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Original Article

Public Health Section

Colour Vision Screening Training Module for School Counsellors: Module Development, Validity and Feasibility Study

BELINA-ANNE WILLIAM M THOMAS[1], SHARANJEET SHARANJEET-KAUR[2], MAHADIR AHMAD[3], LEI HUM WEE[4], MOHD IZZUDDIN HAIROL[5]

ABSTRACT

Introduction: Congenital Colour Vision Deficiency (CCVD) is often undetected in school children due to the absence of colour vision testing in routine school health programmes. Early detection allows timely counselling and career guidance, potentially minimising emotional, behavioural and academic challenges. Training school counsellors to perform colour vision screening may offer a cost-effective and sustainable solution.

Aim: To develop, validate, and assess the feasibility of a Colour Vision Screening Training Module (CVS-T Module) for school counsellors.

Materials and Methods: A three-phase, mixed-methods study was conducted in Kuala Lumpur, Malaysia, between January 2021 and December 2022. The study was guided by Sidek's Module Development Model, which comprised three phases: (I) formulation of the module concept, design, and content; (II) development of the module through literature review and input from subject matter experts (n=4), followed by validation from a multidisciplinary expert panel (n=7); and (III) pilot feasibility testing, in which secondary school counsellors (n=2) applied the module to screen school children (N=44).

Results: Content validation showed excellent agreement (I-CVI=1.0, S-CVI/Ave=1.0, S-CVI/UA=1.0), though such perfect scores are rare and may reflect the expert panel's recruitment. Experts supported the finalised module and the pocket handbook for screening procedures. Feasibility testing revealed 100% agreement (AC1=1.0) for both counsellor and optometrist methods, despite a small, homogeneous male-only sample from one school. Counsellors provided positive feedback on the module's clarity, relevance, and ease of use.

Conclusion: The CVS-T Module is a valid, feasible and practical training resource for school counsellors to conduct in-school colour vision screening. Its integration into school health programs could facilitate the early detection and referral of CCVD, potentially reducing the negative psychological and educational impact of delayed diagnosis. Further studies should evaluate its effectiveness on a larger scale.

Keywords: Congenital colour vision deficiency, Practical training, School counsellor, Training module development

INTRODUCTION

The Congenital Colour Vision Deficiency (CCVD) affects approximately 4-8% of males and 0.5% of females worldwide. Regionally, prevalence is reported at 4.80% for boys and 0.20% for girls in Malaysia [1], 5.3% for boys and 0.2% for girls in Singapore [2], and 2.76% among schoolboys in South India [3]. These variations are likely attributable to differences in genetics, screening protocols, and study populations. Because CCVD consistently disproportionately affects males and can significantly impair academic performance, social interaction, and emotional well-being, the development of a localised, and as Malaysia reports prevalence rates comparable to Singapore and higher than those reported in South India, a Malaysia-specific screening and educational module is warranted to address regional needs and awareness gaps.

Specific educational challenges are frequently faced by children with CCVD, including the misinterpretation of colour-coded charts, maps, graphs, and laboratory specimens. These difficulties are particularly pronounced in colour-dependent science subjects like biology and chemistry, often resulting in lower academic achievement [4]. Furthermore, behavioural and emotional impacts, such as classroom adjustment issues, psychosocial embarrassment, and reduced confidence, have been documented [5,6]. Career opportunities in professions requiring accurate colour discrimination, such as medicine, engineering, aviation, and technical trades, are frequently restricted by undiagnosed CCVD. Driving-related difficulties and occupational preclusions are often encountered [7], leading to long-term implications for career planning and psychological adjustment if early detection and counselling are omitted.

Colour vision testing is frequently excluded from school vision screening programs in developing countries [8]. In Malaysia, the Ministry of Health's School Health Programme routinely screens children aged 7-12 years for refractive errors and ocular pathologies, but CCVD remains unassessed. This omission occurs because conditions with immediate learning impacts are prioritised over non progressive, incurable visual traits [9]. Consequently, many CCVD cases remain undetected until late adolescence or adulthood [10]. This policy gap underscores the necessity of screening to facilitate early counselling, classroom accommodations, and informed vocational guidance, thereby preventing missed opportunities for timely educational adjustments and career planning. Because CCVD screening is a brief, low-cost, one-time procedure, it is ideally incorporated into school health or counselling services [8]. Successful vision screenings can be conducted by trained non health professionals, including teachers and counsellors, who are uniquely positioned to provide early identification and psychosocial support [6].

