

An evaluation of a school based vision screening programme.

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DEDICATION

To Suraya

..... for being you !

Acknowledgements

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ABSTRACT.

The effectiveness of a vision screening programme in government schools in the Durban Functional Region under the jurisdiction of the House of Representatives was evaluated. For the purpose of the study a Comprehensive Vision Screening Programme (CVSP) was developed based on the Modified Clinical Technique (MCT) used in the Orinda Study.

Of the representative sample of 419 children assessed, the CVSP classified 85 (20.3%) as referrals. In comparison, the school health nurses referred 35 (9.6%) of the children for a complete ocular examination, 40 per cent of which were unwarranted.

Analysis of the usable records showed that the school vision screening programme (SVSP) correctly categorised 307 (83.9%) of the children and incorrectly categorised 59 (16.1%) of them. The latter consisted of 3.8% over-referrals and 12.3% under-referrals. The school vision screening programme did not detect with a reasonable degree of accuracy those children with visual disorders. The effectiveness of the SVSP, as determined by the phi coefficient, was 0.35.

Approximately two thirds of the children with visual disorders were not detected by the SVSP. One in every eight children classified as having no visual problem by the SVSP

was an under-referral and two in every five children referred by the SVSP were over-referred. The high incorrect referral rates was attributed to the use of inappropriate screening techniques.

The prevalence of visual disorders in the children was 20.3%; in boys 18.7% and 21.9% in girls. The relative risk of visual disorders in girls compared to boys was 1.2 (95% CI = 0.8 - 1.7). The prevalence of eye co-ordination disorders was 11.2%, refractive error problems 10.3%, visual acuity 4.5%, perceptual status (colour vision and stereopsis) 4.0% and organic disorders 1.2%.

The binocular disorders were characterised as convergence insufficiencies and the disorders of accommodation were described as accommodative insufficiencies. Referable myopia (6.7%) was more prevalent than referable hyperopia (2.1%). Myopia was more prevalent in girls and hyperopia was more prevalent in boys.

The clinical findings of the refractive error was compared to that measured by an autorefractor. The findings were remarkably similar and the study concluded that the difference between the two measures was not clinically significant. The study recommended that the MCT be used as the method of choice in school vision screening protocols.

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Chapter One: PURPOSE AND OBJECTIVES OF THE STUDY.

1.1 Introduction.

The United Nations General Assembly in 1979 endorsed the view that health is an important component of socio-economic development. Further, it was proposed that the goal of health for all by the year 2000 could be attained through the primary health care approach (United Nations, 1979).

The adoption of the Global Strategy for Health for All by the World Health Assembly in 1981 has resulted in the intensification of the worldwide effort directed at the orientation of health systems towards primary health care. This strategy resolves to provide levels of health that will allow all the people of the world to lead socially and economically satisfying lives (World Health Organisation, 1981).

In South Africa, the political transition towards a more humane and caring society provides a unique opportunity to redress the gross social inequities of apartheid. In so doing, it is envisaged that the new society will embrace, as one of its precepts, health as a basic human right.

As the transition to a caring society in South Africa takes root, many changes in the philosophy, organisation,

management and content of health care and health delivery systems need to occur.

The need to provide access to comprehensive health care services for the vast majority of destitute South Africans will occur within the context of limited state resources. This will influence the role of screening programmes as a means to overcome such limitations and will result in the review of the nature and content of screening programmes.

1.2 Screening.

Medical and other health professionals using their skills, knowledge and resources have long established screening programmes in their attempt to detect and confront disease in communities (Friedman, 1987).

The basic purpose of screening programmes is to separate from large groups of people those who have a high probability of having the disease under study, in order for them to undergo diagnosis and if diseased to receive treatment. In this way, screening programmes can also play a role in providing an entry point into the health care delivery systems for those who for political and socio-economical reasons might not have had access to health care.

Screening programmes are designed to be applicable to large groups of people and are therefore generally simple to administer, rapid to execute and inexpensive to implement. Screening tests are also generally less accurate and definite than the procedures and tests used by health professionals in order to arrive at a precise diagnosis. It is for this reason that public health professionals who initiate screening programmes are under special obligation to ensure that such screening programmes do more good than harm (Friedman, 1987).

1.3 Vision Screening.

One of the goals of community optometry is mandatory vision examination of all children for the presence of vision disorders. It may not be possible to realise this goal immediately or in a few years to come but practical steps need to be planned now (Schmidt, 1991).

Friedman, Bieder, David, and Sachs (1980) argue that vision screening programmes attempt to bridge the gap between those who get eye care and those who don't, but may need it. Whilst not necessarily disagreeing with this argument in essence, caution must be applied in order to avoid the creation of double standards, ie, screening for the poor and access to health care for those who can afford it.

If vision screening programmes are to effectively fill the absence of mandatory vision examinations then the programmes implemented must seek to offer the highest accuracy in identifying those that are in need of further attention (Fukai, Matsumoto and Neumaier, 1990).

Vision screening programmes, like all other screening programmes, attempt to divide the population under study into essentially two categories, those who fulfil certain predetermined referral criteria and those that do not. Vision screening programmes are non-diagnostic in nature and are less accurate than thorough vision examinations and will therefore result in correct referrals and incorrect referrals.

Incorrect referrals present many problems; in the case of over-referrals it results in considerable worry, anxiety, unnecessary costs and the inappropriate utilisation of eye care resources. Under-referrals result in undetected vision disorders and their sequelae, they produce a false sense of assurance, compromises the effectiveness and credibility of the screening effort and may lead to unnecessary additional expense. In general, the larger the number of incorrect referrals produced the less accurate and more expensive is the vision screening programme (Ehrlich, Simons and Reinecke, 1983).

Conclusion
Community optometry constantly seeks to prevent ineffective screening programmes from compromising vision screening and clearly communicates the limitations of vision screening. On the other hand, community optometry encourages attempts to investigate and improve procedures that show promise of being effective, reliable, valid, inexpensive, easy, and universally and uniformly applicable (Schmidt, 1990).

1.4 The purpose of the study.

The purpose of the study was to evaluate the vision screening programme for children in Coloured government schools. The existing vision screening methods practiced by the school health nurses were evaluated. It was envisaged that this evaluation would provide information for the improvement, if required, of the school-based vision screening programme undertaken by the school health nurses.

1.5 The objectives of the Study.

1.5.1 To develop a Comprehensive Vision Screening Programme (CVSP).

1.5.2 To obtain a random sample of primary schools which have been visited by the School Health Services within the previous six months.

1.5.3 To determine the visual status of each child in

Standard II in the selected schools using the CVSP.

1.5.4 To determine the reliability and accuracy of the school vision screening programme in detecting visual disorders by comparing it's results to that of the study.

1.5.5 To compare the clinical examination results with that of an autorefractor.

1.5.6 To make recommendations, if necessary, regarding school vision screening methods.

1.5.7 To contextualise this exercise within a broader framework of community optometry.

The standard for comparison was the Comprehensive Vision Screening Programme (CVSP) developed specifically for this study. The CVSP is an upgraded version of the Modified Clinical Technique (MCT) developed for use in the Orinda Study by Blum, Peters and Bettman (1959). The tests in the areas of visual acuity, binocular co-ordination (including convergence insufficiencies), accommodation (amplitude and flexibility), perception status (colour vision and stereopsis), refractive errors, and organic eye disorders.

1.6 The School Vision Screening programme (SVSP).

The target population for the study was chosen from Standard II pupils attending schools in Durban. Vision screening were performed by the school health nurses from the Department of Health, House of Representatives.

School health nurses from this department conducted vision screening in all schools under the auspices of the House of Representatives. In primary schools (from Class 1 to Standard V) compulsory vision screening is performed on children in Class II, Standard II and Standard V. On the rest of the children in primary schools vision screening is performed on a voluntary basis, ie, either requested by parent, teacher or child or if indicated by teacher observation.

Vision screening by the school health nurses consists of visual acuity testing using Snellen visual acuity charts and the detection of any observed manifest tropia or any external ocular pathology determined by direct observation. Visual acuity screening is performed on an "as is" basis, and performance is measured against the adequacy of any eye care previously received. However, for recording purpose, aided and unaided visual acuities are documented.

The referral criteria applied by the nurses in respect of visual acuity is 6/18 or worse for either eye, with 6/9 or 6/12 constituting borderline classification. Visual acuity testing is performed at a test distance of 6 metres and under normal room illumination.

All pupils who fail the school health vision screening programme (visual acuity of 6/18 or worse, any observed manifest tropia, any observed manifest external ocular pathology) are referred for a full visual examination. The parent of each such pupil is notified by letter of the need for their child to undergo a full visual examination. The parent is expected to ensure that their child is seen by either an ophthalmologist or optometrist of their choice. The consulted eye care professional is required to indicate the results of the visual examination together with any recommendations in writing to the school health nurses via the parent.

All pupils with visual acuities of either 6/9 or 6/12 are noted as borderline cases and are required to change their seating arrangements in the classrooms, so as to be seated as close to the class black-board as possible. In the light of this intervention all such pupils were for the purpose of the study evaluation also considered as referrals by the school health nurses.

A follow-up after three months is done by the school health nurses in which all the referrals and borderline cases are rescreened and a check is made to determine whether the recommendations, if any, of the eye care professional have been adopted.

Chapter Two: PUBLIC HEALTH OPTOMETRY - A THEORETICAL FRAMEWORK.

2.1 Primary Health Care.

The primary health care philosophy is based on the broader definition of health by the World Health Organisation as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1947).

Primary health care is defined as "essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country can afford to maintain at every stage of their development in the spirit of self-reliance and self-determination. It forms an integral part both of the country's health system, of which it is the central function and main focus, and of the overall social and economic development of the community. It is the first level of contact of individuals, the family and community with the national health system bringing health care as close as possible to where people live and work, and constitutes the first element of a continuing health care process" (WHO, 1978).

The primary health care approach is directed towards community development and participation. It is an attempt to reduce inequalities in access to health services and promotes an equitable distribution of health resources.

Public health optometrists based on the Declaration of Alma Ata (WHO, 1978) have attempted to derive the obligations of optometry and the responsibilities of individual practitioners in regard to primary health care. From a practitioner oriented perspective Catania (1990) suggests that the following parameters form the basis of the primary health care concept:

I. The point of entry into the health care system which includes the elements of accessibility and availability of health care;

II. The concept of comprehensive care, the ability of health providers to solve most of the patient's problems most of the time;

III. The co-ordination of care, the process whereby health providers take responsibility for assessing the needs and ensuring that other levels of care when needed are obtained;

IV. Accountability of providers to ensure longitudinal continuity of care, the delivery of quality health care, and to identify risks before they become problems;

V. The concept of humanistic care, the responsibility for advocating, counselling, educating, supporting the health care needs of people through concern and compassion.

DiStefano (1976) argues that within the context of primary care optometrists assume the following responsibilities:

- I. To provide an entry, screening, and referral point for the rest of the health care system;
- II. To seek not only to cure or alleviate specific complaints, but also to assume some responsibility for health maintainance;
- III. To concern themselves with human support services which are necessary for the effective utilisation of the health care system;
- IV. To serve as a focal point for coordinating and monitoring the continuity of care that patients require.

Catania (1990) further argues that there are three fundamental reasons which dictate the logic of using eye care as a primary health resource.

Firstly, virtually all people will need eye care at some point in their lives. Secondly, eye care provides for the evaluation, assessment and co-ordination of a broad spectrum of health care needs, including systemic disease, developmental, psychosocial and other related problems that affect the well-being of patients. Thirdly, the delivery of eye care is a non-threatening form of health care to people who are reluctant to seek general or preventive medical care.

It is for these reasons that optometrists, as an eye care providers profession, can coordinate several components of the health care team as they relate to a variety of patient needs and thereby ensure the continuity of overall patient care (Catania, 1990).

2.2 Public health Optometry

The International Optometric and Optical league (IOOL) defines an optometrist as "a person having qualifications in optometry which includes the measurement of errors of refraction, the recognition of departures from the normal, and the fitting and supplying of appliances designed to correct, remedy, or relieve errors of vision" (IOOL, 1974).

Whilst this description somewhat correctly underlines some areas of optometry's involvement it is completely lacking in any reference to the concept of health and more importantly to the optometry's societal obligations. As a starting point, the following social definition of Optometry as proposed by Haffner is offered:

"Optometry is one of society's evolved social institutions conceived with the status of a profession whose practitioners are formally trained with special skills and knowledge acquired during an extensive educational period. Normative

behaviour is acquired through a detailed acculturation process in which service to humanity has been established as a basic precept and the scope of its discipline concentrates upon the causes of and alleviation of human visual disability and the utility of the visual process to people as they function in society's varying and changing cultural patterns. Society, having placed a high premium upon vision and the seeing process, ascribes to the optometrist an important status and in return expects obligatory services in the advancement of knowledge and emphasis upon the welfare of the patient and the community" (Haffner, 1990).

This definition of optometry clearly establishes the nature of the profession as one requiring a mix of both acquired skill and knowledge. Further, it outlines the use of this knowledge and skill within the context of an obligatory social responsibility. This definition also places a responsibility on the profession to involve itself in the prevention of visual disability and the promotion of visual health and well-being of groups of people.

This orientation and understanding of optometry transforms the profession from one that deals with the "selling" of spectacles to that of a public health profession. By so doing, optometry gains entry into the public health domain as an equal partner sharing the noble and humane goal of

preventing and reducing discomfort, disability and disease in society and promoting the quality of life.

Accordingly, public health optometry is defined as "the use of the full scope of optometric services to prevent disease, to prolong life, and to promote health and efficiency of groups of people particularly at the community level" (Kleinstein, 1977). This definition is useful in that whilst it clearly sets out the goals of public health optometry, it also lays the basis for the development of its approach.

The strategic goals of public health optometry, namely, preventive, promotive, curative and rehabilitative, are located within a community-based approach. While public health optometry targets communities and groups of people, it does not view these groups of people or communities as the passive recipients of its services. Public health optometry holds community involvement in the assessment, planning, execution and evaluation of these services to be fundamental to its philosophy. Central to the community-based approach is the development of mechanisms and measures to inform and motivate communities so that they take greater responsibility for their health and well-being (WHO, 1987).

The philosophy of public health optometry is also formed by an understanding of the following factors (Marshall, 1982):

- I. The provision of optometric services (knowledge, skills and training) without any externally imposed limitations;
- II. The classification and recognition of vision disorders, including refractive errors and binocular anomalies as basic health problems;
- III. The definition of its role as part and parcel of an integrated health team involved in the provision of primary health care;
- IV. The recognition of and concern for the visual needs of special groups, such as the young, the elderly and the poor which is located within the context of their socio-economic levels and the environmental demands of their respective community settings.

