ORIGINAL ARTICLE

Behavioural Issues among Primary Schoolchildren with Colour Vision Deficiency

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ABSTRACT

Introduction: Colour vision deficiencies may raise behavioural changes among children. This study explores the presence of any behavioural issues faced by primary schoolchildren with congenital red-green colour vision deficiency (CRGCVD). **Materials and Methods:** Male schoolchildren, aged 8-11 years old, from 10 randomly selected schools in Klang Valley were screened using Ishihara plates and Farnsworth D-15 test. Children with CRGCVD (study group) and without CRGCVD (control group) were asked to complete the Strength and Difficulties Questionnaire (SDQ) for children (self-report) while their class teachers completed the SDQ for teachers (teacher- report). Difficulty scores were calculated. The test categorised behaviour into 3 categories based on the difficulty scores into 'normal', 'borderline' and 'abnormal' behaviours. Non-parametric test was used to compare the median of difficulty scores between control group and study group. Spearman correlation was used to determine association between self-report SDQ and teacher-report SDQ. **Results:** A total of 134 schoolchildren were recruited in this study, of which 44 had CRGCVD and 90 were in the control group. Teacher-reported SDQ for the children were obtained from 134 teachers. No statistically significant differences ($p>0.05$) were noted between the total SDQ scores of children with and without CRGCVD using self-report SDQ and teacher-report SDQ. The total difficulty scores of self-report SDQ and teacher-report SDQ were poorly but significantly correlated. Teachers rated 9.09% of children with CRGCVD as falling under the 'abnormal' category, slightly higher than self-rated of 2.27%. **Conclusion:** This study found no prominent behavioural issues among schoolchildren with CRGCVD.

KEYWORDS: Primary schoolchildren, colour vision deficiency (CVD), Strength and Difficulties Questionnaires (SDQ), behavioural

INTRODUCTION

Colour vision is an important attribute of visual perception. It plays a vital role in our daily lives especially in children. A one-month old infant spontaneously prefers coloured pictures over grey stimuli.[1] The colour discrimination capacities improve with age.[2,3] Human colour vision when normal is trichromatic which implies the presence of all three classes of photopigments. This allows the human eye to differentiate various colours. However, a person with colour vision deficiency (CVD) does not have the ability to see certain type of colours from their surroundings.

CVDs can be classified as anomalous trichromacy, dichromacy or monochromacy. In dichromacy, there can be a defect either along the red-green axis, known as protanopia (red defect) or deuteranopia (green defect), or defect along the yellow-blue axis, known as tritanopia.[4] In dichromats, there is absence in any of the three classes of cone photopigments. In anomalous trichromacy, all three classes of photopigments are present but there is an abnormal shift in the absorption spectrum of the photopigments. This leads to weakness in colour perception, and thus can be termed as protanomalous

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(red weakness), deuteranomalous (green weakness) and tritanomalous (blue weakness).[5] Congenital red-green colour vision deficiency (CRGCVD) is the most common type of defect which can be inherited through X-linked chromosome.[6] Congenital dichromats and severe anomalous trichromats will have confusion to judge the bright colours.[7]

Most children with CVD are not aware of their condition with many only realising so when they are in secondary school.[8] A study by Steward and Cole[7] reported that 49% of dichromats and 8% of anomalous trichromats became aware of their CVD in primary school, and a further 22% of dichromats and 28% of anomalous trichromats in secondary school. Sullivan[8] noted that CVD children tend to lag in subjects where colour is used as a teaching tool such as mathematics, science, geography, reading, sport and food technology. However, studies that have attempted to determine the impact of CVD on academic achievement have reported conflicting outcomes, probably due to differences in study designs.[9-13] There has also been CVD related difficulties in sporting activities.[7,8,13-16]

There is an increasing use of colour in activities conducted in schools and daily living. Individuals with colour vision defects encounter difficulties in performing certain colour-related tasks and in their daily life style. This can affect their learning ability with colour-related tasks.[8,17-20] Consequently, young children with CVD were often mistaken as slow learners or ridiculed in preschool.[21,22] This may cause embarrassment to the child and lead to significant consequences such as school refusal or social withdrawal.