However, to the authors' knowledge. there are no validated, standardised training resources tailored for school counsellors to conduct colour vision screening effectively. To address this need, the authors developed the Colour Vision Screening Training (CVS-T) Module designed to equip school counsellors in Malaysia with essential knowledge, practical skills, and referral pathways for detecting CCVD. This study aimed to develop, validate, and assess

the feasibility of the CVS-T Module to enable sustainable, school-based early detection of CCVD.

MATERIALS AND METHODS

A three-phase, mixed-methods study was conducted in Kuala Lumpur, Malaysia, between January 2021 and December 2022. Sidek's Module Development Model guided the sequential phases of concept formulation, content development, validation, and feasibility testing [11]. Ethical approval was obtained from the Research Ethics Committee, Universiti Kebangsaan Malaysia (UKM PPI/111/8/JEP-2018-124), and written informed consent was secured from all participants. For the school children, parental and legal guardian consent was also obtained.

Inclusion criteria: Secondary school counsellors who consented to participate in the feasibility testing were included, along with male school children aged 13 years enrolled in Form 1 (Year 7 of formal schooling).

Exclusion criteria: Children with known ocular pathologies (such as amblyopia or strabismus) or systemic illnesses affecting vision were excluded from the study.

In Phase I, a comprehensive literature review was conducted to determine the prevalence, impact, and management of CCVD in school-aged children, with particular focus on screening approaches in educational settings. Data were collected systematically from peer-reviewed studies reporting CCVD prevalence, educational challenges, and career implications [Table/Fig-1] [4,7,12].

Reference	Theme	Key findings	Implications for intervention
Barry JA et al., 2017 [12]	Emotions and behaviour	CCVD is linked with emotional distress, low self-esteem, and social withdrawal.	Implement awareness programs for teachers, parents, and school children; integrate psychosocial support.
Mashige KP, 2019 [4]	Academic performance	CCVD hinders interpretation of charts, maps, and lab experiments; lower achievement in science subjects.	Adapt teaching materials with non colour cues; provide targeted academic support and career guidance.
Cole BL, 2004 [7]	Career implications	CCVD restricts entry into medicine, engineering, aviation, and technical trades.	Early screening and counselling to guide career planning.

[Table/Fig-1]: Summary of literature findings supporting CVS-T module development [4,7,12].

Based on this needs analysis, the preliminary CVS-T Module was designed, consisting of three sub-modules: 1) Overview of CCVD – Definition, prevalence, and impact; 2) Challenges for students with CCVD - academic, social, emotional, and behavioural effects; and 3) Preparation and procedure for screening - Step-by-step visual acuity and colour vision testing protocols, recording forms, and referral pathways.

In Phase II, four doctoral-level subject matter experts (50% female; experience: 5 to >25 years) were recruited via purposive sampling: two optometry academicians, one clinical psychologist, and one health educator. The draft module and discussion guide were reviewed two weeks before a structured two-hour online session moderated by the author, designed to allow a comprehensive review while minimising fatigue. The module was subsequently refined and supplemented with a pocket handbook detailing step-by-step procedures and recording guidelines.

The module then underwent face and content validation by seven experts, matching methodological recommendations of six to eight experts to achieve a minimum acceptable Content Validity Index (CVI) of 0.83 [Table/Fig-2] [13]. A 4-point Likert scale CVI form was completed to assess face validity (font, layout, comprehension) and content validity (relevance, simplicity, clarity, ambiguity) [14]. Revisions were guided by open-ended comments, and item-level (I-CVI) and scale-level indices (S-CVI/Ave, S-CVI/UA) were calculated [Table/Fig-3].

Expert panel	Gender	Education level	Working experience (years)
Optometrist (Public)	Female	Master's	8
Optometrist (Public)	Female	Master's	12
Optometrist (Private)	Male	Bachelor's	15
Optometrist (Private)	Male	Bachelor's	7
Optometry lecturer	Female	PhD	20
School teacher	Male	PhD	22
School teacher	Female	Bachelor's	25

[Table/Fig-2]: Demographics of the expert panel involved in CVS-T module validation.