These factors, in the main, determine the emphasis that public health optometry places on the provision of eye care. Public health optometry places a responsibility on the profession to provide eye care at three different levels. It is this multi-levelled orientation that ensures the comprehensive nature of public health optometry. The levels of responsibility of comprehensive optometry to patients and families are:

<u>Level of Responsibility</u>	<u>Type of optometric care</u>
1. Primary	Promotive and Preventive.
2. Secondary	Diagnostic, Treatment and limitation of visual disability.
3. Tertiary	Modification of the environment; rehabilitation.

Marshall (1985) describes these responsibilities as preventive interventions and states that primary prevention occurs at the prepathogenesis phase and prior to clinical manifestation of any signs and/or symptoms of pathological involvement. Primary prevention includes the basic elements of health promotion which is defined as any combination of health education and related organisational, economical or political interventions designed to facilitate behavioural and environmental changes conducive to health.

Marshall (1985) further states that secondary and tertiary prevention may be more appropriately described as disease control. These occur during the pathogenesis phase with either the early detection and treatment of disease (secondary prevention) or the limitation and rehabilitation of disease outcome (tertiary prevention).

The American Optometric Association (AOA) asserts that:-

"Optometric preventive care involves all phases of the practice of optometry. It is the arranging of conditions and

situations to allow the individual to function at his or her highest level of visual performance and may be provided at three levels" (AOA, 1980). The three levels as proposed by the AOA are:

I. Primary Optometric Preventive Health Care

Preventing the onset of vision conditions so that they will not be detrimental to the full development or utilisation of the individual's potential, and that visual performance be raised and enhanced to optimum levels.

II. Secondary Optometric Preventive Health Care

Preventing or reversing ongoing vision deterioration, so that any interference with the individual's potential would be reversed, and visual performance raised above minimum levels.

III. Tertiary Optometric Preventive Health Care

Preventing an existing vision condition from further deterioration, to ameliorate the seriousness of the disability and dependence resulting from reduced potential so minimum levels of visual performance are maintained.

As one would notice, the three levels outlined by the AOA coincides with Marshall's approach of the levels of preventive intervention as well as the multi-levelled optometric responsibility approach discussed earlier.

This multi-levelled approach of public health optometry influences and is linked to the form in which the delivery of vision care takes place. The three basic forms of the delivery of vision care, located within the philosophy of public health optometry are (Nussenblatt, 1981):

I. Community optometric services -

Optometric health activities focusing on population groupings, including community-based visual health promotion and protection programmes.

II. Personal optometric services -

Optometric health activities designed to restore and maintain optimal visual efficiency of the individual. Services included here are, individual prevention, detection and referral, diagnosis, treatment, rehabilitation and maintenance of visual health.

III. Optometric support services: -

Optometric health activities that facilitate the provision of vision care including activities that influence the way or conditions under which vision care services are delivered.

2.2.1 Community optometric services.

This form of delivery of vision care includes important aspects such as vision health education programmes and vision health promotion programmes. Community optometry seeks to increase the efforts of the profession to effectively inform and educate the community about vision health and preventive measures involving vision health care. This could take the form of encouraging the inclusion of vision health education courses in schools, vision education programmes activated through the media to focus on the proper usage of eyes and the recognition and avoidance of eye hazards.

This activity is also aimed at promoting a better quality of life in the family, the school, the community and the work place through the reduction of the burdens associated with undetected and uncorrected visual anomalies.

Public health optometrists adopt a dynamic approach in respect to visual health promotion and education and seeks the active participation of the profession in these areas of community optometric services. Further, public health optometry view these activities as basic health services and consequently encourages their inclusion in the delivery of health care services in primary health care environments.

The importance of these aspects of primary vision care is highlighted by the understanding of the visual requirements of people as they interact with their environment. For example, the need for adequate visual abilities of the infant and young child necessary for the development of reading skills. Further, the need for efficient visual skills of the older student since most learning is visually based, and the necessity for good vision which is essential for efficiency and productivity in the work place (Barlett, 1988).

Community optometry also defines its role and responsibility in the spheres of environmental and occupational health. Its involvement here includes activities such as: the development of standards for protective and industrial eyewear, the development of visual criteria required in the performance of various types of occupations, the promotion and the development of safer work environments. Other activities include: the revision and the development of new visual standards regarding the operation of motor vehicles, the visibility and the construction of street and highway signs, the effects of pollutants upon the eye and vision, criteria development regarding the installation and the use of various types of lighting fixtures in schools, homes and industry (Marshall, 1982).

Community optometry recognises that accidents and injuries are major contributors to mortality, morbidity and disability in both the industrialised and developing countries. It therefore seeks to prevent the loss of potentially productive years of life due to death or disability as a result of accidents (WHO, 1987).

2.2.2 Personal Health Optometric Services

This form of delivery of vision care is directed towards the individual and is based on the principles of equity, access and coverage. Community optometry holds that in the provision of personal health optometric services the profession must ensure the equitable distribution of optometric resources. Optometry must constantly seek to expand its accessibility to socio-economically and geographically disadvantaged groups, make available the full array of its skills and engender the optimum utilisation of its services.

In the provision of personal optometric services public health optometry is informed by and is sensitive to epidemiological research. Studies have shown that vision problems are much more prevalent among the poor than among those of higher income (AOA, 1976) whilst others have found

vision care to be one of the major unmet health care needs of low-income groups (Hankins, 1979).

Personal health optometric services include the interventions of detection and referral, diagnosis and treatment, rehabilitation and environmental modifications (second and third level of public health optometry responsibilities).

Detection optometric services are primarily vision screening activities. Community health optometry encourages the design and implementation of accurate and effective vision screening programmes for school children, adults (particularly the elderly) and industrial workers in high risk industries. Multiphasic and high risk screening programmes are also emphasised (Friedman, 1987).

Diagnosis and treatment services are for the identification, alleviation and limitation of visual disorders or disability. Community optometry encourages the diagnosis and treatment of visual disorders and vision-related learning disabilities of every child not only prior to school enrolment but also regularly during the school years.

It further argues that these services be made readily available and accessible to geographically disadvantaged and

socio-economically disadvantaged groups, including the poor, the young and the elderly. This implies the provision of these services to institutional populations as well, such as childrens' homes, homes for the aged and other non-conventional settings (Langer, 1970).

Rehabilitative and restorative services are designed to assist the visually disabled to return to optimum visual health and to his or her full potential and productivity. This entails the expansion of services to the blind or the visually handicapped and the encouragement of the profession to provide low vision care and other visual rehabilitative services to communities.

2.2.3 Optometric Support Services.

Optometric support services are essentially activities that facilitate or determine the form, nature and content of the delivery of optometric services. These activities include health care administration, optometry human resource development, economics and planning, epidemiology, research and community participation programmes.

2.2.3.1. Health care administration

The formal participation of optometry in the administration of health is crucial in order to correctly define and locate the role of optometry within the sphere of community health. It is at the administrative level that all major decisions that govern the overall utilisation and direction of optometry is made. Hence it is identified by community health optometrists as a key area of involvement.

Informed participation in the area of health administration should aim to achieve the inclusion of optometric services in all health care deliveries (eg., hospitals and polyclinics). Further, health administrators should also ensure that optometric services are provided at recognised and acceptable levels of standards to the profession. Administrators should develop a national health policy that provides for the vision-care of all those who need it.

2.2.3.2 Optometric research and epidemiology.

Epidemiology is the science that studies the distribution and the determinants of disease in human populations. Further, epidemiology attempts to "determine the multiple factors and the interrelationships associated with disease or disability, and seeks to control such disease or disability by the interception of these factors and their interaction at as many points possible" (Spencer, 1980).

Optometric epidemiology involves the study of the incidence and prevalence of visual disorders and the effects of these disorders upon the health of people in general and in regard to specific groups. Epidemiology also involves the generation of "risk factors" in relation to vision morbidity, the determination of visual morbidity profiles and the identification of the visually at-risk. Epidemiology also contributes to the development and implementation of accurate and effective optometric screening programmes for the early detection of visual disorders.

Optometric epidemiology attempts to contribute to the development of causation theories in regard to visual disorders and disease. Further, optometric epidemiology designs and evaluates by the use of scientific methodology interventions in the pursuance of alleviation, diagnosis and treatment of visual disorders.

Optometric epidemiology contributes to the evaluation of the profession in the delivery of its service, thereby assisting in the attainment of a more efficient and effective delivery of eye care.

Community optometry endorses the doctrine of Essential National Health Research (ENHR). The objectives of ENHR are (ENHR, 1991):

I. To improve the quality of life of the vast majority of the world's people who are poor, disadvantaged and deprived;

II. To enable these people, their families and their communities to take responsibility for their own health;

III. To focus national resources for research - human, institutional and financial - upon the health problems of these people; and

IV. To find solutions for these health problems which are realistic, effective and within national means.

This approach to research asserts that the process must include the participation of national decision makers, the research community and the people from the community whom the research is intended to assist. The essential national health research approach thus calls for effective linkage and dialogue amongst the representatives of these three constituencies. Some of the areas of research which could be included within this approach are:

I. Participatory research at the community level to identify and prioritise community health problems;

II. Epidemiological research at the national and sub-national

level to classify and quantify health problems as seen by health researchers;

III. Participatory research to rationalise epidemiological data with health needs and problems as defined by the community;

IV. Priority setting in respect of this rationalisation;

V. Policy analysis and economic research to establish appropriate health research policies to attempt to solve the problems;

VI. Operational research to improve health systems management and resource allocation;

VII. Communication research to effectively communicate the results of research to decision makers;

VIII. Policy analysis to institute the appropriate health policies aimed at achieving equity in health.

2.2.3.3 Optometric Human resource development, planning and economics

Marshall (1990) defined human resource rationalisation in regard to health care systems in terms of the available human resources required for the implementation of various aspects of health sciences and delivery. Many factors must be taken into account when evaluating health resource requirements. Assessments of optometric human resources must therefore be studied in relation to size and density of populations, demographic characteristics and trends, together with the demand, utilisation, availability, accessibility and distribution of optometric resources.

Public health optometry economics and planning are those activities that deal with the investigations into the cost of the delivery of vision care. The ever increasing cost of vision care in the conventional modes of delivery such as private practice constantly denies more and more people access to vision care. Community optometry seeks to make available and accessible to these people optometric services at costs affordable to them.

Public health optometry planning involves the development of more effective and efficient ways in the delivery of vision care and pays serious attention to optometry's participation in multidisciplinary care settings (Wilson and Hoffman, 1989).

Planning necessitates the evaluation of governmental and private enterprise spending in the provision of vision care. Planning also involves the assessment of optometric educational institutions in relation to their production, training, utilisation, ideological content and direction of optometric resources, together with an audit of the distribution and interaction of health care professionals within the context of primary health care (Hankins, 1979).

Chapter Three: VISION SCREENING PROGRAMMES : A REVIEW OF LITERATURE.

3.1 Vision Screening Methods.

Many different methods have been used by researchers to determine the prevalence of visual disorders in communities. The following is an updated list of the review of Blum et al (1959) and that of Schmidt (1990).

3.1.1 Symptoms Inventory.

A series of questions designed to detect the presence or absence of symptoms suggestive of vision problems.

3.1.2 Observation.

Observing the behaviour of children as they engage in visual related tasks, where signs of difficulty may reveal vision problems.

3.1.3 School Achievement.

School achievement is used as an indicator of vision problems, particularly at the reading level, when it is not commensurate with mental ability.

3.1.4 Paper and Pencil Test.

These require no content knowledge but only visual recognition of forms.

3.1.5 Visual Acuity.

Visual acuity methods involve the use of different sizes of figures or letters which the child is asked to identify. The ability of the child to identify such letters is then taken as a measure of the child's ability to see detail. Visual acuity is normally measured using Snellen acuity charts.

3.1.6 The plus sphere test.

The child is required to look through a pair of plus sphere lenses (1.50 DS to 2.50 DS) while viewing a Snellen acuity chart. If the child can see the 6/6 row on the chart then the child is considered to be hyperopic.

3.1.7 The Cover Test.

A test to assess the degree of co-ordination between the two eyes. The test can be conducted at both viewing distances, ie, at 6 meters and at 40 cm.

3.1.8 The Worth 4-dot Test.

A bichrome test of fusion that reveals problems in the co-ordination of both eyes.

3.1.9 The Maddox Rod Test.

This test determines the postural position of the eyes when fusion is interrupted; it, like the Worth 4-dot test is also used to detect eye co-ordination problems.

3.1.10 The California State Recommended Procedure.(CSRP)

This battery of tests includes testing in visual acuity, the plus sphere test, and an optional cover test.

3.1.11 The Massachussets Vision Test.(MVT)

This combination of tests includes testing in visual acuity, the plus sphere test, and the Maddox rod test at distance and near testing distances.

3.1.12 The Keystone Telebinocular.(TB)

A stereoscope and a series of double-picture stereograms test visual acuity, lateral imbalances (phoria), fusion, and stereopsis at optically projected distance and near fixation points. The Telebinocular also includes a rudimentary colour test.

3.1.13 The Bioptor.

A simpler stereoscope with pairs of slides similar in construction and test content to that of the Telebinocular.

3.1.14 The Ortho-Rater.(OR)

A stereoscope with pairs of slides similar in construction and test content to that of the Telebinocular.

3.1.15 The Sight-Screener.(SS)

A vision screening battery in the Brewster stereoscope form, similar in construction and test content to that of the Telebinocular.

3.1.16 The Vision Tester.

A stereoscope with pairs of slides similar in construction and test content to that of the Telebinocular.

3.1.17 The Modified Clinical Technique (MCT).

A modification of clinical procedures used in screening that includes assessment of visual acuity, refractive status, ocular co-ordination at distance and near, and inspection for pathology.

3.1.18 Random Dot Stereograms.(RDS)

Random dot stereograms are stereoacuity screening tests used to identify both reduced stereo acuity and binocular anomalies. In the application of the random dot stereogram test the functional outcome of vision, binocular performance, rather than a component of the process such as visual acuity, refractive state or fusion is evaluated.

3.1.19 The American Optometric Association Head Start Program. (AOA-HSP)

The AOA Head Start program (AOA, 1982) essentially favours the MCT and includes the screening of refractive errors, binocular vision problems, visual acuity, ocular health, and colour vision problems. The program also screens for ocular motor problems (pursuits and fixations), convergence insufficiency and convergence excess, facility of accommodation and near visual acuity (See Table 1).

3.1.20 Modified Clinical Technique with Preferential Looking Acuity.

In this variation of the MCT, designed essentially for pre-school populations, preferential looking cards (PL) are substituted for the Snellen acuity test to measure visual acuity in very young children (Schmidt, 1991).