Behavioural issues such as sadness, social withdrawal and anxiety can cause a decline in academic performance, social activities and career planning.[23] Cognitive element for children are closely related to setting and achieving goals, academic achievement and social interaction with friends and school teachers.[24] According to a study, behavioural problems can lead to reading difficulities. Off-task and disruptive behaviours are also able to affect children's performance in school and interfere with children's learning mode. The ability of the children to read can be enhanced by overcoming the behavioural issues.[25] However, Perez et al.[26] found that individuals with red-green vision defect were more skilled in controling emotions, matured thinker, and calm when dealing in decision making.

To date, no studies have been done in Malaysia to examine behavioural status among primary school children with CRGCVD. This study aimed at identifying any behavioural issues experienced by children with CVD through self-report and teachers report. The association between self-report and teacher-report was also investigated.

MATERIALS AND METHODS

Study Population

A cross-sectional study was carried out among male primary school children in the Klang Valley. The study was conducted in 10 primary schools selected based on Fisher random sampling method. All school children within the age range of 8 to 11 years old were invited to participate in this study.

In this study, there were two groups of samples; the study and control group. The study group comprised of school children with CRGCVD while the control group was school children with normal colour vision status. Homogeneous purposive sampling was used to recruit the school children with CRGCVD whereas convenient sampling was used to recruit the control group. The inclusion criteria were school children aged between 8-11 years old wearing optimum power spectacles, the child's parent gave consent to participate in this study as well as the child voluntarily participated in this study. The monocular VA with spectacle correction must be 6/9 or better at a distance and N6 or better when near. The exclusion criteria were presence of any physical and/ or cognitive problems (example Dyslexia, Down syndrome, Autism, ADHD), history of a systemic disease and ocular illness or any monocular and binocular vision disorders such as suppression, amblyopia and strabismus.

Apart from school children, their teachers were also recruited into this study. Sample size calculation was done using Daniel formula.[27] The sample size needed was a minimum of 44 school children for the study group, 90 school children for the control group and 134 teachers.

Study Procedures

The study was conducted according to the Declaration of Helsinki. This experimental study was

approved by the Universiti Kebangsaan Malaysia Research and Ethics Committee (Project Code NN-2017-004). Informed consent was obtained from all subjects prior to data collection.

All the school children were screened using Ishihara plates. The school children who failed the Ishihara test were then tested with Farnsworth D-15 test. The school children who failed the colour vision tests were recruited into the study group (CRGCVD group) whereas those who passed the test were recruited into the control group.