Expert panel	Appropriateness of font size	Neatness and layout of items	Ease of understanding
Optometrist (Public)	No additional comments	No additional comments	No additional comments
Optometrist (Public)	No additional comments	No additional comments	Include a summary at the end of each module, emphasising key points for teachers
Optometrist (Private)	No additional comments	No additional comments	No additional comments
Optometrist (Private)	No additional comments	No additional comments	No additional comments
Optometry lecturer	Satisfactory and appropriate	Satisfactory and clear	Satisfactory
School teacher	-Reduce spacing between headings. -The font size for headings is too large and should follow the UKM formatting style. -Use 1.5 line spacing and standardise the font to Times New Roman (UKM standard)	Items should be properly grouped to avoid misalignment	Good and easy to understand
School teacher	No additional comments	No additional comments	No additional comments

[Table/Fig-3]: Suggestions and feedback from the experts.

In Phase III, feasibility testing included participating secondary school counsellors and 13-year-old male students enrolled in Form 1 (Year 7).

Sample size calculation: The sample size was determined based on established guidelines for pilot and feasibility studies. Minimum thresholds of 12 participants per group [15] or 30–50 participants overall [16] were met by including 44 school children. The participation of two counsellors was deemed sufficient to evaluate usability and training delivery, consistent with feasibility principles, where small numbers of implementers can successfully demonstrate practicality [16].

Study Procedure

Screening was conducted in the school counselling room under standardised lighting conditions, with visual acuity assessed before colour vision testing. Re-screening of the student cohort was performed by an optometrist two weeks later. Theoretical instruction and a two-hour practical training session were provided to two secondary school counsellors before screening 44 male students. A single school was selected for accessibility and standardisation [14]. Demographics are summarised in the feasibility dataset. Counsellor feedback on clarity, relevance, and usability was collected and analysed thematically. Data collection for Phases I-II was conducted online, while Phase III was implemented face-to-face at the participating school.

To evaluate the consistency of screening outcomes, inter-rater agreement was assessed using Gwet's AC1 coefficient [17].

STATISTICAL ANALYSIS

Data were analysed using Statistical Package for Social Sciences (SPSS) version 23.0, with descriptive statistics used for demographics. Screening agreement between counsellors and the optometrist was evaluated using Gwet's Agreement Coefficient (AC1). Counsellor feedback regarding module relevance, clarity, simplicity, and ambiguity was analysed both statistically and thematically. Module validation was evaluated using CVI procedures, calculating item-level (I-CVI) and scale-level (S-CVI/Ave, S-CVI/UA) indices.

RESULTS

Expert recommendations regarding scope, procedures, and implementation feasibility were successfully incorporated into the final CVS-T Module. Following the analysis of qualitative data, accuracy was verified through a member-checking process with the expert panel [Table/Fig-4].

Subject	Key recommendations
What is the content of the CVS-T module?	i. Overview of CCVD ii. Challenges faced by school children with CCVD iii. Currently available management options iv. Role of schoolteachers v. Step-by-step procedure for visual acuity and colour vision screening
Should a pocket guide be developed so that teachers can easily refer to it when conducting visual acuity and colour vision screening?	Yes
What is the age of school children to be tested?	13-year-old/Form 1 school children; other school children to be tested upon request
Where will the test take place?	In the school counselling room, with good lighting
How often will visual acuity and colour vision screening be conducted?	Once, at the beginning of the year, for Form 1 school children
Who will conduct the visual acuity and colour vision screening?	Teachers (School counsellors)
What level of visual acuity will be used as the cut-off before proceeding to colour vision screening?	6/9 (0.2 logMAR) or better
How will the program be evaluated to ensure the accuracy of the results?	School children screened by the school counsellor will be re-screened by the researcher, who is also an optometrist, after two weeks, to prevent memorisation of the screening chart
Where will school children who fail the screening be referred to?	University Optometry Clinic
What is the impact of the program?	i. Early detection and referral of school children with CCVD; ii. Early support and counselling for school children with CCVD; iii. Reduction of emotional, behavioural, social, and academic problems caused by late diagnosis; iv. Cost-effectiveness

[Table/Fig-4]: Structured outcomes of expert consultation on CVS T module content and feasibility.