3.1.21 Refraction screening.

Refraction screening by the use of traditional retinoscopy of infants and school-going children has also been used as a method of vision screening (Ingram, 1977). Refraction screening has the advantage of requiring only minimal co-operation on the part of the child or infant tested. However, refraction screening does not appear by itself to constitute an adequate screening measure (Ehrlich et al, 1983).

3.1.22 Photorefraction Techniques.

Photorefraction techniques employ a photographic retinoscopic procedure in which the retinal reflex, as seen in the pupil, is used to screen the refractive conditions and ocular alignment of young children. Kaakinen (1979) argued that photorefraction is a suitable method for screening young infants. This method holds promise as an effective screening method. However research is required to determine its adequacy as a single screening test or whether it can be used in combination with other tests. Further, refinement in accuracy of the procedure and lower cost instrumentation will also enhance the usefulness of this method.

3.1.23 Contrast Sensitivity Function Screening.

The CSF is a vision test that uses sine wave grating stimuli rather than letters or discs. The test consists of reducing the contrast of a grating until the threshold of visibility is reached. Contrast sensitivity is defined to be the reciprocal of threshold contrast. Legge and Rubin (1986) in evaluating the use of the CSF as a screening test, raised important questions concerning the scoring, accuracy, reliability and robustness of the CSF in screening situations. They concluded that the CSF cannot be of much value in vision screening until these questions are answered through further research.

3.1.24 The Pinhole method for visual acuity screening.

Although not commonly used for screening, the pinhole disc has been described by Loewenstein, Palmberg, Connett, Deborah and Wentworth (1985) as a highly effective method for visual acuity screening. They report that the false-positive rate of the Snellen acuity method is reduced by more than 50 per cent.

3.2 Selected Vision Screening Methods.

3.2.1 Visual Acuity Screening

The most widely used vision screening method is that of visual acuity by the means of Snellen letter acuity testing. Snellen acuity measurements are rapidly obtained, averaging approximately two minutes per child (Simons and Reinecke, 1974) and would appear to be an inexpensive method of screening since large numbers of people can be screened in short periods.

However, many studies such as the Orinda Study and the New York State Optometric Association Vision Screening Study (NYSOA) by Lieberman, Cohen, Stolzberg and Ritty (1983) showed that significant vision disorders remain undetected

when Snellen acuity is the sole determinant for referral or non-referral. Woodruff (1986) also showed while that 97.2 per cent of the children screened in his study demonstrated good visual acuity as measured by Snellen acuity charts, 13 per cent of them had refractive errors or other ocular anomalies requiring correction.

The criteria for passing or failing the Snellen acuity test also varies considerably depending on the cut-off point set by those who are administering the test. Pass-fail criteria vary from high standards set at 6/6 or better monocularly to low standards of 6/12 or better for either eye. Age related Snellen acuity standards are also widely used.

The St Louis Study by Crane, Scobee, Green and Price (1952) showed that even when high standards are used Snellen acuity screening results yielded a large number of incorrect referrals. They reported a 6.3 percent over-referral rate and a 14.3 per cent under-referral rate. The application of lower standards of Snellen acuity testing reduces the over-referral rate (1.0%) but increases the number of under-referrals (21.2%)(see Table 2).

Further, the Orinda study showed that nearly 50 per cent of all the children with referable vision problems remained undetected by Snellen acuity testing. The NYSOA study

reported that Snellen acuity testing correctly identified only 33 per cent of the true referrals, whilst Lieberman et al (1985) in a study designed to validate the NYSOA vision screening battery reported that Snellen acuity testing misses 75.5 per cent of the children found to have vision problems when given a complete visual examination.

There are many factors that may reduce the reliability of Snellen acuity testing, such as improper lighting, nonstandard contrast of the chart background to the test characters, variations in the testing distance and the level of training and performance of the examiner. Blum et al (1959) pointed out that whilst Snellen acuity may appear simple to administer, it is nevertheless a complex psychophysical measurement involving perception, judgment, and knowledge of the optics of the eye and the physiology of the photoreceptors and nervous systems.

Many other reasons have also been offered for the poor performance of Snellen acuity testing as a sole device in vision screening. These include the difficulty in obtaining accurate visual acuity measurements with Snellen acuity charts from young children (Schmidt, 1991); the complex nature of the relationship between visual acuity and refractive error (Blum et al, 1959); the drawback of requiring the use of an occluder which causes decreased

co-operation in many young children and the failure of visual acuity testing to distinguish between reduced acuity due to amblyopia and that due to simple refractive errors or visual immaturity (Ehrlich et al, 1983).

3.2.2 The Modified Clinical Technique (MCT)

The Modified Clinical Technique was developed during the Orinda Study and is essentially a modification of clinical procedures that screens in the areas of visual acuity, refractive error, eye co-ordination and organic or pathological problems. The battery of tests used in the MCT includes visual acuity testing (distance and near), retinoscopy, the cover test (distance and near) and ophthalmoscopic inspection for pathology or anomalies. The procedure used and the referral criteria applied are listed in Table 1.

The Orinda Study and the development of the MCT was an interdisciplinary effort to improve the effectiveness and validity of vision screening involving public health officials, optometrists, ophthalmologists, school psychologists, educators, biostatisticians and parents from the residential area of Orinda, California.

The MCT developed well defined clinical criteria for the

evaluation of vision screening. These criteria were derived from a comparison between the clinical data from the ophthalmologist's and optometrist's eye examinations, together with a major sampling of the opinions of optometrists and ophthalmologists (Peters, 1984).

The Orinda study showed that the MCT best determined which schoolchildren needed further visual attention and that when the results of the MCT was compared with clinical examinations conducted by both optometrists and ophthalmologists, 97.2 per cent of the children screened were correctly identified (17.2 per cent referrals with 80 per cent non-referrals) with only 2.8 per cent incorrect referrals. The effectivity of the MCT, as determined by the phi coefficient, established in the Orinda Study was +0.91. Hammond and Schmidt (1986) have demonstrated similarity and consistency of MCT results with those established in the Orinda study. The accuracies of other vision screening techniques are compared in Table 2.

The MCT has in many ways become the yardstick in respect to vision screening and is used as the method of vision screening in many parts of the world. Many studies have repeatedly shown that the MCT is by far the most reliable and valid method of vision screening for the detection of visual problems (Schmidt, 1991; Woodruff, 1986).

Schmidt (1991) in a study of pre-school populations showed that when preferential-looking cards are used as the method of assessing visual acuity instead of the conventional Snellen acuity charts then the overall effectiveness of the MCT as a screening procedure increased.

However, despite the proven success of the MCT, it is not yet widely used a school vision screening method. Ehrlich et al (1983) and the authors of the NYSOA Study criticise the MCT in so far as the procedure requires the services of an eye professional to perform the retinoscopy and ophthalmoscopy testing. They argue that the inclusion of an eye professional in the screening programme raises the cost of the screening effort to impractical levels and that screening should essentially be conducted by non-professionals utilising proper screening equipment.

3.2.3 Random Dot Stereogram Screening. (RDS)

Ehrlich et al (1983) stated that stereoscopic testing would appear in principle to be the most effective vision screening method, as it assesses the desired functional end result - normal binocular vision rather than a component of the binocular vision process, such as refraction.

Simons and Reinecke (1974) reported that a new type of stereotest, the random dot stereogram, was an effective screening method for amblyopia and strabismus where a 250 seconds of arc disparity was used. They showed that none of the 70 strabismus and amblyopia patients with visual acuity worse than 6/9 in either eye, interocular acuity difference of worse than one line between eyes, or constant tropia passed the test.

In a further investigation of this method Simons (1981) reported no under-referral of children with clinically significant binocular problems. Rosner (1977) also demonstrated the effectiveness of this method in a study designed to compare detection performance of the MCT to that of the Random Dot E (RDE) stereogram test. He reported that whilst the MCT required the services of vision professionals and the use of the cover, visual acuity and near point of convergence tests as the minimum regime required to detect all children with binocular abnormalities, the RDS test as a single test made the same number of correct referrals. The study further points out, that the RDS can be administered by non-professionals.

Hammond and Schimdt (1986) screened 483 school children using both the RDE stereogram test and the MCT. The validity of each technique was described using the phi coefficient and

was compared with similar reports in the literature for the MCT, Snellen acuity and other vision screening procedures. They found the effectiveness of the RDE to be +0.52 and showed that the RDE was more effective than all procedures studied except the MCT, whose effectiveness was found to be +0.91 (see Table 2).

Maslin and Hope (1990) in a study to determine the validity of the RDE as a screening test for reduced visual acuity, amblyopia and strabismus concluded that in school-aged children the RDE reliably detected all cases of amblyopia and strabismus. However, they reported that a significant number of children passed the RDE test despite reduced acuities and that the majority of these children had low degrees of myopia. They concluded that screening with the RDE in isolation would be inadequate.

The RDS screening methods are simple screening methods that could quite easily be taught to non-professionals, could be completed on each child in less than two minutes, requires no verbal responses, are reliable, safe, inexpensive and easy to use. It is for these reasons that further investigations into the effectiveness of RDE need to be carried out in order to make a final determination in this matter.

3.3 Brief Review of Selected Studies.

For the purposes of this evaluation three screening efforts are reviewed from the many studies reported in the literature. The first of these, the St. Louis Study, was an attempt to compare the results of various screening techniques available at the time to that of the clinical data obtained from an ophthalmologist. The second is the Orinda Study that produced the MCT which is fast becoming the accepted method of screening. The third is the NYSOA Study which attempted to produce a screening battery that screens those visual tasks that are important to the academic task demands and which could be administered without the need of a vision care professional. In this review no attempt is made to analyse any one study completely, rather the benefits of each of these outstanding studies to the field of vision screening are highlighted.

3.3.1 The St. Louis Study.

The St. Louis Study by Crane et al (1952) was one of the first substantive attempts to study the effectiveness of vision screening. The study compared the screening results of 1215 school children (drawn from two different grades) with the results of an ophthalmological examination. The study found that about 31 per cent of the school-children needed

some kind of visual attention or care. Further, the study reported that the prevalence of visual problems seemed to be higher in children drawn from the higher school grade than those from the lower school grade. However, it would appear that no consideration was given to the implications of previous vision care in the report.

When comparing the results of the various screening methods and the results of the clinical examination they found that the stereoscope screening instruments (the B&L Ortho-Rater, the AO Sight Screener and the Keystone Telebinocular) gave similar results; all of them over-referred more than the number of the correct referrals.

They found that the best method of screening to be the MVT which had a phi coefficient of +0.45. Teacher observation had a low phi coefficient of +0.15, whilst Snellen acuity coefficients varied from +0.43 to +0.35 depending on whether a high (6/6) or low (6/12) standard for the cut-off was used. The study found further that even the best screening method missed one third of all those children found to be in need of attention. The study also found that the number of incorrect referrals are reduced by retesting all those who failed the referral criteria during the initial trial.

Crane et al (1952) concluded that there was no effective vision screening method and recommended the Snellen visual acuity test as being the best for all conditions, with the MVT test being the instrument of choice if one of the multiple-test procedures is desired.

The St. Louis Study despite being an outstanding contribution to the field of vision screening does not, unfortunately, provide any guidelines to devise an adequate screening programme which is efficient in terms of its referral rate, ie, identifying those children who should have professional visual attention.

3.3.2 The Orinda Study.

The requirement by the State of California for adequate vision tests for all primary school children prompted a comprehensive longitudinal study into vision screening methods by Blum, Bettman and Peters, reported in 1959. This study, now considered to be a classic in the field of vision screening was called the Orinda Study due to the location of the effort in the Orinda Union School District.

Approximately 95 per cent of elementary school children in the district were chosen for the study, 1163 children were examined in 1954; of these, 1032 were tested again in 1955

and 941 of these were retested in 1956. In total, 941 children were tested longitudinally across a three year time-span.

Seven different screening methods were used in the study and the results were compared to the clinical findings of all referrals at the University of California School of Optometry and the Stanford University School of Medicine Department of Ophthalmology. As a result of this comparison, a highly effective series of tests and associated referral criteria collectively named the Modified Clinical Technique (MCT) was established. Of all the screening methods studied the MCT proved to be the most efficient.

The clinical criteria established in this study were derived from an analysis of the clinical data and the joint decisions of the study staff consisting of both ophthalmologists and optometrists. The clinical criteria chosen compared favourably with the criteria obtained from a survey on vision screening received from ophthalmologists and optometrists throughout the United States.

The need for professional visual attention was the basis for the evaluation of the screening referrals and decisions were described in terms of four criteria: visual acuity, refractive error, binocular co-ordination and organic eye

problems. A child was considered as a referral if the child failed to satisfy any of the established criteria listed in Table 1.

The study found that the incidence of vision problems increased with age at a rate of approximately 1.6 per cent a year and of the age group 5-7, 18 per cent had vision problems which increased to 31 per cent in the age cohort 13-15. Blum et al (1959) further reported that the vision measurements of children with vision problems changed more than they did for other children and concluded that those children with vision problems need the most frequent professional attention.

The Orinda Study reported that by far the most efficient screening method was the MCT in that it was the only method that detected essentially all the children with visual disorders who needed professional attention, and with a minimum of over-referrals. The comparison of the results of the MCT with clinical examinations conducted by both optometrists and ophthalmologists showed that the MCT correctly classified approximately 98 per cent of the children with only 2 per cent incorrect referrals. The Orinda Study referred 18 per cent of the children for further visual attention and classified 80 per cent as non-referrals. The effectiveness of the MCT established in this study was +0.91.

The Massachusetts Vision Kit was found to be the second most efficient method if both the test and retest technique is used. The retest reduces the number of referrals, in particular, the over-referrals more than the correct referrals thereby increasing the efficiency of screening. However only about one half of the correct referrals are identified by the MVK technique and there are relatively few over-referrals.

The Telebinocular's efficiency as a screening method is almost equivalent to that of the MVK and when administered with a retest technique it identifies slightly more of the correct referrals but increases the over-referral rate at the same time.

The California State Recommended Procedure was found to be the next best method in this study and appears to miss about 75 per cent of the correct referrals. The efficiency of the CSRP as a screening method increases when the retest technique is used and the over-referral rate can be minimised by eliminating the cover test from the protocol. The cover test was reported to give poor results when used by either teachers or nurses.

As far as the various forms of observations by either parent, teacher or school health nurse were concerned, the study

reported that these methods are of little value as screening methods. Questionnaires were found to be ineffective and the observations of the teachers and nurses proved to be inefficient. However, the study also found that the improved training and experience of those involved in screening resulted in increased efficiency of most screening methods.