The Strength and Difficulties Questionnaire

The Strength and Difficulties Questionnaire (SDQ) for self-report (Malay version) and teacher-report (Malay version) were utilized in this study as the Malay language is the primary language of communication in this population sample. The SDQ is one of the standard mental health screening questionnaires for children aged 4-17 years old.[28] The SDQ was originally developed and validated within the UK, and its reliability and validity have been simulated in many countries, however in Malaysia only the SDQ teacher-report has been validated. According to Taha,[29] sensitivity and specificity of teacher-report SDQ (Malay version) were 88.9% and 84.9% respectively. The SDQ for self-report was originally published in English. We translated it to the Malay language with the help of language teachers. Forward and backward translation was conducted; however, it has not been validated. The SDQ consists of 25 questions which measure 5 elements of behaviour, namely emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems and prosocial behaviour. A summary score is calculated as 'sum of item scored' divided by 'number of completed item' multiplied by the 'number of items'. The 'total difficulties score' is the 'sum of summary scores of emotional scale, conduct scale, hyperactivity scale and peer problem scale'. Three choice Likert scale were used in SDQ; 'not true', 'somewhat true', and 'certainly true'. Category bands and total difficulties score (0-40) are used to classify as 'normal', 'borderline' and 'abnormal'.[30] For the self-reported SDQ, 'normal' score is between 0-15, 'borderline' is between 16-19 and 'abnormal' is 20-40. For the teacher-report SDQ, the 'normal' score is between 0-11, 'borderline' is between 12-15 and 'abnormal' is 16-40. The summary scores for each of the 5 elements can also be categorised as 'normal', 'borderline' and 'abnormal'. When using self-report SDQ, for emotional problems and hyperactivity, 'normal' score is between 0-5, 'borderline' is 6 and 'abnormal' is between 7-10. For behavioural problems, 'normal' score is between 0-3, 'borderline' is 4 and 'abnormal' is between 5-10. In the case of peer relationship problems, 'normal' score is between 0-3, 'borderline' is between 4-5 and 'abnormal' is between 6-10. For prosocial behaviour, 'normal' score is between 6-10, 'borderline' is 5 and 'abnormal' is between 0-4. When using teacher-report SDQ, for emotional problems, 'normal' score is between 0-4, 'borderline' is 5 and 'abnormal' is between 4-10. For behavioural problems, 'normal' score is between 0-2, 'borderline' is 3 and 'abnormal' is between 5-10. In the case of hyperactivity, 'normal' score is between 0-5, 'borderline' is 6 and 'abnormal' is between 7-10. In the case of peer relationship problems, 'normal' score is between 0-3, 'borderline' is 4 and 'abnormal' is between 5-10. For prosocial behaviour, 'normal' score is between 6-10, 'borderline' is 5 and 'abnormal' is between 0-4.[30, 31]

The school children and teachers were given a short briefing about the questionnaire prior to data collection. As most of the school children could read, they filled the questionnaires themselves. However, the 8 years old school children needed assistance, therefore, the researcher along with other research assistances helped fill in the questionnaires. All data was entered into a specially designed database under website *https://sdqscore.org/Amber*.

Statistical Analysis

Statistical analysis was performed using the software package SPSS 22.0. The threshold statistical significance was taken as p=0.05. A nonparametric test (Mann-Whitney U Test) was used to compare the median of difficulty scores between the control group and study group. Spearman correlation was used to determine association between self-report SDQ and teacher-report SDQ.

RESULTS

A total of 148 parents' and teachers' consent forms were distributed. However, only 139 parents' and teachers' consent forms were completed and returned. A total of 134 male schoolchildren were recruited in this study, of which 44 had CRGCVD and

90 were the control group. Teacher-reports SDQ for the schoolchildren were obtained from 134 teachers.

There were 115 Malay (85.82%), 2 Chinese (1.50%) and 17 Indian (12.69%) male schoolchildren in this study. The study group (CRGCVD) comprised of 13 schoolchildren who were protans (red defect) and 29 schoolchildren who were deutans (green defect). The control group (normal colour vision status) comprised of 73 schoolchildren. A summary of the demographic data is shown in Table 1.

Table 1. Summary of demographic data of subjects

Colour Vision Status	Ethnic			
	Malay n (%)	Chinese n (%)	Indian n (%)	Total n (%)
Protan	13 (9.70)	0	0	13 (9.70)
Deutan	29 (21.64)	1 (0.75)	1 (0.75)	31 (23.14)
Normal	73 (54.48)	1 (0.75)	16 (11.94)	90 (67.17)
Overall Total	115 (85.82)	2 (1.50)	17 (12.69)	134 (100.00)

Table 2 shows the Total Difficulty (TD) scores of schoolchildren with CRGCVD and with normal colour vision status. The mean TD scores of schoolchildren with CRGCVD (11.68±4.31) was slightly higher than schoolchildren with normal colour vision status (10.89±5.08). However, there was no significant difference between the mean TD scores of schoolchildren with CRGCVD and normal students (control group) using self-report SDQ (U=1738.50, p= 0.25). For the teacher-report SDQ, the mean TD scores of schoolchildren with CRGCVD (10.18±4.21) was also slightly higher than normal students (9.81±4.58). Again, there was no significant difference between the mean TD scores of schoolchildren with CRGCVD and normal students using teacher-report SDQ (U=1845.50, p= 0.52).

