – 12 years attending paediatric OPD of Saveetha Medical College and Hospital were taken up for the study. Visual acuity and colour vision test using the Ishihara chart was conducted for all the children. Results were tabulated and statistically analysed. It was noted that 7 (4.14%) children were found to be colour deficient. Out of which 6 (7.68%) and 1 (1.10%) were Male and Female children respectively. Considering the religion, the higher prevalence of colour vision deficiency was found among Muslim children 4(14.8%) as compared to Hindu 2 (2.1%) and Christian 1 (2.1%) children. Early diagnosis of this defect helps them in minimising the potential problems they face in their everyday life, and enable them to make adaptive strategies to improve the quality of life and most importantly helps them in choosing appropriate professional choice in their career and creating awareness through education. Medical counselling will improve to reduce the occurrence of Colour Vision disorder.

Lack of awareness among the children about their colour vision status was primarily due to inadequate screening test. Children suffering from colour vision defects experience difficulties in their everyday life, especially in schools, if the colours are used for learning purpose. In today's world, where computers play a significant role in education, colour vision defects cause learning disabilities when visual graphics are used. Children will not be able to recognise their defects unless precisely screened.

Unfortunately, there are no treatment protocols available to date, so early detection of CVD is essential in helping them to adapt and make more
informed about their career choices. This also allows parents and teachers to alter the teaching methodology for adequate and appropriate learning. Reports regarding the prevalence of CVD are only limited in our study area. Hence, this study aims to find the prevalence of CVD among the paediatric population in the age group of 4-12 years and also compare the difference in prevalence rate among males and female children in Saveetha Medical College and Hospital.

Methodology

Data was collected by conducting a descriptive cross-sectional study at paediatric OPD from a Tertiary care health set up in Saveetha Medical College and Hospital, Saveetha Nagar, Thandalam. The sample size was determined based on the statistical formula and the population proportion of CVD considered in the previous studies. The sample size for this study is 175 (81 Male and 94 Female children). Oral consent for screening the children along with their social demographic details was obtained from Parents/Guardian before screening. Initially, visual acuity was tested, and all the children with visual acuity of above 6/18 and best-corrected refractive errors were included in the study. Children with any visual defects and poor visual acuity were excluded from the study. Following this, all children underwent colour vision screening. Colour vision test was performed to screen 175 children of age group 4-12 years with Ishihara chart (38 plates edition).

The procedure was well explained to all children before performing the test. The test was conducted during the day time in natural daylight. The plates were held at 75 cm from the children, and they were asked to identify the numbered plates & coloured winding lines. No time limit was imposed, if any inadequate answers were given, then the test was repeated for three times. Children who were unable to read the numbers were asked to trace the shape of numbers and coloured winding lines with a pencil. If the child did not understand the direction of lines drawn, then they were considered to be non-cooperative. Assessment of the children was done based on instructions given in the Ishihara manual. Based on that, the ability of the children to recognise and differentiate the colours on plates were assessed, and the data were collected and statistically analysed.

RESULTS

A total of 175 children (81 Male and 94 Female children) were screened with Ishihara chart, and the overall response rate was 96.6% (Table 1) with 6 of them only being classified as non-cooperative. It was noted that 7 (4.14%) children were found to be colour deficient. Out of which 6 (7.68%) and 1 (1.10%) were Male and Female children respectively (Table 2). This shows that the gender-based differences in colour deficiency are statistically significant (P-value = 0.031) and more prevalent among Male than in Female children.

Further, based on religion Muslim children had a higher prevalence of colour deficiency 4 (14.8%) which is statistically significant (P-value = 0.009) as compared to other religion like Hindu 2(2.1%) and Christians 1(2.1%), (Table 2).

DISCUSSION

“Screening is done to detect the presence or absence of a defect” (Chandak et al., 2017). In this study, colour vision testing was done using Ishihara chart (38 plate edition), which is simple, more reliable, well-known and widely used pseudo isochromatic plates. The sensitivity and specificity of Ishihara chart were 96% and 98.5% respectively (Chandak et al., 2017), which was equally valid like any other screening test according to previous studies (Birch, 1997; Dain et al., 1998). In our study, all the children were found with congenital colour vision defects, and there were no children with acquired colour vision deficiency, similar findings were found in a study (Yasmin et al., 2009). Hence, Ishihara chart test was used for screening.

This study provides a primary database of CVD among children of Thandalam, which helps us to understand the prevalence rate of CVD in our region. During the study, our initial observation was that younger age children, especially between the 4-6 age group were not co-operative as they were unable to read the numbers/patterns in the plates and differentiate the colours. We had to spend a lot of time in making them understand the purpose of the testing and teaching them the test methodology in such a way that they could extend their co-operation.