The study recommended that a qualified professional examiner should be employed to screen, using the MCT, all children in the first grade of elementary school. All children classified as non-referrals by the MCT should be rescreened on an annual basis with the Snellen acuity test and all children failing the MCT should be referred for further professional attention. Thereafter the parents of children with known visual problems should receive a reminder that their children need regular professional attention at least once a year without screening. The study further recommended that the school health education programme should include material on visual health that influences parents to seek regular professional attention for those children with visual problems.

In a review of the Orinda Study, at a symposium on optometry's obligations in vision screening, Peters (1984) made the following points, which effectively summarises the

contribution of the Orinda study to the field of vision screening:

I. The Orinda Study was an outstanding interdisciplinary effort to establish vision screening validity. It involved public health officers, optometrists, ophthalmologists, school psychologists, educators, parents, school health nurses, biostatisticians and others. Such a mix of people, talents and disciplines that has not been duplicated before or since.

II. The Orinda Study sought to recognise the essential element of clinical criteria for evaluating vision screening.

III. It provided a detailed study of the effects of previous care on present visual performance in the population under study and supported the notion that all vision problems are chronic conditions requiring periodic, regular professional attention.

IV. The Orinda Study established that the best screening results are obtained when a professionally trained optometrist uses a MCT.

V. The study provided detailed guidelines on how to develop an "ideal" vision screening programme for primary school

children that was both efficient and cost effective.

VI. The Orinda Study showed that hyperopia of approximately 1.75 D or more does not decrease with age as was previously believed; the relation between spherocylindrical refractive error and visual acuity was shown to be a complex one and the natural history of vision problems in children from 5 to 15 years was established.

Many researchers have sought to improve on the criteria and methods of screening established by the Orinda Study. Schimdt (1991), using preferential-looking cards as a method of assessing visual acuity, established the effectiveness of the MCT as determined by the phi coefficient to be as high as +0.94.

The Orinda has also been criticised. Ehrlich et al (1983), argue that the MCT is more of a complete eye examination than a screening programme and that required services of vision professionals raises the cost of the screening effort to impractical levels. The study has also been criticised for excluding other clinical criteria for the detection of vision performance problems. Nevertheless, the Orinda Study and the associated MCT will remain as a sterling contribution to the development of appropriate and effective screening programmes.

3.3.3 The New York State Optometric Association (NYSOA) Study.

The NYSOA study in 1980 set out to develop a valid and reliable screening programme based on the visual needs of learning such as acuity, accommodation, muscle co-ordination, visual motor integration and other related skills such as colour vision.

The NYSOA study criticised other screening batteries on the basis that there is often no clear definition given for the areas or skills being tested, lack of cost effectivity, lack of clear cut referral criteria, and the need for highly trained personnel (in reference to the MCT). Based on these reasons the NYSOA study developed a battery of tests which was designed to screen a child's visual skills necessary for the learning process. The characteristic screen together with the tests used and referral criteria applied is given in Table 1.

In a pilot study, 500 school children were screened using the NYSOA screening battery. The screening was performed by students of the State University of New York's College of Optometry and by volunteers from the Parent Teacher Association who were trained by members of the project team. In addition to the screening, 147 children received a

comprehensive visual examination at the University's Optometric Clinic and the results of the examination were then compared to that of the screening effort.

The NYSOA Study reported that the screening battery correctly identified 98 children (sensitivity of 79 per cent) as requiring professional visual attention as compared to 33 children so identified by Snellen acuity testing (sensitivity of 26.6 per cent). Based on these findings the study concluded that the NYSOA screening battery is a more efficient instrument than the Snellen acuity test for school children.

In Lieberman et al (1985), the authors of the NYSOA study in an attempt to validate their screening battery, reported a sensitivity of 71.7 per cent and a specificity of 65 per cent. Further, they reported that the Snellen acuity test misses 75.5 per cent of the children found to have vision problems when given a complete visual examination.

However, despite the advantages of the NYSOA screening battery over the Snellen acuity test it tends on average (the results of the original and validation study taken together) to have excessive over-referral and under-referral rates which consequently reduce the overall effectiveness of the screening battery.

3.4 Conclusion.

A review of literature on vision screening shows that the procedures used for vision screening as well as their effectiveness vary greatly. Unfortunately the drawback to many vision screening programmes has been the disagreement between professionals as to what constitutes a valid screening programme particularly in terms of the referral criteria (Myrowitz, 1984).

However, vision screening from a public health perspective still represents an effective way to care for population groups who do not have easy access to health care delivery systems. As such vision screening programmes must therefore be designed in a manner that ensures optimal care for the population under study.

TABLE 1. VISION SCREENING PROCEDURES AND REFERRAL CRITERIA OF DIFFERENT SCREENING PROCEDURES.

1. Modified Clinical Technique (Orinda Study)		
Visual Acuity	6/12 or less either eye	
Refractive Error :		
Hyperopia	≥ + 1.50 DS	
Myopia	≥ - 0.50 DS	
Astigmatism	≥ 1.00 DS	
Anisometropia	≥ 1.00 DS	
Co-ordination Problems	Distance	Near
Tropia	Any	Any
Esophoria	≥ 5 pd	≥ 6 pd
Exophoria	≥ 5 pd	≥ 10 pd
Hyperphoria	≥ 2 pd	≥ 2 pd
Organic Problems	Any	
2. AMERICAN OPTOMETRIC ASSOCIATION (AOA)		
Ametropia		
Myopia	-0.75 DS	
Hyperopia	+2.00 DS	
Astigmatism	1.00 DC	
Anisometropia	1.00 DS	
Binocular Vision Dysfunction		
Tropia		
Heterophoria	Distance	Near
Esophoria	8 pd	8 pd
Exophoria	10 pd	12 pd
Hyperphoria	2 pd	2 pd
Sensory Perception		
Snellen Acuity	6/12 or less	
Colour Vision	Failure on any standard test	
Organic Ocular Health	Evidence of organic or infectious disease absence/abnormal retinal light response	

cont./

TABLE 1 (cont.). VISION SCREENING PROCEDURES AND REFERRAL CRITERIA OF DIFFERENT SCREENING PROCEDURES.

3. THE NYSOA VISION SCREENING BATTERY	
Visual Acuity	
Distance	6/12 less, either eye
Near	Same as above
Hyperopia (+1.50 DS test)	Less than 2 line blur of best distance acuity
Acc. Facility +/- 2.00 DS	Less than 6 cycles/min
Con. Insufficiency	Greater than 10 cms.
Stereopsis (Titmus stereo test)	7 or less on Wirt circles
Eye Track Skills (NYSOA K-D)	> 1 sd above age norm in NYSOA manual
Eye Hand Co-ordination visual motor co-ordination	Less than age norm as specified in manual
Colour Vision (Keystone)	Failure to read numbers
Keystone Telebinocular Skills	
Vertical Imbalance	As specified in manual
4-Ball Fusion Distance	As specified in manual
4-Ball Fusion Near	As specified in manual

TABLE 2. COMPARATIVE ACCURACY OF VARIOUS VISION SCREENING PROCEDURES (Schmidt, 1991).

STUDY	CORRECT REFERRALS			INCORRECT REFERRALS			EFFECTIV- ENESS
	TR (%)	NR (%)	TOT (%)	FP (%)	FN (%)	TOT (%)	PHI-COEFF
St. Louis Study (Crane et al, 1952)							
Clinical	31.0	69.0	100.0	0.0	0.0	0.0	+1.00
INSTRUMENTS							
MVK	17.3	57.3	74.6	15.7	9.7	25.4	+0.40
OR	24.5	38.5	63.0	30.5	6.5	37.0	+0.32
SS	23.5	42.0	65.5	27.0	7.5	34.5	+0.34
TB	20.5	40.1	60.6	32.9	6.5	39.4	+0.35
Snellen							
High	12.7	66.7	79.4	6.3	14.3	20.6	+0.43
Low	5.8	72.0	77.8	1.0	21.2	22.2	+0.35
ORINDA STUDY (Blum et al, 1959)							
Clinical	17.9	82.1	100.0	0.0	0.0	0.0	+1.00
MCT	17.2	80.0	97.2	2.0	0.8	2.8	+0.91
INSTRUMENTS							
MVK	13.5	49.3	62.8	30.8	6.4	37.2	+0.24
MVK (retest)	9.4	80.1	89.5	2.8	7.7	10.5	+0.59
TB	15.6	26.6	42.2	56.5	1.3	57.8	+0.20
TB (retest)	9.6	77.2	86.8	5.7	7.6	13.3	+0.52
NYSOA STUDY (Lieberman et al, 1983)							
NYOSA Battery	66.7	7.5	74.2	8.2	17.7	25.7	+0.19
Ohio State University Study (Hammond and Schmidt, 1986)							
RDE	10.6	75.4	86.0	8.1	6.0	14.1	+0.52
MCT	16.1	81.1	97.3	1.4	1.3	2.7	+0.91

Key :

TR = True referrals, NR = Non-referrals, TOT = Total,
FP = False positives, FN = False negatives.

Chapter Four: RESEARCH DESIGN AND METHODOLOGY

4.1 Background factors

The aim of this study was to evaluate the effectiveness of the current vision screening methods used by the school health nurses in order to improve the efficiency of the screening programme.

It was envisaged that this evaluation would yield useful information which would form the basis of the recommendations made to the relevant authorities. These recommendations pay particular attention to the development of more effective vision screening methods and to the training of the school health nurses in these methods.

Equally important, the study was also designed to determine the prevalence of visual disorders among primary school children under the care of the relevant school authority. The visual disorders targeted were: vision loss, eye co-ordination problems, refractive errors, organic abnormalities, colour vision and stereopsis disorders.

4.2 General Plan

For the purpose of the evaluation, a Comprehensive Vision Screening Programme (CVSP) was designed and developed based on the Modified Clinical Technique used in the Orinda Study. The CVSP includes the tests used in the Orinda Study but in addition incorporated tests in the areas of accommodation (amplitude and flexibility), perceptual status (colour vision and stereopsis) and convergence insufficiencies.

The tests included in the CVSP were performed by senior optometry students under the direct supervision of the author. Each child in Standard II who had been screened by the school health nurses within the previous six months was assessed. A child that failed any one of the tests comprising the CVSP was referred for a detailed clinical examination.

Parents of the children identified by the CVSP to be in possible need of visual attention were given a referral letter indicating the necessity for a detailed visual examination. A similar letter was sent to the school health nurse together with an offer of the services of the community clinic based at the University of Durban-Westville. The clinical examination were also performed by senior students under the supervision of optometrists based at the clinics.

In addition to the clinical examination the children were also tested on an auto-refractor. The results obtained by the auto-refractor were then compared to the refractive error findings of the clinical examination.

Based on the results of the clinical examination the need for visual attention was determined and reflected as a referral. The child was considered to have failed the CVSP or the clinical examination if visual performance did not meet the any one of the fail-criteria as listed in Table 3 and Table 4 respectively.

The author was confident that the CVSP's initial classification of non-referrals would closely approximate the true situation in the population under study. This was based on the already established high accuracy of the MCT, the inclusion of other tests in the CVSP and the modification of the pass-fail criteria of the visual acuity tests.

4.3 Definitions.

Correct referrals are defined as those children correctly categorised by the school vision screening programme and can be identified as referrals or non-referrals. Referrals (true positives) are those children correctly identified by the vision screening method as needing further visual attention

by failure to meet the criteria established for passing the screening. Referrals in this study are thus defined as those children in need of professional visual attention after having failed both the CVSP and the detailed clinical examination.

Non-referrals (true negatives) are those people correctly categorised by the vision screening method as needing no further visual attention by satisfying the criteria established for passing the screening. Non-referrals in this study are defined as those children who passed the CVSP or the clinical examination and are most probably not in need of professional visual attention.

Incorrect referrals are defined as those children not correctly categorised by the vision screening method and they could be identified as over-referrals or under-referrals. Over-referrals (false positives) are those children incorrectly identified by the school vision screening method as needing further visual attention, ie, referring children without vision problems.

Under-referrals (false negatives) are those children incorrectly identified by the vision screening method as needing no further visual attention, ie, missing children with vision problems (Schimdt, 1991).

Reliability or reproducibility refers to the consistency of the results produced by the screening procedure. Reliability is a measure of how closely a series of observations or measurements of exactly the same thing match one another (Friedman, 1987).

Validity or accuracy refers to the ability of the screening programme to correctly divide the screened population into those who may have and those who may not have vision problems. Validity is a measure of how closely the observations or measurements correspond to the actual state of affairs (Friedman, 1987).

The determination of referrals and non-referrals were then used as a basis for the evaluation of the efficiency of the school based screening programme as administered by the school health nurses.

4.4 The Target Population.

In terms of the objectives of this study, two important criteria were taken into account in determining the target population:

Firstly, the target population had to be geographically well

defined in relation to size and accessibility in order that a representative sample could be drawn. This was necessary for the development of a generalisable visual morbidity profile.

Secondly, a school-based vision screening programme performed by the school health nurses must have been administered throughout the target population. This was necessary for the evaluation of the school-based vision screening programme, the development of more effective vision screening methods and the training of the school health nurses in these methods.

The target population chosen for this study, based on the above criteria, was all Coloured pupils in Standard II residing in the Durban Functional Region (DFR).

The Standard II pupils were chosen as the target population because they were considered to be old enough to effectively participate in the CVSP yet were young enough to benefit from early diagnosis and treatment of visual disorders, in keeping with the recommendations of the American Optometric Association (AOA, 1976).

The Department of Health, House of Representatives, administers a school-based vision screening programme

throughout the target population. In the DFR there are 15 primary schools with a total of approximately 1700 Standard II pupils under the jurisdiction of the above authority.

4.5 Sampling Technique.

The sampling frame comprised all primary schools where vision screening was undertaken by the school health nurses during the 6 month period prior to the administration of the CVSP. A shorter inter-test cut-off interval would have restricted the sampling frame whilst the use of a longer inter-test cut-off period would have introduced into the evaluation possible error due to changes in visual status of the pupils.

Random sampling was used. Based on a population size of 1700 pupils a sample size of 212 was calculated using Epi Info¹ based on the following assumptions:

Alpha = 0.05

Prevalence of visual disorders = 10%

Relative error = 2.5%

Response rate = 90%

A representative sample was assured by over-sampling to a total of 419 pupils, ie, 25% of the total population.

¹ Epi Info is a public domain computer software package for epidemiology and disease surveillance. Centre for Disease Control Atlanta, Georgia.

Each school was allocated a unique number for sampling purposes. A random number table was used to select schools. As each school was selected a cumulative total of the number of Standard II children was obtained. When this cumulative total reached 419 no further schools were selected.