Table 2. Total Difficulties score of study group (CRGCVD) and control group (normal students).

Type of SDQ* reporting	Colour Vision Status	n	(mean ± SD**)	Median
Self-report	Normal	90	10.89±5.08	10
	CRGCVD	44	11.68±4.31	11.5
Teacher-report	Normal	90	9.81±4.58	9
	CRGCVD	44	10.18±4.21	9

**Strength and Difficulties Questionnaire, **standard deviation*

Schoolchildren with CRGCVD categorised by teacher-rated SDQ as 'normal' were 68.18%, 'borderline' were 22.73%, and 'abnormal' were 9.09% whilst for self-report SDQ; 'normal' were 90.91%, 'borderline' were 6.82%, and 'abnormal' were 2.27%. For the control group, schoolchildren categorised by teacher-rated SDQ as 'normal' were 68.89%, 'borderline' were 16.67%, and 'abnormal' were 14.44% whilst for self-report SDQ; 'normal' were 84.44%, 'borderline' were 7.78% and 7.78% were 'abnormal'. Summary of TD SDQ percentages is shown in Figures 1a and 1b.

Specific comparisons of TD scores were then carried out between protans and deutans categorised as 'abnormal' and is shown in Figure 2. Deutans compared to protans were seen to have higher TD scores both by self-report and teacher-report.

Further analysis was done to explore the summary scores in the 5 elements of behaviour. As can be seen in Table 3, all 5 elements were categorised as 'normal' with self-report SDQ and teacher-report SDQ except for prosocial behaviour with teacher-report SDQ. Analysis of the 5 elements of behaviour was also carried out amongst protans and deutans.

Table 3. Summary scores of 5 elements of behaviour in the SDQ.

Elements	Colour Vision Status	Summary Scores Mean±SD (median)	
		Self-report	Teacher-report
Emotional problems	Normal students	2.84±2.17 (2.50)	1.48±1.81 (1.00)
	CRGCVD*	3.16±2.02 (3.00)	1.77±1.63 (1.00)
	p value	0.35	0.15
Conduct problems	Normal students	1.86±1.65 (1.50)	1.82±1.56 (1.00)
	CRGCVD*	2.36±1.78 (2.00)	1.45±1.36 (1.00)
	p value	0.12	0.15
Hyperactivity	Normal students	2.82±1.58 (3.00)	3.43±1.77 (3.00)
	CRGCVD*	3.07±1.90 (3.00)	3.52±1.85 (3.00)
	p value	0.48	0.72
Peer relationship problems	Normal students	3.38±1.94 (3.00)	3.04±1.40 (3.00)
	CRGCVD*	3.09±1.97 (3.00)	3.20±1.58 (3.00)
	p value	0.42	0.87
Prosocial behaviour	Normal students	6.69±2.19 (7.00)	5.24±2.13 (5.00)
	CRGCVD*	7.09±2.34 (7.00)	5.43±2.37 (5.00)
	p value	0.29	0.73