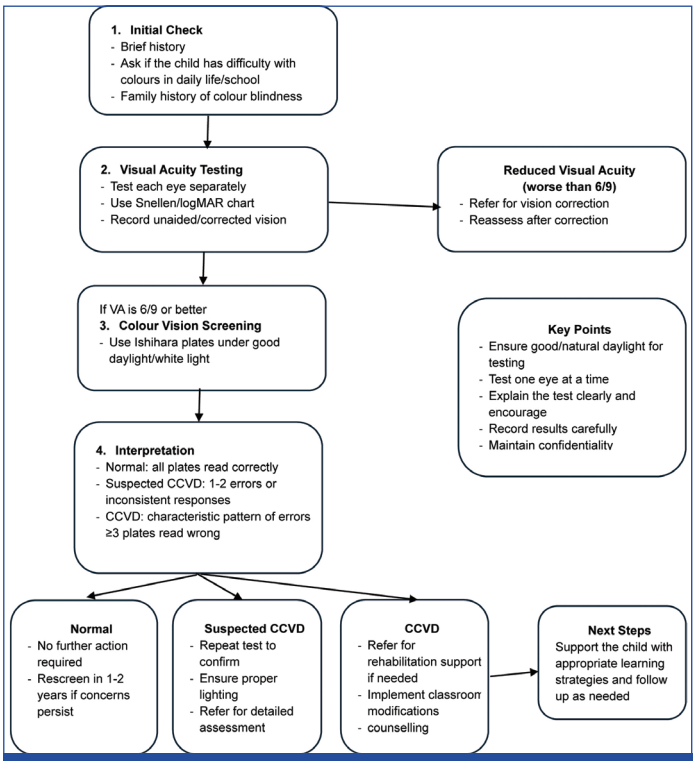
CVS-T module had S-CVI/Ave=1.0 and S-CVI/UA=1.0 for all four criteria (relevance, simplicity, clarity, and ambiguity). The high score of the CVI indicated the panel's agreement on the contents and met a satisfactory level [Table/Fig-5]. Step-by-step screening instructions are summarised in the pocket handbook to ensure procedural consistency [Table/Fig-6].

Qualitative feasibility analysis evaluated module implementation, counsellor acceptance, training effectiveness, and operational challenges. Following training, 44 consented male school children (aged 13 years) were screened by two counsellors [Table/Fig-7].

Both school counsellors and the optometrist correctly identified that none of the school children had CCVD, as shown in [Table/Fig-8]. High screening reliability was confirmed, demonstrating perfect agreement (AC1=1.0) between the trained counsellors and the optometrist. High acceptability was reported by the counsellors

Sub-module		Content
CVS-T-1	Congenital Colour Vision Deficiency (CCVD) - Overview	a) What is colour vision? b) How do we see colour? c) Normal colour vision d) Colour vision deficiency e) Inheritance of CCVD f) Types of CCVD g) Management of CCVD
CVS-T-2	Challenges faced by School children with CCVD	a) Why do school children with CCVD face challenges? b) What are the challenges faced by school children with CCVD? c) The role of schoolteachers in supporting school children with CCVD d) Conducting colour vision screening for all children upon entry to your school
CVS-T-3	Introduction to Visual Acuity and Colour Vision Screening	a) Visual acuity screening b) How is colour vision deficiency screening conducted? c) Examples of Ishihara pseudoisochromatic plate tests

[Table/Fig-5]: CVS-T modules and content.



[Table/Fig-6]: Structured screening workflow for detecting CCVD.

School counsellors' demographics (n=2)	Description	n
Gender	Male	1
	Female	1
Age (years)	25-39	1
	40-55	1
Ethnicity	Malay	2
Education level	Bachelor's	1
	Master's	1
Working experience (years)	5-10	1
	>10	1
School children's demographics (N=44)	**Description**	**n**
Gender	Male	44
Age (years)	13	44
Ethnicity	Malay	38
	Chinese	2
	Indian	4

[Table/Fig-7]: Demographics of the CVS-T module's feasibility study participants.

Variables			School counsellor (Screener 1)		
			CCVD		
			Present	Absent	Total
Optometrist (Screener 2)	CCVD	Present	0 (a)	0 (b)	0 (g1)
		Absent	0 (c)	44 (d)	44 (g2)
	Total		0 (f1)	44 (f2)	44 (N)

[Table/Fig-8]: Screening result comparison between school counsellors and an optometrist.

regarding module font, layout, clarity, and illustrative utility. Overall, the CVS-T module was shown to be an effective, structured training tool for equipping school counsellors to conduct visual acuity and colour vision screenings.