4.6 The Procedure of the CVSP.

Authorisation for the study was obtained from the Department of Health, House of Representatives based on the presentation of the study protocol to the school health nurses. Permission was obtained from the Principals of the selected schools, and ethical approval for the study was granted by the Ethics Committee at the University of Durban-Westville. Finally, informed consent for the testing of each child was obtained from their parents/guardians.

The Comprehensive Vision Screening Programme was administered by final year student clinicians from the University of Durban-Westville, supervised by the author. Fourteen student clinicians were needed on each screening day to undertake the tests at each of the eight stations. These stations were located in two classrooms provided by each school.

An organising committee was appointed to prepare and check apparatus and other necessities prior to screening, plan the

lay-out of each station, set up apparatus, and assign personnel to the different stations.

Each class of pupils was screened in turn. The pupils were accompanied by their teacher to the screening venue, where the teacher assisted in maintaining order while testing was in progress.

The first station was registration where the pupils were handed their pupil screening record forms. Student clinicians entered the name, age and gender of the pupil, the name of the school, the date and assigned a unique reference number to each pupil record form. Each pupil was required to spell their name out to the student clinician in order to avoid spelling errors and to elicit a degree of pupil participation in the screening programme. The pupils carried their forms from station to station.

The second station was visual acuity testing at distance and near. Student clinicians recorded the visual acuity of the pupil at far and near for the right eye (OD), left eye (OS), and binocularly (OU). For distance visual acuity testing a Clement Clarke Snellen Acuity chart was used at a test distance of six metres. Near visual acuity was tested using a reduced Snellen card. Both far and near acuity was recorded as a Snellen fraction on the record form with the threshold

of acuity defined as the Snellen line at which more than half the letters were correctly read. Illumination conditions approximated those under which the school health nurses conducted screening, ie, normal daylight conditions were used. For the purposes of the CVSP the criteria of 6/6 or less, for either eye, was chosen as the basis for referral or non-referral. However, for the clinical examination the criteria of 6/12 was used.

Station three was a combination of testing for near point of convergence (both the break and recovery values), amplitude of accommodation and accommodative facility.

The near point of convergence was tested using a fixation bead of approximately 6 mm diameter. The pupils were asked to watch the bead as it was moved closer towards their nose. The test was conducted thrice and if in two of these trials the pupil's response was such that either the subjective or the objective break point was over 10 cm or the subjective or objective recovery points were over 15 cms then the pupil's response was recorded as a fail and the appropriate area in the record form was checked.

The amplitude of accommodation was tested binocularly using the push-up method with an RAF rule. The test was also conducted thrice and recorded results were based on the

demonstrated repeatability in two such trials. If the measured amplitude of accommodation was greater than 8.00 diopters then a pass was checked on the record form, if not, a fail was recorded. The test was performed under day-light conditions with no effort to provide additional lighting at near.

McKenzie, Kerr, Rouse and Deland (1987) in a study designed to evaluate the reliability of accommodative facility testing concluded that baseline facility rates of subjects with below normal accommodative facility tend to fluctuate significantly from one testing period to the next. Further, Wick and Hall (1987) suggested that for the purposes of screening the often used criteria of 7 cpm maybe to high.

Based on the recommendation of the above two studies a pass-fail criteria of 5 cpm was chosen as the baseline for referral or non-referral.

Accommodative facility testing was performed binocularly whilst the pupil viewed a row of 6/9 letters on a reduced Snellen Acuity reading card at 40 cms. A \pm 2.00 D pair of flippers was used to create the binocular accommodative demand. The pupil was asked to look at the row of 6/9 letters through the flippers and was instructed to say "now" when the line was clear whilst the student clinician recorded the

number of times "now" was said per minute.

Testing only began after the pupil demonstrated an understanding of the procedure which consisted of not more than three flips. Each time the student said "now", the flipper was turned by the pupil clinician and the number of cycles per minute was noted. The cycles per minute was calculated by dividing the number of flips by 2, according to the following formulae: $[\text{cycles/min (cpm)} = \text{flips}/2]$. If at the end of the minute the pupil demonstrated an accommodative facility greater than 5 cpm then a pass was checked on the record form, if not, a fail was recorded. The test was performed under day-light conditions with no special effort to provide additional lighting at near.

Station four was the cover test performed both at distance and at near. For distance, the cover test was performed using a 6/9 target or the best acuity attainable by the pupil. The presence of a tropia, any lateral phorias greater than 4 prism diopters and any vertical phorias greater than 2 prism diopters were recorded and checked as a fail. At near, a reduced Snellen target of 6/9 was used at a distance of 40 cms. The presence of a tropia, an esophoria greater than 4 prism diopters, an exophoria greater than 8 prism diopters and a vertical phoria greater than 2 prism diopters were checked as a fail.

Prism bars and loose prisms were used to neutralise the presence of tropias and phorias. The test was performed under day-light conditions with no effort made to provide additional lighting.

Station five was designed for the testing of colour vision and stereopsis. Colour vision testing was performed using the screening portion of the Standard Pseudoisochromatic Plates for Congenital Colour Vision Defects distributed by Igaku-Shion. Screening was performed as prescribed by the manufacturer. A separate score sheet, supplied by the manufacturer, containing the responses of the pupil was attached to the screening record card. If the pupil failed the colour vision screening test, a defective response was checked on the record card.

Fine stereopsis testing was performed by the usage of the Frisby Stereotest as prescribed by the manufacturer. The 3mm thick plate was chosen providing a criteria of 75 sec arc stereoacuity at a viewing distance of 60 cms. The plate was presented to the pupil for the circle-in-depth identification. Testing only began after the pupil demonstrated an understanding of the test procedure and the assessment of the stereoacuity was determined by the pupil correctly identifying the circle-in-depth on three such presentations. If the pupil failed to correctly identify the

circle-in-depth in each of the three trials, fine stereopsis was recorded as absent on the screening record card.

Station six was refractive error assessment as determined by static retinoscopy. Student clinicians performed static retinoscopy by the usage of lens bars, and a plus 2 diopter working distance lens during the determination of the refractive status of the two principal meridians whilst the pupil viewed a distant Snellen acuity target of 6/60. The illumination was kept just bright enough to enable the clinician to record results on the screening record cards. Based on pre-determined criteria the refractive error was then classified either as a referral or non-referral.

Station seven was ocular health assessment. Student clinicians checked for pupillary light response, the near reflex, and any external or internal pathology. The detection of any abnormality or pathology constituted a fail and a subsequent referral.

Station eight, the final station, was the checking station where all record forms were scrutinised for recording errors and inconsistencies. Student clinicians based at this station also ensured that a letter from the Department of Optometry was sent to all parents of the pupils listing the performance of the pupil in the screening programme. For those pupils who

failed the CVSP, the letter explained the areas of failure and what kind of follow-up care was needed. In addition, a letter was also sent to the school health nurses indicating the results of the CVSP and the follow-up care needed.

After the screening programme was completed in each school, the school health nurse records for the pupils screened by the CVSP were obtained for purposes of the evaluation.

4.7 The referral criteria.

The criteria that were developed for the CVSP, and those used for classification of the referrals in the clinical examination are given in Tables 3 and 4 respectively.

4.8 Previous eye care.

The CVSP was applied on an "as is" basis, visual performance was measured against the adequacy of any eye care previously received. Pupils wearing spectacles who failed both the CVSP and the clinical examination were classified as a referral if the present care was inadequate and if further professional attention was indicated.

TABLE 3. THE FAIL-CRITERIA USED IN THE CVSP TO REFER CHILDREN FOR A CLINICAL EXAMINATION.

CHARACTERISTIC SCREENED	PROCEDURE TEST USED	REFERRAL CRITERIA
VISUAL ACUITY		
Distance	Snellen (6 metres)	< 6/6 either eye
Near	Reduced Snellen (40cm)	
BINOCULAR STATUS		
Distance		
Exophoria	Cover Test	= > 5 pd
Esophoria	Cover Test	= > 5 pd
Hyperphoria	Cover Test	> 2 pd
Tropia	Cover Test	Any Tropia
Near		
Exophoria	Cover Test	= > 8 pd
Esophoria	Cover Test	= > 2 pd
Hyperphoria	Cover Test	> 2 pd
Tropia	Cover Test	Any Tropia
Convergence Point		
Break	Fixation Bead (Push Up Method)	> 10 cms
Recovery		> 15 cms
Accommodation		
Amplitude	RAF Rule	< 8.00 D
Facility	*/_ 2.00 DS Flippers	< 5 cyl/min
Refractive Status		
Hyperopia	Retinoscopy	> +1.25 DS
Myopia		> -0.50 DS
Astigmatism		> 0.75 DS
Anisometropia		> 0.75 DS
Organic Problems	Ophthalmoscopy	Any Pathology
Perception Status		
Colour Vision	Pseudo-Isochromatic Plates	> 2 Incorrect
Stereopsis	Frisby Stereo Test	> 75 sec arc

TABLE 4. THE FAILED CRITERIA USED IN THE CLINICAL EXAMINATION TO CLASSIFY REFERRALS.

1.	VISUAL ACUITY	
	Distance	< 6/12 either eye
	Near	< 6/12 either eye
2.	BINOCULAR CO-ORDINATION	
	1. Distance	
	Exophoria	≥ 5 pd
	Esophoria	≥ 5 pd
	Hyperphoria	≥ 2 pd
	Tropia	any tropia
	2. Near	
	Exophoria	> 8 pd
	Esophoria	≥ 5 pd
	Hyperphoria	≥ 2 pd
	3. Near Point Convergence	
	Break	> 10 cms
	Recovery	> 15 cms
3.	PERCEPTION STATUS	
	Colour Vision	> 2 Incorrect Response (SPP)
	Stereopsis	> 75 sec arc
4.	REFRACTIVE ERRORS	
	Myopia	≥ -0.75 DS
	Hyperopia	$\geq +1.50$ DS
	Astigmatism	≥ 1.00 DS
	Anisometropia	≥ 1.00 DS
5.	OCULAR PROBLEMS	Any Problems

4.9 Follow-up care.

The school health nurse and the parent of each child classified as a referral (failing both the CVSP and the clinical examination) were notified by letter in which the findings were outlined and recommended action was suggested. All pupils in need of spectacle care were given a spectacle prescription and those in need of visual therapy were offered the services of the appropriate clinic run by the Department of Optometry at the University. No further follow-up was made to see if the recommended action or advice was taken.

4.10 Usable records.

Of the 419 pupils screened by the CVSP, there were for the purposes of the evaluation, 366 usable school health nurse records. Of the 181 pupils referred by the CVSP for a full visual examination, 162 pupils underwent the clinical examination conducted in the Department of Optometry at the University of Durban-Westville for which there were 149 usable school health pupil records.

4.11. Statistical Methods.

4.11.1 Evaluation of the SVSP.

Statistical measures such as sensitivity, specificity, false negative rate, false positive rate, positive predictive value, over-referral rate, negative predictive value, the under-referral rate and the phi coefficient were calculated (Allen, 1976). All the statistical measures generated for the school vision screening programme were measured against the findings of the clinical examinations.

Table 5 indicates the format used to analyse the results of the school vision screening programme as compared to the final diagnostic results.

TABLE 5. FORMAT USED TO EVALUATE THE SVSP RESULTS.

<u>SVSP Results.</u>	<u>The Study Findings.</u>		
	REFER	NON-REFER	TOTAL
REFER	a	b	a+b
NON-REFER	c	d	c+d
TOTAL	a+c	b+d	a+b+c+d

Key :
 a = true positive or referral
 b = false positive or over-referral
 c = false negative or under-referral
 d = true negative or non-referral

and where,
 sensitivity = $a/(a+c)$
 specificity = $d/(b+d)$
 false negative rate = $c/(a+c)$
 false positive rate = $b/(b+d)$
 positive predictive value = $a/(a+b)$
 over-referral rate = $b/(a+b)$
 negative predictive value = $d/(c+d)$
 under-referral rate = $c/(c+d)$
 phi-coefficient = $ad - bc/\sqrt{((a+b)(c+d)(a+c)(b+d))}$

Sensitivity of the school vision screening programme is defined as the ability of the programme to correctly identify those pupils with visual disorders and consequently in need of visual attention. Sensitivity is thus the proportion of true positives to the total number of affected children. The complement of sensitivity is the false negative rate and is the proportion of false negatives to the total number of affected children. The numerator of the false negative rate is the number of under-referrals.

Specificity of the school vision screening programme is defined as the ability of the programme to correctly classify those children without visual disorders as non-referrals. Specificity is thus the proportion of true negatives to the total number of nonaffected children. The complement of specificity is the false positive rate and is the proportion of false positives to the total number of nonaffected children. The numerator of the false positive rate is the number of over-referrals.

The positive predictive value of the screening programme is the proportion of the children with visual disorders among those who have been classified as positives by the programme. On the other hand, the over-referral rate is defined as the ratio of false positives to the total number of children screened positive by the screening programme and is the

complement of the positive predictive value.

The negative predictive value of the screening programme is the proportion of the children without visual disorders among those who have been classified as negatives by the programme. On the other hand, the under-referral rate is defined as the ratio of false negatives to the total number of children screened negative by the screening programme and is the complement of the negative predictive value.

In addition, another statistical measure, the phi coefficient (closely related to the chi square) could be used to determine the validity of the screening method. Values of the phi coefficient range from -1.00 to +1.00, the closer the value is to +1.00, the more valid the test (Schmidt, 1990).

4.11.2 Visual morbidity profile.

Prevalence of the different visual disorders detected is used to describe the visual morbidity profile. The prevalence rate is calculated by:

$$\text{Prevalence rate} = \frac{\text{number of children with visual disorder}}{\text{total number of children screened.}}$$

In the above calculation, the numerator included only those children who were derived from the denominator population.

In this study, the prevalence of visual disorders describes

were calculated in the total population, in boys and in girls.

The relative risk (RR) of the visual disorders in girls compared to boys is also presented. In this study relative risk is defined as the ratio of the prevalence of visual disorders in girls compared to that found in boys and is calculated by:

$$\text{Relative risk} = \frac{\text{prevalence of disorder in girls}}{\text{prevalence of disorder in boys.}}$$

The confidence interval² (CI) of the relative risk was measured at the 5% level of significance. Epi Info was used to calculate all rates and ratios. Further, the chi square test and where appropriate the Fisher exact test was used to determine statistical significance (alpha = 0.05).

4.11.3 Refractive error data analysis.

Analysis of refractive error data was based on the recognition of the matrix-variate nature of dioptric power (Harris, 1990). The statistical analysis of the refractive error data was performed at the Department of Optometry, Rand Afrikaans University.³

² In this study the confidence interval (CI) is written as:
(95% CI = lower limit - upper limit)

³ Professor Harris is based at this university and together with his colleagues have developed a computer software program that analyses refractive error data.