** congenital red-green colour vision deficiency*

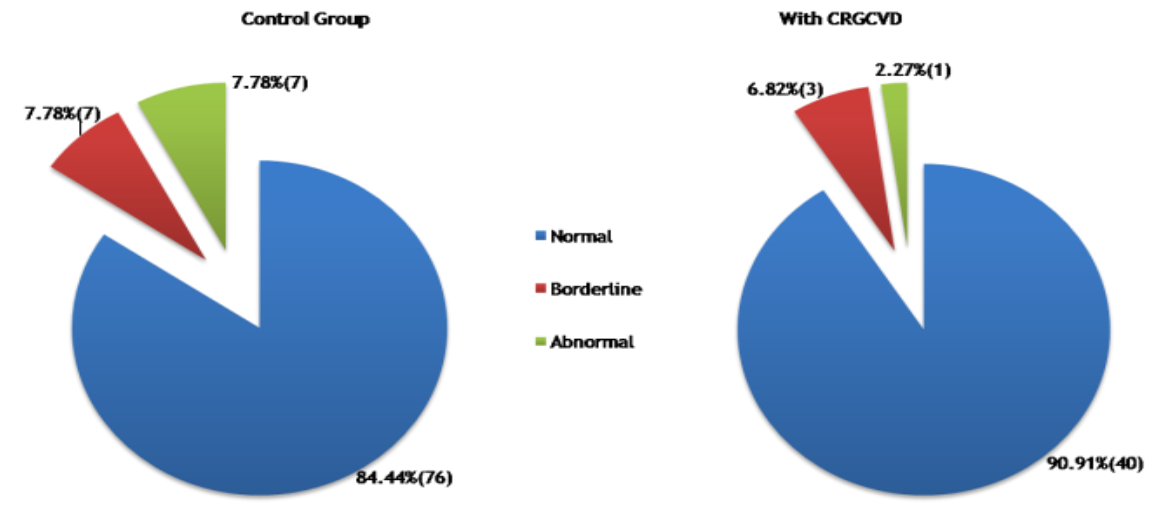

Figure 1a. Summary of Total Difficulties Scores using self-report Strength and Difficulties Questionnaire (SDQ)

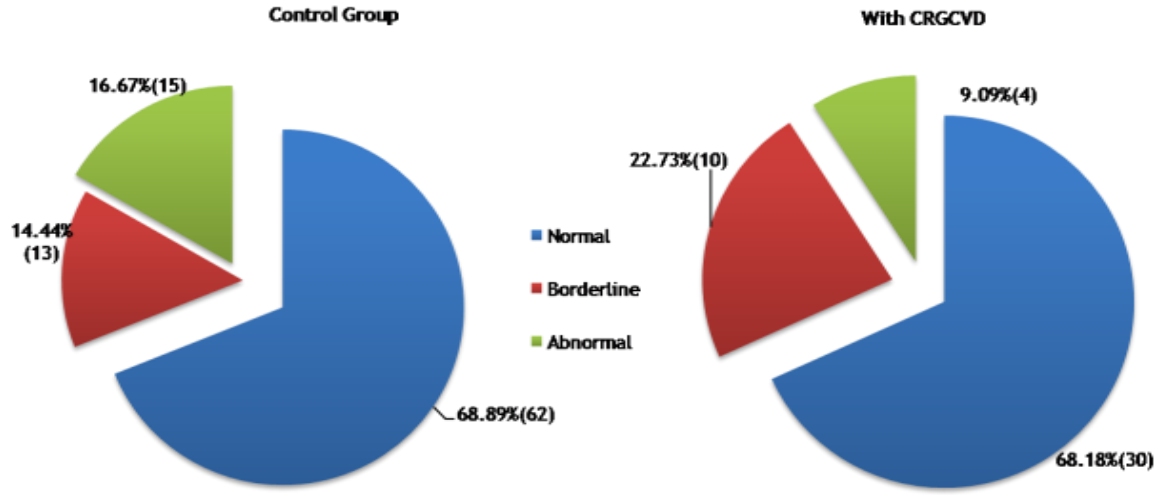

Figure 1b. Summary of Total Difficulties Scores using teacher-report Strength and Difficulties Questionnaire (SDQ)

It can be seen in Figure 3a that the deutans have higher percentage of summary scores in peers related problem (9.09%) according to self-report SDQ whereas protans and deutans have similar prosocial behaviours (15.91%) summary scores according to teacher-report SDQ. For the schoolchildren without CRGCVD, it can be seen in Figure 3b that elements which have higher percentage of summary scores were peer-related problem (14.44%) and prosocial behaviour (15.56%) according to self-report SDQ whereas teacher-report SDQ showed only prosocial behaviour (30%) was high.