In this study, the CVD prevalence rate was 4.14%, and our findings were nearly similar to the prevalence rate of previous other studies across India like 4.07% in (Dronamraju and Meerakhan, 1961), 4.06% in (Chakrabarti and Chakraborti, 2015). However our results were higher than a few studies like 2.9% in (Mahajan and Gogna, 1977), 2.5% in (Gupta et al., 2017), 2.1% in (Agarwal and Bansod, 2014), 2.02% in (Chandak et al., 2017), 1.4% in (Basavaraj et al., 2019), and lower than the prevalence rate of Manipuri Muslims (Shah et al., 2013) which was 5.28%.
Table 1: Social Demographic Characteristic of children in Saveetha Nagar, Thandalam

| Religion | Age Groups    | Male | Female | Total | Co-operated | Response Rate % |
|----------|---------------|------|--------|-------|-------------|----------------|
| Hindu    | 4 To 6 Years  | 16   | 22     | 38    | 35          | 92.1%          |
|          | 7 To 9 Years  | 14   | 24     | 38    | 38          | 100.0%         |
|          | 10 To 12 Years| 12   | 10     | 22    | 22          | 100.0%         |
| Christian| 7 To 9 Years  | 11   | 9      | 20    | 20          | 100.0%         |
|          | 10 To 12 Years| 13   | 14     | 27    | 27          | 100.0%         |
| Muslim   | 4 To 6 Years  | 8    | 7      | 15    | 12          | 80.0%          |
|          | 10 To 12 Years| 7    | 8      | 15    | 15          | 100.0%         |
| Total    |                | 81   | 94     | 175   | 169         | 96.6%          |

Table 2: Frequency distribution of CVD in Children

| Variables | Colour Vision Normal | Colour Vision Deficient | Total Deficiency | Chi-Square | P-Value |
|-----------|----------------------|-------------------------|------------------|------------|---------|
| Gender    |                      |                         |                  |            |         |
| Male      | 72 (92.32 %)         | 6 (7.68 %)              | 4.14%            | 4.5986     | 0.031997a |
| Female    | 90 (98.10 %)         | 1 (1.10 %)              |                  |            |         |
| Religion  |                      |                         |                  |            |         |
| Hindu     | 93 (98.0%)           | 2 (2.1%)                | 4.14%            | 9.2189     | 0.009957b |
| Christian | 46 (97.9%)           | 1 (2.1%)                |                  |            |         |
| Muslims   | 23 (85.2%)           | 4 (14.8%)               |                  |            |         |

On comparing our results with the studies done across the world, near similar results were found in studies like 4.1% in (Woldeamanuel and Geta, 2018), 4.24% in (Wale et al., 2018). Further, there are few studies with Low prevalence rate, like 3.8% in (Niroula and Saha, 2010), 2.1% in (Shrestha et al., 2010), 2.6% in (Tabanssi et al., 2008), 2.5% in (Oduntan et al., 2019), 2.3% in (Ugalahi et al., 2016). Some Studies had a higher prevalence rate like 5.4% in (Chia et al., 2008), 4.9% in (Thomas et al., 2018). The variation in the results between our study and other studies is mainly due to heterogeneity of study population, Study area (Geographical location), and Screening methodologies used for the colour vision test.

In this study, the prevalence of CVD was 7.68% in male children and 1.10% in female children. This shows that the frequency of CVD is higher among male children as compared to female children. Studies similar to our findings (Shah et al., 2013; Fareed et al., 2015), and several other published literature strongly suggest the association of colour vision defect with a genetic disorder. It is due to X-linked recessive nature of trait (i.e., single X-chromosome in males are more prone to colour deficiency, Whereas in the female they have a pair of X-Chromosome, so they act as a carrier which reduces the risk of the CVD). It thus occurs in males (Shah et al., 2013). This Genetic factor can be explained by associating it with religion.

Among the 175 children screened, around 56.0% were Hindu, Christian 26.9% and Muslim were 17.1%. The prevalence rate of colour vision deficiency was high among Muslim children (14.8%) as compared to Hindu (2.1%) and Christian (2.1%). The reason behind the majority of Muslims was colour deficient, are mostly because of the practice of consanguineous marriages, which is supported by studies done by (Rahman et al., 1998) and (Shah et al., 2013), wherein it resulted in children born with this congenital disorder.

Majority of children were unaware of their colour vision status, and similar studies done by (Chakrabarti and Chakraborti, 2015), reported the same, and this is because most of the children are not undergoing any eye examination. Hence, to create awareness about colour vision defects, there should be an increased number of colour vision screening test to be taken among children.

Limitation

Anomaloscope is used for confirmatory diagnosis, which could not be used here because of limited time duration for testing and availability. Though
the sensitivity of the Ishihara test was 96%, it cannot detect minor defects. Hence, the children with a family history of colour blindness are advised to undergo a diagnostic test which helps in confirming the presence of colour vision disorder.

Ethical consideration
Before starting the study, the Institution Review Board of Saveetha University has approved our protocol, later grant sanction form was obtained from HOD of all the department. Further, informed oral consent was obtained from all the parents/guardians and children before they were included in our study. After the testing, children with a deficiency were given appropriate counselling along with their parents about the prognosis and all its related implication on their future career and prospects.

CONCLUSIONS
For an individual to understand and analyse the visual world, colour vision plays a significant role as an integral component. Those who have colour vision defects experience difficulties in day to day life, early diagnosis of this defect helps them in minimising the potential problems that they face in everyday life, change in their behaviour, making adaptive strategies for the improvement of their quality of life and most importantly helps them in choosing appropriate professional choices in their career. It is worth to evaluate the gene frequencies among the population, which helps in identifying individuals with colour deficiency so that necessary medical counselling can be provided. Ultimately this will help to minimise the risk of disorder from getting transmitted to their offspring’s.

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Conflict of Interest
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