Chapter Five: RESULTS.

5.1 Effectiveness of the SVSP.

Of the 419 children assessed the CVSP classified 85 (20.3%) as referrals. In comparison, the school health nurses referred 35 (9.6%) of the children for a complete ocular examination, 40 per cent of which were unwarranted.

Analysis of the usable records (N=366) showed that the SVSP correctly categorised 307 (83.9%) of the children and incorrectly categorised 59 (16.1%) of them. The incorrect referrals consisted of: 3.8% over-referrals and 12.3% under-referrals (Table 6).

The sensitivity of the SVSP was 31.8% (95% CI = 31.7 - 31.9) as shown in Table 7. The proportion of children with visual disorders classified as negative to the total number of affected children was 68.2% (false negative rate).

The specificity of the SVSP was 95.3% (95% CI = 95.2 - 95.4). The proportion of false positives to the total number of children without visual disorders was 4.7% (false positive rate). The proportion of children with visual disorders classified as positive by the SVSP was 60.0% (positive predictive rate) and the over-referral rate was 40.0%.

TABLE 6. COMPARISON OF THE RESULTS OF THE SVSP IN RELATION TO THAT OF THE CVSP.

CVSP-STUDY			
SVSP Results	+	-	Total
+	21 (a)	14 (b)	35
-	45 (c)	286 (d)	331
Total	66	300	366

TABLE 7. STATISTICAL MEASURES COMPARING THE PERFORMANCE OF THE SVSP TO THAT OF THE CVSP.

	MEASURES	VALUE (%)
1.	Sensitivity	31.8 +/- 0.1
2.	False Negative Rate	68.2
3.	Specificity	95.3 +/- 0.1
4.	False Positive Rate	4.7
5.	Positive Predictive Rate	60.0
6.	Over-referral Rate	40.0
7.	Negative Predictive Value	86.4
8.	Under-referral Rate	13.6
9.	% Agreement	83.9
10.	% Disagreement	16.1
11.	Phi Coefficient	0.35

✧ The proportion of children without visual disorders classified as negative by the SVSP was 86.4% (negative predictive rate) and the under-referral rate was 13.6%.

5.1.1 The performance of SVSP against specific visual disorders.

The sensitivity of the SVSP in regard to visual acuity disorders was 69.2% and the specificity was 92.6% (Table 8). In comparison to other disorders the sensitivity of the SVSP to visual acuity disorders was the highest. For visual acuity disorders the SVSP under-referral rate was 1.2%.

The SVSP referred 51.5% of the children with refractive error disorders and correctly classified as negative 94.6% of the non-referrals. The SVSP under-referral rate for refractive error disorders was 5.4%.

The SVSP sensitivity and specificity in regard to eye co-ordination disorders was 22.5% and 92.0% respectively. The under-referral rate for eye co-ordination disorders was 9.4%.

The sensitivity and specificity of the SVSP to perception status disorders was 25.0% and 90.9% respectively. For these disorders the under-referral rate was 2.7%.

The SVSP showed a sensitivity of 33.3% and a specificity of 90.9% in regard to organic disorders. For organic disorders the under-referral rate was 0.6%.

TABLE 8. STATISTICAL MEASURES EVALUATING THE PERFORMANCE OF THE SVSP AGAINST EACH OF THE CRITERIA USED IN THE CVSP.

STAT MEASURE (SVSP)	VA	RE	BC	PS	OP
Sensitivity	69.2	51.5	22.5	25.0	33.3
False Negative Rate	30.8	48.5	77.5	75.0	66.7
Specificity	92.6	94.6	92.0	90.9	90.9
False Positive Rate	7.4	5.4	8.0	9.1	9.1
Positive Predictive Value	25.7	48.6	25.7	8.6	2.8
Negative Predictive	98.8	94.6	90.6	97.3	99.4
Under-referral Rate	1.2	5.4	9.4	2.7	0.6
% Agreement	91.8	90.7	85.4	88.8	90.2
% Disagreement	8.2	9.3	14.6	11.2	9.8
Phi Co-Efficient	0.38	0.45	0.15	0.10	0.12

KEY : VA = VISUAL ACUITY, RE = REFRACTIVE ERROR
 BC = BINOCULAR CO-ORDINATION, PS = PERCEPTUAL STATUS
 OP = ORGANIC PROBLEMS.

5.2 Prevalence of visual disorders.

The study sample consisted of 214 (51%) boys and 205 (49%) girls. The average age in both sexes was 9.9 years and the range varied from 9 years to 18 years.

The prevalence of visual disorders in the children assessed was 20.3%. Visual disorders were prevalent in 18.7% of the boys and in 21.9% of the girls. The prevalence of almost all visual disorders detected were higher in girls than boys,

however this difference was not statistically significant ($X = 0.5$, $p = \text{NS}$). The relative risk (RR) of visual disorders in girls compared to boys was 1.2 (95% CI = 0.8 - 1.7) as shown in Table 9.

The prevalence of eye co-ordination disorders was 11.2%, that of refractive error problems 10.3%, visual acuity 4.5%, perceptual status (colour vision and stereopsis) 4.0% and 1.2% in the case of organic problems.

5.2.1 Visual acuity.

The prevalence of binocular distance visual acuity was 1.7% and 0.7% in the case of binocular near visual acuity disorders. Visual acuity disorders were more prevalent in girls than boys. However, the difference in prevalence between the sexes was not statistically significant ($X = 2.3$, $p = \text{NS}$). The relative risk of visual acuity disorders in girls compared to boys was 2.3 (95% CI = 0.9 - 5.8).

A total of 98.3% of the children had binocular distance visual acuities of 6/9 or better (Appendix A, Table I). Among the CVSP referrals approximately 92.0% had binocular distance visual acuity of 6/9 or better (Appendix A, Table II). Similar visual acuity ratings were found in 86.0% of the children who had referable refractive error problems

(Appendix A, Table III).

There was no statistically significant difference (Fisher exact test; $p = \text{NS}$) in the binocular distance visual acuities measurements of boys and girls. Binocular distance visual acuity ratings of 6/9 or better were measured in 98.6% of the boys and in 98.0% of the girls (Appendix A, Table IV and Table V).

At visual acuity ratings of 6/12 or better no statistical significant difference ($X = 0.9$, $p = \text{NS}$) was found between right and left eyes. Binocular distance visual acuity ratings of 6/12 or better were measured in 96.9% and 98.0% of right and left eyes respectively (Appendix A, Table VI and Table VII).

There was no statistically significant difference ($X = 0.9$, $p = \text{NS}$) in the prevalence of binocular distance visual acuity disorders compared to that of near visual acuity disorders. However, the relative risk of distance visual acuity disorders in children compared to that of near visual acuity disorders was 2.3 (95% CI= 0.7 - 8.9).

Binocular near visual acuity ratings of 6/9 or better were demonstrated by 99.3% of the children (Appendix A, Table VIII). Similar visual acuity ratings were measured in 96.4%

of the total referrals and in 95.3% of the children referred for refractive error disorders (Appendix A, Table IX and Table X).

There was no statistically significant difference (Fisher exact test; $p = \text{NS}$) in the binocular near visual acuity measurements between the boys and girls. Binocular near visual acuity ratings of 6/9 or better were measured in 99.6% of the boys and in 99.0% of the girls (Appendix A, Table XI and Table XII).

At visual acuity ratings of 6/9 or better no statistically significant difference ($X = 1.9$, $p = \text{NS}$) was found between right and left eyes. Binocular near visual acuity ratings of 6/12 or better were measured in 98.2% and 99.1% of the right and left eyes respectively (Appendix A, Table XIII and Table XIV).

5.2.2 Binocular eye co-ordination disorders.

Binocular co-ordination disorders were prevalent in 11.2% of the children. The prevalence was higher in girls (13.6%) than boys (8.9%) but this difference was statistically not significant ($X = 1.6$, $p = \text{NS}$). However, the relative risk of binocular co-ordination disorders in girls compared to boys

was 1.5 (95% CI = 0.9 - 2.7).

The prevalence of near point convergence (NPC) problems was 2.9%. No statistically significant difference was found between the NPC break and recovery values ($X = 0.1$, $p = \text{NS}$) or between the sexes ($X = 0.9$, $p = \text{NS}$).

While none of the children had vertical phoria disorders, 5.7% had lateral phoria disorders. The prevalence of lateral phoria disorders were higher at near than at distance (48% vs 0.9%). This difference was statistically significant ($p < 0.01$) and the relative risk of near phoria disorders compared to that of distance phoria disorders in children was 5.0 (95% CI = 1.8 - 14.5).

The prevalence of exophoria was higher than that of esophoria at both distance and at near. At near, this difference was statistically significant ($p < 0.01$). No statistically significant difference was found in the prevalence of phoria disorders between the sexes ($X = 1.07$, $p = \text{NS}$). However, the relative risk of near exophoria in girls compared to boys was 1.8 (95% CI = 0.7 - 4.4).

The mean distance lateral phoria was 0.41 prism diopters (pd) of exophoria in the total sample, 0.38 pd exophoria for boys and 0.43 pd exophoria for girls. For both boys and girls the

mean distance vertical phoria was orthophoria.

The mean near lateral phoria in the sample was 2.2 pd exophoria, in girls 2.48 pd exophoria and in boys 1.78 pd exophoria. As in the case of the distance values, the mean near vertical phoria was orthophoria.

Tropias were prevalent in 5.0% of the children and all the tropias detected were lateral. The prevalence of lateral tropias were higher at near than at distance (3.6% vs 1.4%). This difference was statistically significant ($p < 0.05$) and the relative risk of near lateral tropias compared to that of distance lateral tropias in children was 1.7 (95% CI = 0.7 - 3.8).

The prevalence of exotropia was higher than that of esotropia at near but not at distance. The difference in prevalence at near was not statistically significant ($X = 1.1$, $p = \text{NS}$). The relative risk of near exotropia to near esotropia in children was 2.0 (95% CI = 0.7 - 5.8).

The overall prevalence of accommodative disorders was 5.7%; of these 3.1% were accommodation facility disorders and 2.6% were amplitude of accommodation disorders. The difference in the prevalence of accommodative disorders in boy and girls was statistically significant ($p < 0.05$) and the relative

risk of these disorders in girls compared to boys was 3.9 (95% CI = 1.5, 10.4).

5.2.3 Perception status disorders.

The prevalence of perception status disorders was 4.2%; colour vision (2.4%) and stereopsis (1.9%). The difference in the prevalence of colour vision disorders between boys and girls was not statistically significant (Fisher exact test; $p = \text{NS}$). However, the relative risk of colour vision disorders in boys compared to girls was 1.5 (95% CI = 0.4 - 5.0).

The prevalence of stereopic disorders was higher in girls (2.9%) than boys (0.9%), though this difference was not statistically significant (Fisher exact test; $p = 0.2$). Fine stereoacuity was absent in 21.7% of the children that had eye co-ordination disorders (excluding accommodative disorders).

5.2.4 Refractive error disorders.

5.2.4.1 Prevalence.

Referable refractive errors were prevalent in 10.3% of the children. The prevalence of refractive errors was higher in girls (10.7%) than boys (9.8%); this difference was not statistically significant ($X = 0.1$, $p = \text{NS}$).

Referable myopia was prevalent in 6.7% of the children and 2.1% had hyperopia requiring correction. This difference was statistically significant ($p < 0.01$) and the relative risk of myopia compared to hyperopia in the children was 3.1 (95% CI = 1.5 - 6.5). The relative risk of referable hyperopia in girls compared to boys was 1.3 (95% CI = 0.4 - 4.8) whilst referable myopia was relatively evenly distributed between the sexes.

The prevalence of astigmatism requiring correction in the children was 3.8% and this was higher in girls (5.4%) than boys (2.3%). Although this difference was not statistically significant ($X = 1.9$, $p = \text{NS}$) the relative risk of referable astigmatism in girls was 2.3 (95% CI = 0.8 - 6.5).

The prevalence of referable anisometropia was 4.0% in the children and this was also higher in girls (5.4%) than boys (2.8%). This difference was not statistically significant ($X = 1.2$, $p = \text{NS}$) and the relative risk of referable anisometropia in girls compared to boys was 1.9 (95% CI = 0.7 - 5.1).

TABLE 9. SEX SPECIFIC PREVELENC (PREV) OF THE VARIOUS VISUAL DISORDERS DETECTED.

NO	VISUAL DISORDER	PREV IN SAMPLE	PREV IN GIRLS	PREV IN BOYS	RELATIVE RISK	CI=95% LOWER ; UPPER	
1	VA:Dist/Near	4.5	6.3	2.8	2.3	0.9 ; 5.8	
	Dist VA (OU)	1.7	1.9	1.4	1.4	0.3 ; 6.2	
	Near VA (OU)	0.7	0.9	0.5	2.0	0.2 ; 22.8	
2	Eye Co-ord.	11.2	13.6	8.9	1.5	0.9 ; 2.7	
	NPC (Break)	2.9	3.9	1.9	2.1	0.6 ; 6.8	
	NPC (Recover)	2.9	3.9	1.9	2.1	0.6 ; 6.8	
	Dist. Lateral Phoria:	0.9	1.5	0.5	3.1	0.3 ; 29.9	
	Exophoria	0.9	1.5	0.5	3.1	0.3 ; 29.9	
	Near Lateral Phoria:	4.8	6.3	3.3	1.9	0.8 ; 4.7	
	Exophoria	4.3	5.8	3.3	1.8	0.7 ; 4.4	
	Esophoria	0,5	0.5	0.0			
	Dist Tropia:	1.4	1.4	1.4	1.0	0.2 ; 5.1	
	Exotropia	0.7	0.5	0.9	0.5	0.1 ; 5.7	
	Esotropia	0.7	0.9	0.5	2.1	0.2 ; 22.8	
	Near Tropia:	3.6	3.9	3.3	1.2	0.4 ; 3.2	
	Exotropia	2.4	1.9	2.8	0.7	0.2 ; 2.4	
	Esotropia	1.2	2.0	0.5	4.2	0.5 ; 37.1	
	Amp of Acc.	2.6	4.4	0.9	4.7	1.1 ; 21.5	
	Acc Facility	3.1	4.9	1.4	3.5	1.0 ; 12.5	
	3	Perceptual Status	4.2	4.9	3.3	1.5	0.6 ; 3.8
		Colour Vision	2.4	1.9	2.8	0.7	0.2 ; 2.4
		Steropsis	1.9	2.9	0.9	3.1	0.6 ; 15.3
	4	Refract.Error	10.3	10.7	9.8	1.1	0.6 ; 19.3
Myopia		6.7	6.3	7.0	0.9	0.4 ; 1.8	
Hyeropia		2.1	2.4	1.9	1.3	0.4 ; 4.8	
Astigmatism		3.8	5.4	2.3	2.3	0.8 ; 6.5	
Anisometropia		4.0	5.4	2.8	1.9	0.7 ; 5.1	
5	Organic Problems	1.2	1.4	0.9	1.5	0.3 ; 9.3	
6	TOTAL	20.3	21.9	18.7	1.2	0.8 ; 1.7	

5.2.4.2 Mean refractive errors.

In the right eyes of the children the mean refractive error (sphere/cylinder x axis) was + 0.05 DS/ -0.02 DC x 155 and in the left eyes + 0.09 DS/ - 0.03 x 18 (Table 10).