Overall, Spearman correlation was used to determine the association between self-report SDQ and teacher -report SDQ. Correlations between TD scores for different informants were all significant, but weak (self-report SDQ and teacher-report SDQ among schoolchildren with CRGCVD [r_s (44) = 0.30, p = 0.04] and normal students [r_s(90) = 0.23, p = 0.03].

DISCUSSION

The TD scores of schoolchildren with CRGCVD were slightly higher than normal students using self-report SDQ while the teachers rated both groups as having similar TD scores. The results of TD scores from self-report SDQ and teacher-report SDQ were still within the 'normal' behavioural category according to the standard cut-off point of SDQ band. There were no

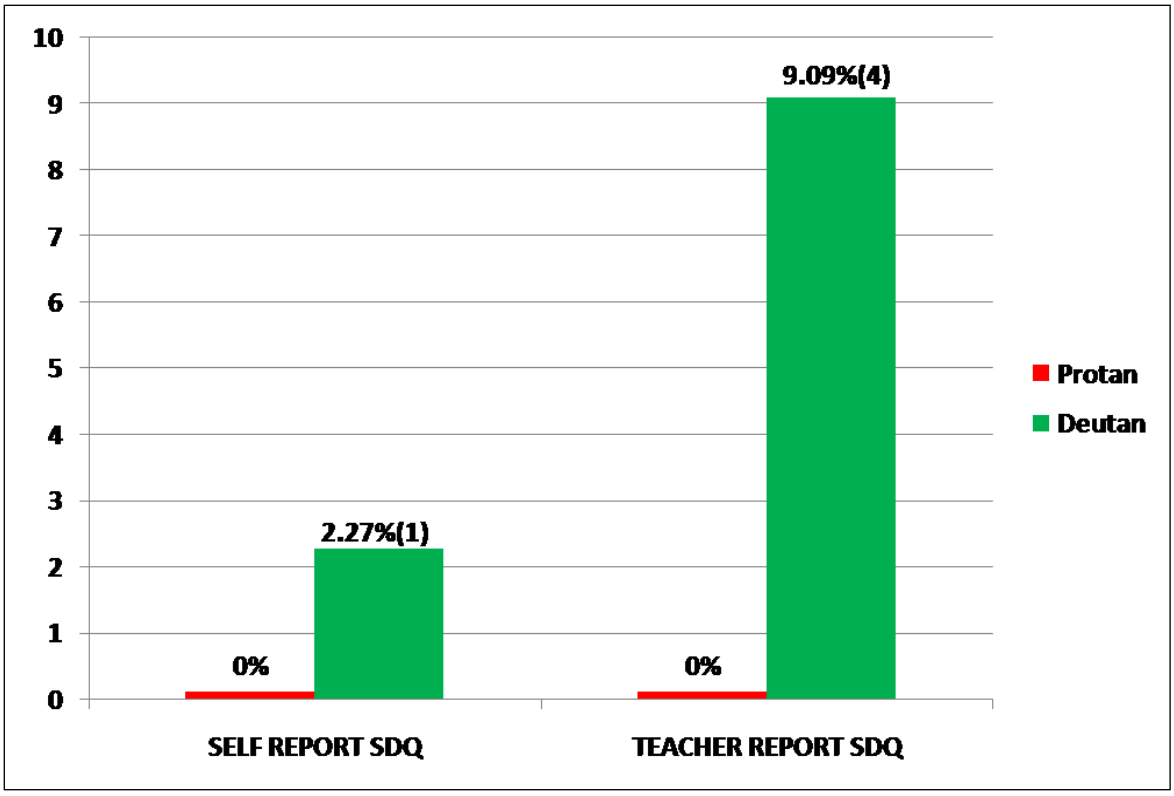

Figure 2. Total Difficulties Scores of Deutans and Protans categorised as 'abnormal'.

significant behavioural issues detected in schoolchildren with CRGCVD from the overall evaluation using self-report SDQ and teacher-report SDQ.