DISCUSSION

The CVS-T was developed to equip school counsellors with the knowledge and skills required for visual acuity and colour vision screening. Structured competency-based training principles were integrated to ensure both conceptual understanding and hands-on proficiency. Adaptability to school time constraints was demonstrated by the module's two-session, two-hour format. A theoretical foundation of CCVD, its educational impacts, and screening standards were established, while hands-on experience was provided during the practical component to facilitate skill transfer [18]. This balance between theory and practice remains essential when screening procedures are implemented by non-eye-health professionals.

Male students were specifically selected because congenital red–green colour vision deficiency is an X-linked recessive condition that occurs far more frequently in males than females [19]. Restricting the sample to boys increased the likelihood of detecting affected individuals and allowed for a focused evaluation within the highest-risk group. In line with a train-the-trainer approach [20], trained school counsellors are positioned as key agents to extend screening practices across the education system. Practical applicability and sustainability within real-world contexts are further enhanced by the inclusion of ready-to-use resources, including a pocket handbook and recording forms. A robust design was confirmed by face and content validity assessments among a multidisciplinary panel of seven experts (n=7). Face validity achieved 100% agreement, while content validity measures achieved the maximum score (I-CVI=S-CVI=1.0). While universal agreement is uncommon, this statistical outcome is attributed to the module being modelled directly on uncontroversial, well-established Ishihara-based clinical protocols [21,22]. Because the items represented operational translations of existing standard practices rather than novel methodologies, high rating convergence was facilitated among the experienced optometric and educational panellists. Mathematically, this consensus across the small panel size yielded a CVI of 1.00. However, because perfect indices can reflect rating scale ceiling effects, content validity should be interpreted as a single component of evidence rather than absolute proof of instrument robustness. The module's practical applicability is further supported by the accompanying feasibility study data.

High effectiveness in a school setting was demonstrated by the feasibility study, with trained counsellors reporting screening confidence comparable to that of an optometrist. Perfect inter-rater agreement (AC1=1.0) was achieved, which is attributed to the highly standardised administration, instructions, and scoring criteria embedded within the training module to minimise procedural variability. Although Gwet's AC1 was utilised to mitigate prevalence and marginal probability effects [17], this perfect agreement must be interpreted with caution due to potential ceiling effects inherent to structured screening tasks with dichotomous outcomes. This outcome aligns with literature emphasising the impact of supervised, practical training on skill acquisition in non health professionals [23]. Similar to the findings of previous studies, the integration of expert-led demonstrations with guided practice significantly improved screening performance [24,25]. In these studies, the trainer (an optometrist or ophthalmologist) first demonstrated the screening process, after which counsellors practised with another trained school counsellor and with actual school children, receiving direct feedback from the trainer. This approach is mirrored in the CVS-T Module, which aims to build competence and confidence while accommodating variability in school children's responses.

Limitation(s)

The generalisability of present study is constrained by the small, male-only sample drawn from a single urban school. While this design aligned with feasibility and standardisation goals, it limits external validity. Male students were selected because congenital red–green colour vision deficiency is an X-linked recessive condition with markedly higher prevalence in males; however, future studies should include both genders to provide a more representative assessment. The composition of the expert panel, which was heavily weighted toward practicing optometrists, may have introduced discipline-specific biases despite the inclusion of educational experts. The perfect inter-rater agreement (AC1=1.0) should also be interpreted with caution, as the absence of confirmed CVD cases in the sample likely inflated agreement statistics. In addition, the content validation process may have been affected by response bias or ceiling effects inherent to structured rating scales. To strengthen external validity, future research should employ multi-site recruitment, include diverse populations with confirmed CVD cases, and consider alternative validation approaches such as Delphi techniques or triangulated qualitative feedback.

CONCLUSION(S)

In conclusion, the CVS-T module is a valid, feasible, and effective resource for training school counsellors to conduct colour vision screenings. Its integration into school health services could facilitate CCVD early detection and referral, thereby reducing the impacts of late diagnosis. Future evaluations should involve larger, more diverse populations.

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PARTICULARS OF CONTRIBUTORS:
1. PhD Student, Centre for Community Health Studies, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.
2. Professor, Centre for Rehabilitation and Special Needs Studies, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.
3. Associate Professor, Centre for Community Health Studies, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.
4. Professor, School of Medicine, Faculty of Health and Medical Sciences, Taylor's University, Subang Jaya, Selangor, Malaysia.
5. Associate Professor, Centre for Community Health Studies, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Mohd Izzuddin Hairol,
Associate Professor, Centre for Community Health Studies, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia.
E-mail: izzuddin.hairol@ukm.edu.my

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