There was no statistically significant difference, ($\alpha = 0.05$, Snedecor's F-distribution = 2.6), between the refractive error means of the two eyes. The test statistic (w) for dioptric power was considerably smaller when left eyes were reflected ($w = 0.426$) as compared to unreflected left eyes ($w = 2.36$). Stated differently, after body symmetry was taken into account the not statistically significant finding between the mean refractive error of the right and left eyes was more strongly demonstrated.

The mean refractive error for boys (right eye) was + 0.12 DS/ -0.02 x 2 whilst that for girls was pl/ -0.04 x 140 (Table 11). Although the mean refractive errors between the sexes was not statistically significant, boys are slightly more hyperopic than girls. Further, girls are slightly more astigmatic than boys and the direction of the astigmatism on average appears to be "oblique" in girls as compared to "with-the-rule" in boys.

TABLE 10. MEAN REFRACTIVE ERROR FOUND IN RIGHT AND LEFT EYES.

EYE	SPHERE	CYL	AXIS
RIGHT	+0.05	-0.02	155
LEFT	+0.09	-0.03	18

TABLE 11. RIGHT AND LEFT EYES MEAN REFRACTIVE IN BOYS AND GIRLS.

EYE	BOYS			GIRLS		
	SPHERE	CYL	AXIS	SPHERE	CYL	AXIS
RIGHT	+0.12	-0.02	2	0.00	-0.04	140
LEFT	+0.16	-0.03	178	+0.03	-0.04	34

5.2.4.3 Frequency distribution.

Myopia was found in 25.3% of the children, hyperopia in 57.3% and emmetropia in 17.4%. Myopia was more prevalent in girls (27.8%) than boys (23.9%) however this was not statistically significant ($X = 0.6$, $p = NS$). On the other hand, hyperopia was more prevalent in boys (60.2%) than girls (54.1%) and this was also not statistically significant ($X = 1.4$, $p = NS$). Although no statistically significant difference ($X = 0.1$, $p = NS$) was found between the sexes, emmetropia was higher in girls (18.0%) than boys (16.8%).

The frequency distribution curve of the nearest equivalent spheres in the sample for right eyes shows that the curve is skewed towards the myopic side and the highest peak is at

plano (Appendix A; Table XV).

Astigmatism was found in 32.2% of the children. The highest frequency of the astigmatic refractive error was at 0.25 DC (14.5%) followed by 0.50 DC (12.2%). In the astigmatic population 47% had with-the-rule astigmatism, 28.4% against-the-rule and 24.6% oblique astigmatism (Appendix A, Table XVI and Table XVII).

5.2.4.4 Clinical vs Auto-refractor findings.

The mean of the difference between the clinical and auto-refractor in the right eye was +0.22 DS/-0.22 x 87 and +0.21 DS/ -0.24 x 76 in the left eye (Table 12). These means were obtained by averaging the difference of the auto-refractor findings from that of the clinical findings.

Whilst no statistical test was performed to determine whether these findings were significantly different, by observation the study concluded that the difference was not clinically significant.

TABLE 12. MEAN OF THE DIFFERENCE BETWEEN THE CLINICAL AND AUTO-REFRACTOR FINDINGS OF THE REFRACTIVE ERROR.

EYE	SPHERE	CYL	AXIS
RIGHT	+0.22	-0.22	87
LEFT	+0.21	-0.24	76

5.2.5 Organic disorders.

The prevalence of organic disorders was 1.2 % and no statistically significant difference (Fisher exact test: p = NS) was found between the sexes. The organic disorders found were two lenticular opacities, a hordeolum, a pterygium and a corneal opacity.

Chapter Six: DISCUSSION.

6.1 Evaluation of the SVSP.

The prevalence of visual disorders in school children found in this study (20.3%) is consistent with the findings of visual disorders in children assessed in other countries. In Californian school children a prevalence of 21% was reported (Blum et al, 1959), in Canadian children from the province of New Brunswick a prevalence of 27% was found (Woodruff, 1986) and in Australian school children from the province of Queensland a prevalence of 27% was reported (Macfarlane, Fitzgerald and Stark, 1987b).

The referrals of the school health nurses in the comparative sample (9.6%) is consistent with their findings in the total population of children screened (9.4%). This substantiates the representativeness of the sampling procedures used in this study and adds credibility to the findings.

The overall performance of the SVSP (phi coefficient: 0.35) is poor and the high percentage of incorrect referrals compromise the screening effort. The poor performance of the SVSP is the result of the use of Snellen letter acuity as a basis for referral (Crane et al, 1952).

The school health nurses did not detect with a reasonable degree of accuracy those children with visual disorders (low sensitivity). On the other hand, the school health nurses detect with a high degree of accuracy those children with normal vision (high specificity).

Approximately two-thirds of the children with visual disorders are not detected by the SVSP, resulting in an excessively high under-referral rate. One in every eight children classified by the SVSP as having no visual problem was an under-referral. Two in every five children referred by the SVSP were over-referred. The high incorrect referral rates is attributed to the usage of inappropriate screening techniques.

One would have expected, due to the low standards of Snellen visual acuity ratings used in the SVSP, a higher number of under-referrals than obtained (Schmidt, 1990). The lower percentage of under-referrals found could be attributed to the inclusion of other criteria in the SVSP battery. Further, it is possible that the experience of the school health nurses in vision screening is a positive contributor to the effectiveness of the effort.

The SVSP's low sensitivity to eye co-ordination disorders (the visual disorder with highest prevalence) is due to

"nurse observation" as the basis of referral. Researchers have reported that gross observation of the eyes as a screening procedure for strabismus produce high over-referral and under-referral rates (Ehrlich et al, 1983). Studies have shown that only about 50% of strabismic children have a cosmetically noticeable defect (Ingram, 1977). Further, Reinecke (1979) suggests that a manifest deviation must be at least 7 degrees to be detected by observation even by trained clinical observers.

The low sensitivity of the school vision screening protocol to eye co-ordination problems is a major contributor to the high under-referral rate. Similar findings were reported in a study by Macfarlane, Fitzgerald and Stark (1987a).

An investigation into the relationship of visual acuity and eye co-ordination disorders showed that the usage of a 6/12 Snellen acuity referral criterion will refer approximately 50% of the children with eye co-ordination problems. Screening techniques other than Snellen acuity testing must therefore be used in order to detect those children with co-ordination disorders without visual acuity loss.

In this regard the training of the school health nurses in the use of the cover test or similar techniques could contribute to their detection of eye co-ordination disorders.

These two simple interventions (higher standards of acuity ratings and the use of the cover test) will improve the ability of the school health nurse to detect eye coordination disorders in children.

The SVSP refers only about half of the number of children that present with referable refractive error problems. This finding taken together with the high sensitivity of the SVSP to visual acuity problems supports the argument that the relationship between refractive error and visual acuity is a complex one.

Data from the Orinda Study show that significant refractive error will remain undetected when visual acuity is the only criterion for referral or non-referral. The results of this study show that visual acuity loss does not always accompany the presence of a referable refractive error problem.

It can be reasonably assumed that the school health nurses using higher standards of Snellen letter acuity ratings (for example 6/12) would detect almost all of the children that present with visual acuity disorders. However, this in itself would not significantly contribute to an increased effectiveness of the screening effort since a high percentage of the children with referable visual disorders demonstrate acceptable standards of visual acuity (6/9).

It is also interesting to note that undetected refractive error problems contribute significantly to the under-referral rate of the SVSP. On the other hand, undetected visual acuity disorders did not influence the under-referral rate.

The results of the comparison between the autorefractor and the clinical findings of this study indicated a non-significant clinical difference. This suggests the use of autorefractors as a basis for referral for refractive error disorders. The use of the autorefractor by school health nurses in the referral of refractive errors would therefore significantly improve the effectiveness of the screening effort.

Wesemann and Rassow (1987) in a comparative study of different automatic infrared refractors found that autorefractors produce good starting values for subjective refinement in more than 90% of normal eyes. They concluded that the autorefractors tested could be recommended for an accurate preliminary refraction. Similar findings were reported by in a study by Perrigin, Grosvenor and Perrigin (1985).

However there are many factors that could influence the use of autorefractors in this regard and further research is needed in order to arrive at a final determination. Such an

investigation should include an assessment of the following factors: cost, training of the nurses, transportability of the equipment, the effects of over-accommodation and the referral criteria to be used.

Further, the use of plus spheres in the detection of referable refractive errors should also be investigated. Despite the high prevalence of referable myopia and the complex relationship between refractive errors and visual acuity, any attempt to determine inexpensive and simple means to detect refractive error disorders should be encouraged.

6.2 The prevalence of visual disorders.

6.2.1 Visual acuity.

Acceptable distance binocular visual acuity of 6/9 was demonstrated in 98% of the children. This finding as discussed before, explains the substantial under-referral rate of the school health nurse screening effort.

The prevalence of visual acuity disorders found in this study (4.5%) is similar to those reported by other researchers such as: 2.8% in 6 year old children (Woodruff, 1986), 4.5% in a sample of 10 year old children (Stewart-Brown and Butler, 1985) and 4.2% in primary school children (Macfarlane

et al, 1987b).

Errors of the school health nurses with regard to visual acuity measurements could be due to reduced testing distances, incomplete coverage of the eye not being assessed and inadequate lighting. Visual acuity charts incorporating improved design principles, such as Bailey and Lovie charts, should be used for acuity measurements.

The overwhelming majority of the children (99.3%) demonstrated near visual acuity ratings of 6/9 or better. It follows that the distance visual acuity assessments alone would suffice since almost all of the children referred for near acuity problems were also referred for distance visual acuity loss.

6.2.2 Eye co-ordination problems.

The prevalence of near point of convergence disorders found in this study (3%) is lower than that reported by other researchers. Letourneau, Lapierre and Lamont (1979) using similar criteria reported a 10% prevalence in a study of school children between the ages of 7 and 14 years. Macfarlane et al (1987b) reported that a prevalence of 6.5% of reduced convergence ability (near point greater than 6 cm) in their study. The lower prevalence found in this study

could be attributed to differences in the measuring instruments and the fixation targets used in the study design. Further, the present study did not attempt to investigate the child's ability to sustain convergence over a period for a near centred visual task.

The high prevalence of phorias (exophoria and esophoria) at near indicates that many of the children have difficulty in coping with near point stress. This suggestion is strengthened by the statistically significant difference finding in the prevalence of latent strabismus at near compared to that of distance. Further, the high prevalence of exophoria is supportive of the near point of convergence findings.

The prevalence of manifest strabismus found in this study (5%) closely approximates that found by others. Woodruff (1986) reported a 4.0% prevalence, 5.0% by Reinecke (1979) and Brown and Jones (1977) reported 3.5 %. The statistically significant difference in the prevalence of near strabismus compared to that of distance strabismus further supports the suggestion that children have difficulty in coping with the demands of near centred visual tasks.

The binocular deviations of the children could be best characterised as convergence insufficiency as proposed by

Daum (1986). The key features of convergence insufficiency are: primarily latent deviations, more likely in females, small angle of deviation at distance with large angles at near and remote near point of convergence. These findings accentuate the need for screening children for near visual disorders particularly the ones described above.

The high prevalence of accommodative deficiencies indicate that many children with normal vision have significant accommodative dysfunction. Adequate and comfortable near centred visual tasks demand that pre-presbyopic subjects must accommodate rapidly, smoothly and accurately in addition to being able to sustain the required focus for an appropriate time (Wick and Hall, 1987).

The accommodative facility disorders found in this study (6%) are considerably lower than those found by other researchers. Wick and Hall (1987) in their study reported a finding of 25% accommodative disorders whilst Lieberman et al (1985) reported 37.0%. These difference could be attributed to lower cut-off values used in this study and the absence of the monitoring of suppression.

The disorders of accommodation found in this study could best be described as accommodative insufficiency. The key features of this insufficiency as described by Daum (1983)

are: low amplitude of accommodation, reduced facility of accommodation, tendency towards convergence insufficiency as a result of exophoria and remote near point of convergence. This study adds its voice to that of many others in calling for routine testing of the different components of accommodation in children. Further, the high prevalence of accommodative insufficiency that was found support the need for screening children for near visual disorders.

6.2.3 Perceptual disorders.

The prevalence of abnormalities in colour perception found in this study (2.4%) is similar to that reported by others. Macfarlane et al (1986) using the Ishihara test reported a prevalence of 3.8% whilst Pease and Allen (1988) using a new test called the Pease-Allen Color Test (PACT) reported a prevalence of 2.8%. Both of these studies reported a higher prevalence of colour vision abnormalities in boys than in girls, a finding corroborated by this study.

Defective colour vision may cause problems with particular tasks at school although it does not in itself present as an obstacle to achievement (Steward and Cole, 1989). Teacher awareness of a child's defective colour perception would facilitate the usage of more appropriate teaching methods and aids sensitive to this disorder. Knowledge of defective

colour vision would facilitate an understanding of the limitations that such vision places on entry into certain occupations. Despite the lower prevalence of defective colour vision in girls, testing for both sexes is recommended.

The stereoacuity findings of this study (2%) do not correlate well with those reported by others. Woodruff (1986) reported that 11.7% of the children studied responded to disparities greater than 70 sec arc (Titmus Random Dot stereogram). Macfarlane et al (1987b) using the Lang random-dot stereogram found that 15% of the school children studied could not perceive the 500 sec arc image.

The lower prevalence of reduced stereoacuity found in this study could be due to the use of different test instruments and referral criteria. These differences suggest that the results may not be unconditionally compared. Further, in an evaluation study of the Frisby test, Cooper and Feldman (1979) found that additional clues such as binocular parallax, lateral displacement, patient head movements and reflections of the perspective material may give higher stereoacuity values.

However, only 14% of the manifest strabismic children demonstrated reduced stereoacuity. This finding supports the recommendation that stereoacuity testing alone should not be

used as a screening technique outside an assessment battery such as the MCT (Woodruff, 1986). Further, Manny, Martinez, and Fern (1991) stated that caution should be exercised in the use of stereotests as screening instruments to identify anisometropia or amblyopia.