There was a weak but significant correlation between TD scores for self-report and teacher-report SDQ's. There seems to be commonalities between self-report SDQ and teacher-report SDQ. Sargisson et al.[32] found that the correlation between teacher and student ratings to be 0.28. These were because teachers spend a longer time with a big number of schoolchildren and were not able to see any small changes in behaviour. However, the teacher is able to observe the abnormal and severe behaviour of a child.[32] Goodman et al.[31] suggested that if the teacher's assessment is collected, it is useful to include student's or parent's version as whistle-blower, because both parties will give different information. Koskelainen et al.[33] also found that the correlation between the self-report SDQ and teacher -report SDQ in the population of children with normal levels of behaviour is weak (0.20). Teachers can give reliable information because they are able to understand and answer the questions more thoroughly than children who have different levels of understanding. The child may easily be tampered with feelings and emotions for each type of question.[33]

The summary scores of the 5 elements of behaviour as well as that TD scores from this study were compared with the British norms[34] as there are no established norms of such in Malaysia or in the Asian region. This study is the first study to measure behavioural issues for children with CVD in this part of the world. Comparing with the norms from Britain, might not be suitable due to difference in psychometric factors like ethnicity and lifestyle.[34] The percentage of schoolchildren with CRGCVD that have issues of the 5 elements of behaviour was 31.8% by self-report and 56.8% by teacher-report. In the case of normal students without CRGCVD, the percentage of schoolchildren that have issues with 5 elements of behaviour was 45.56% by self-report and 56.66% by teacher-report. All the elements were within the 'normal' category for self-report SDQ. In the case of teacher-report SDQ, only the prosocial behaviour was 'borderline'. The views and the extent of teachers' thinking is different from students but percentage of CRGCVD schoolchildren who have the abnormal behaviour was still within the range reported by Goodman in British children population.[35] According to a study by Ehsan et al., many school teachers focused on the attitude of discipline and academic issues when evaluating the level of behaviour of a child.[36]

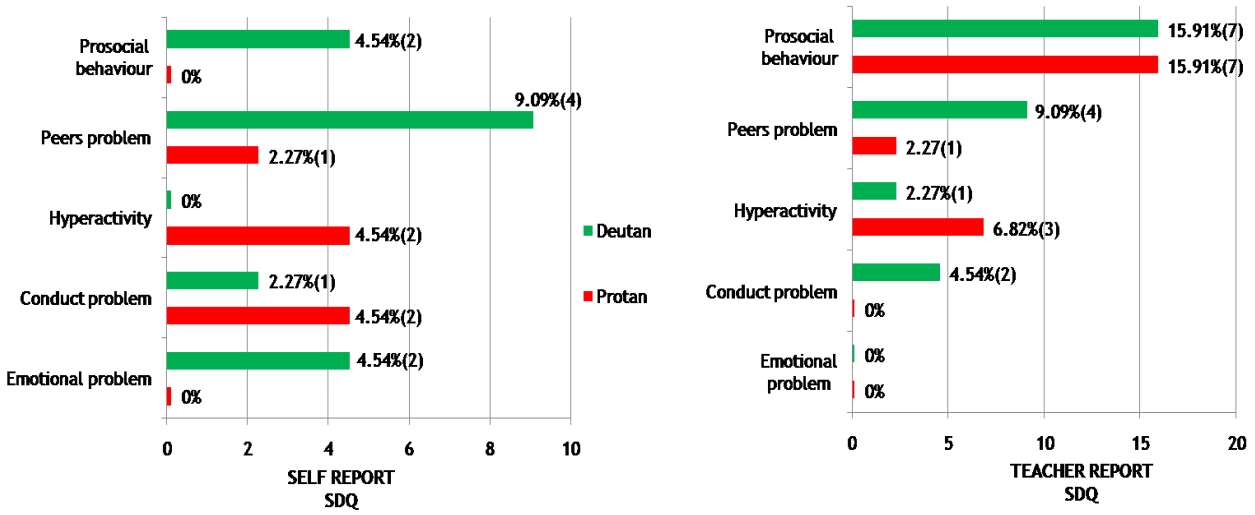

Figure 3a. Percentage of protan (red bars) and deutan (green bars) schoolchildren with the 5 elements of behaviour reported using self-report and teacher-report SDQ.

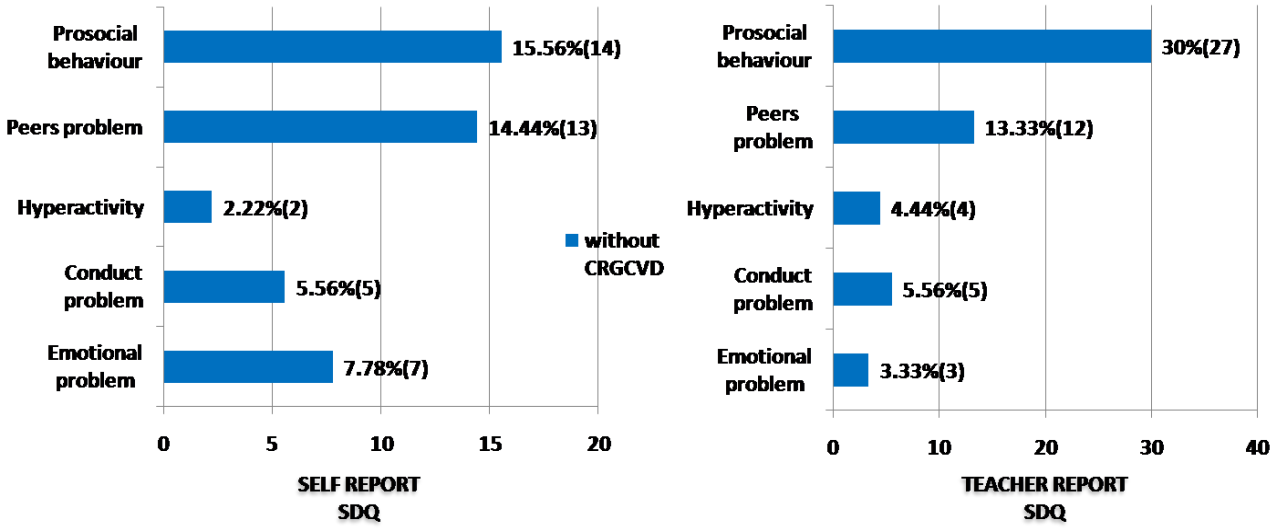

Figure 3b. Number of normal schoolchildren without CRGCVD with the 5 elements of behaviour reported using self-report and teacher-report SDQ.

The type of colour vision deficiency seemed to have an effect on the TD scores by self-report and teacher-report. Deutans (green defects) were noted to have higher TD scores compared to protans (red defects) by both self-report and teachers-report. However, teachers-report indicated higher scores compared to self-report.

Only the prosocial behaviour element had borderline summary scores with teacher-report and it was similar for protans and deutans. It is however unclear as to the reason for this. Perhaps peer related problems (9.09% for deutans, 2.27% for protans by self-report and teacher-report) contributes to prosocial behaviour issues.

Limitations of this study were the sampling data which focused on schools in the Klang Valley only. Only male schoolchildren were screened for colour vision deficiency because the prevalence of the female subject with CRGCVD was extremely low, i.e 0.2%, whereas the prevalence for male subjects was 4.8% according to research Reddy & Hassan.[37] As such, the control group was also male schoolchildren. This study also did not grade the severity of the CRGCVD.

CONCLUSION

This study showed that there were no prominent behavioural issues among children with CRGCVD. However, teacher-report indicated that these children have 'borderline' prosocial behaviour. Colour vision screening should be established early in primary schools for healthy behavioural development of a child.

CONFLICT OF INTEREST

None declared

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