6.2.4 Refractive errors.

Many studies have reported a higher prevalence of referable myopia to that of hyperopia for this age group. Blum et al (1959) in the Orinda Study reported that the prevalence of referable myopia (6%) was 2% higher than that of hyperopia. Grosvenor (1988) in a study of Melanesian children also found the prevalence of myopia (equal to or greater than -0.50 D) to be higher than that of hyperopia (greater than or equal to $+1.25$ D). Similar findings were also reported by Wong (1976) in a study of youths in a juvenile detention home population and Fledelius (1988) in a survey of myopia prevalence in Scandinavia.

The findings of this study are comparable to those reported by others for school children of age group 8-10 and supports the view that the development of myopia is pre-pubertal. Given the similarities in visual demands and somewhat related life-styles it seems reasonable to speculate that

environmental factors could interact with genetic susceptibility in the development of myopia (Lin and Chen, 1988).

Further, considering the higher prevalence of referable hyperopia ($> 1.25D$) in girls together with the over-all prevalence of myopia (girls) and hyperopia (boys) one can postulate that the rate of "myopisation" is greater in girls than boys for the pubertal or pre-pubertal age group. Goss (1991) in an analysis of the pioneering work in this field by Hirsh (1952) and of the Pullman Study (1954) states that the age of onset of myopia in girls appear to precede that of boys by approximately 2 years.

Although hyperopia was prevalent in approximately 60% of the children, clinically significant hyperopia was found in only 2% of them. Grosvenor (1991) commenting on changes in spherical refraction during adult years states that significant hyperopia does not increase in prevalence during the school years nor does it tend to progress in amount. He further adds that the prevalence of myopia increases markedly and the myopic condition tends to progress rapidly for several years. However, the influence of hyperopia on scholastic performance (Rosner and Rosner, 1987) and its association to esotropia (Robb and Rodier, 1986) warrants the early detection and treatment of such a refractive

abnormality.

The distribution of astigmatism in this study (32%) was similar to the 33% reported by Wong (1976) but higher than the 23% found by Woodruff (1986). However, the referable astigmatism found in this study (4%) was lower than the 7% found by Woodruff (1986) and the 6% reported in the Orinda Study.

The prevalence of anisometropia found in this study (4%) is similar to that reported by other studies. Woodruff (1986) found a prevalence of 3.6%, the Orinda Study reported 3.5% and Flom and Bedell (1985) reported 3.4%.

Woodruff (1986) citing von Noorden (1980) suggests that interference with the fusion process as a result of anisometropia may precipitate strabismus. Ingram and Walker (1979) reported that an interocular difference in refractive error of 1.00D in humans can lead to a poorly developed quality of binocular vision, with amblyopia developing in the more ametropic eye. This is corroborated by the findings of this study; 53% of the children with anisometropia demonstrated visual acuities of less than 6/12, more than half of whom (55%) also had eye co-ordination problems.

6.2.5 Organic disorders.

The prevalence of organic disorders in this study (1.2%) was lower than the 3% and 3.8% reported in the Orinda Study (1959) and the 7.3% reported by Wick and Crane (1976). However other researchers reported lower eye health prevalence values in children: 0.5% in Woodruff's (1986) study and 1% in Macfarlane et al's (1987b) study. The nature of the organic disorders detected in this study indicate that no special screening technique is required for their detection.

6.2.6 Sex differences.

In almost all of the visual disorders examined this study found a higher prevalence of visual disorders in girls than boys. Many other researchers such as; Wong (1976), Steward-Brown and Butler (1985) and Woodruff (1987) report similar findings.

Steward-Brown and Butler (1985) suggest that visual defects are more common in girls at 10 years of age partly because of the earlier onset of puberty in girls. Woodruff (1987) suggests that the high frequency of iron deficiency in pubertal age could be a risk factor for girls in so far as higher prevalence of visual disorders are concerned.

Chapter Seven: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

7.1 Summary.

A review of the literature pertaining to vision screening shows that the procedures used for vision screening as well as their effectiveness vary greatly. Unfortunately, the drawback to many vision screening programmes has been the disagreement between professionals as to what constitutes a valid screening programme particularly regarding referral criteria.

The Modified Clinical Technique (MCT) introduced to the field of vision screening more than thirty years ago has been shown repeatedly to be a very effective screening protocol. The MCT minimises both the under-referrals and the over-referrals and is cost effective.

Despite many studies criticising the sole and over-reliance on Snellen acuity as a screening technique, it's use is still widespread.

The purpose of this study was to evaluate the school vision screening programme (SVSP) for children in government schools under the jurisdiction of the House of Representatives in the

Durban Functional Region. It was envisaged that this evaluation would provide information for the improvement of such vision screening programmes. The study was also designed to generate a visual morbidity profile of these school children in terms of prevalence of specific visual disorders.

For the purpose of this study a Comprehensive Vision screening Programme (CVSP) was developed based on the MCT used in the Orinda Study (1959). The CVSP also incorporated testing in the areas of accommodation, colour vision, stereopsis and convergence. The referral criteria adopted in this study were based on those developed in the Orinda Study and from other recent studies.

The CSVP was carried out in schools in which the children had been screened by the school health nurses within a six month period. Five such schools were chosen and a total of 419 primary school children were screened. All children who failed the CVSP were referred for a full visual examination. There were 181 CVSP referrals of which 162 underwent a full clinical examination at the community clinic based at the University of Durban-Westville. The evaluation of the SVSP was done against the findings of the CVSP and the clinical examination.

The study found that 20.3% of the children screened were in need of visual attention. Analysis of usable records (N = 366) showed that the school vision screening programme correctly categorised 307 (83.9%) of the children and incorrectly categorised 59 (16.1%) of them. The incorrect referrals consisted of 3.8% over-referrals and 12.3% under-referrals.

The school health nurses did not detect sufficiently accurately those children with visual disorders. On the other hand, the school nurse detects with a high degree of accuracy those children with normal vision. Further, nurse observation as a basis of referral for eye co-ordination disorders was found to be unreliable.

Approximately two thirds of the children with visual disorders were not detected by the SVSP. One in every eight children classified as having no visual problem by the SVSP was an under-referral. Two in every five children referred were as over-referred. The high under-referral rate is attributed to the usage of inappropriate screening techniques such as low standards of Snellen acuity ratings and "nurse observation".

The prevalence of visual disorders in the children was 20.3%, 18.7% in boys and 21.9% in girls. The relative risk of visual

disorders in girls compared to boys was 1.2 (95% CI = 0.8 - 1.7). The prevalence of eye co-ordination disorders was 11.2%, refractive error problems 10.3%, visual acuity 4.5%, perceptual status (colour vision and stereopsis) 4.0% and organic disorders 1.2%. The findings of this study correlates well with those reported by other researchers.

7.2 Conclusions.

7.2.1 The SVSP classified with a high degree of accuracy children without visual disorders as non-referrals (high specificity).

7.2.2 The SVSP did not detect sufficiently accurately those children with visual disorders (low sensitivity).

7.2.3 The under-referral rate of the SVSP was unacceptably high and compromised the screening effort.

7.2.4 The high incorrect referral rates were primarily due to the use of inappropriate screening techniques such as low standard Snellen acuity ratings and "nurse observation".

7.2.5 The experience of the school health nurses in vision screening contributed positively to the effectiveness of the screening effort.

7.2.6 Nurse observation as a basis of referral for eye coordination disorders was found to be unreliable and errors in this regard are a major contributor to the high under-referral rate.

7.2.7 Snellen visual acuity screening did not reliably detect children with refractive error disorders. Visual acuity loss did not always accompany the presence of referable refractive error problems and the majority of children with such disorders demonstrated acceptable visual acuity.

7.2.8 The school health nurses did not screen school children for the visual disorders that are most prevalent.

7.2.9 The school children assessed demonstrated a high prevalence of eye co-ordination problems characterised as convergence and accommodative insufficiencies.

7.2.10 The prevalence of significant myopia in school children of age group 9-10 was high and children were more at risk of having referable myopia than referable hyperopia.

7.2.11 The prevalence of visual disorders were higher in girls than boys for this age group and this may be related to the earlier onset of puberty in girls.

7.3 Recommendations.

7.3.1 The training programme of the school health nurses should incorporate courses on the visual disorders most prevalent in school children.

7.3.2 The training courses should concentrate on signs, symptoms and the effects of these disorders on the learning process of children.

7.3.3 The screening programme of the school health nurses should be reviewed in regard to the findings of this study.

7.3.4 The Modified Clinical Technique should be used as the vision screening protocol for school children.

7.3.5 The Modified Clinical Technique should incorporate screening in the areas of visual acuity, convergence insufficiencies, accommodative insufficiencies, refractive error, colour vision and organic visual disorders.

7.3.6 The school health nurses should be trained in the following tests; Distance Snellen acuity (6/12 criteria using Bailey and Lovie charts), near point of convergence test, the cover test (distance and near), amplitude of accommodation (RAF rule push-up test) and facility testing, Standard

Pseudo-Isochromatic Plates colour vision test, retinoscopy and external ocular examination testing.

7.3.7 The school health department should investigate the cost effectiveness of the usage of autorefractors as an instrument to screen for refractive errors.

7.3.8 The school health department should approach optometric teaching institutions to assist in the training of the school health nurses.

7.3.9 The school health department should consider a more structured role for these institutions in the screening programmes of school.

7.3.10 The school health department should introduce visual health education programmes as part of their health education and health promotion efforts.

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APPENDIX A:

Supplementary Results Tables.

TABLE 'I. BINOCULAR DISTANCE VISUAL ACUITY DISTRIBUTION IN SAMPLE (N=419).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	398	398	95	95
2	6/9	14	412	3.3	98.3
3	6/12	2	414	0.5	98.00
4	6/18	3	417	0.7	99.50
5	6/24	1	418	0.25	99.75
6	6/36	1	419	0.25	100
7	6/60	0	419	0	100
8	< 6/60	0	419	0	100

TABLE II. BINOCULAR DISTANCE VISUAL ACUITY DISTRIBUTION IN THE POPULATION OF REFERRALS, (N=85).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	66	66	77.6	77.6
2	6/9	12	78	14.1	91.7
3	6/12	2	80	2.3	94.0
4	6/18	3	83	3.5	97.5
5	6/24	1	84	1.2	98.7
6	6/36	1	85	1.2	100
7	6/60	0	85	0	100
8	< 6/60	0	85	0	100

⁴ For tables I - XIV F = Frequency, Cum F = Cumulative Frequency.

TABLE III. BINOCULAR DISTANCE VISUAL ACUITY DISTRIBUTION IN THE POPULATION OF REFRACTIVE ERROR REFERRALS, (N=43).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	29	29	67.4	67.4
2	6/9	8	37	18.6	86
3	6/12	2	39	4.6	90.6
4	6/18	3	42	6.9	97.5
5	6/24	0	42	0	97.5
6	6/36	1	43	2.3	100
7	6/60	0	43	0	100
8	< 6/60	0	43	0	100

TABLE IV. BINOCULAR DISTANCE VISUAL ACUITY DISTRIBUTION IN BOYS, (N=214).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	206	206	96.3	96.3
2	6/9	5	211	2.3	98.6
3	6/12	1	212	0.5	99.1
4	6/18	1	213	0.5	99.6
5	6/24	1	214	0.5	100
6	6/36	0	214	0	100
7	6/60	0	214	0	100
8	< 6/60	0	214	0	100

TABLE V. BINOCULAR DISTANCE VISUAL ACUITY DISTRIBUTION IN GIRLS, (N=205).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	192	192	93.6	93.6
2	6/9	9	201	4.4	98.0
3	6/12	1	202	0.5	98.5
4	6/18	2	204	1	99.5
5	6/24	0	204	0	99.5
6	6/36	1	205	0.5	100
7	6/60	0	205	0	100
8	< 6/60	0	205	0	100

TABLE VI. DISTANCE VISUAL ACUITY DISTRIBUTION IN RIGHT EYES, (N=419).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	383	383	91.4	91.4
2	6/9	18	401	4.3	95.7
3	6/12	5	406	1.2	96.9
4	6/18	6	412	1.4	98.3
5	6/24	1	413	0.25	98.15
6	6/36	3	416	0.7	99.25
7	6/60	1	417	0.25	99.50
8	< 6/60	2	419	0.5	100

TABLE VII. DISTANCE VISUAL ACUITY DISTRIBUTION IN LEFT EYES, (N=419).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	388	388	93.6	93.6
2	6/9	19	407	4.5	97.1
3	6/12	4	411	0.9	98.0
4	6/18	3	414	0.7	98.7
5	6/24	2	416	0.5	99.2
6	6/36	3	419	0.7	100
7	6/60	0	419	0	100
8	< 6/60	0	419	0	100

TABLE VIII. BINOCULAR NEAR VISUAL ACUITY DISTRIBUTION IN SAMPLE, (N=419).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	406	406	96.9	96.6
2	6/9	10	416	2.4	99.3
3	6/12	1	417	0.25	99.5
4	6/18	0	417	0	99.5
5	6/24	0	417	0	99.5
6	6/36	1	418	0.25	99.7
7	6/60	1	419	0.25	100
8	< 6/60	0	419	0	100

TABLE IX. BINOCULAR NEAR VISUAL ACUITY DISTRIBUTION IN POPULATION OF REFERRALS, (N=85).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	75	75	88.2	88.2
2	6/9	7	82	8.2	96.4
3	6/12	1	83	1.2	97.6
4	6/18	0	83	0	97.6
5	6/24	0	83	0	97.6
6	6/36	1	84	1.2	98.8
7	6/60	1	85	1.2	100
8	< 6/60	0	85	0	100

TABLE X. BINOCULAR NEAR VISUAL ACUITY DISTRIBUTION IN POPULATION OF REFRACTIVE ERROR REFERRALS, (N=43).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	39	39	90.7	90.7
2	6/9	2	41	4.6	95.3
3	6/12	0	41	0	95.3
4	6/18	0	41	0	95.3
5	6/24	0	41	0	95.3
6	6/36	1	42	2.3	97.6
7	6/60	1	43	2.3	100
8	< 6/60	0	43	0	100

TABLE XI. BINOCULAR NEAR VISUAL ACUITY DISTRIBUTION IN BOYS, (N=214).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	209	209	97.7	97.7
2	6/9	4	213	1.9	99.6
3	6/12	1	214	0.5	100
4	6/18	0	214	0	100
5	6/24	0	214	0	100
6	6/36	0	214	0	100
7	6/60	0	214	0	100
8	< 6/60	0	214	0	100

TABLE XII. BINOCULAR NEAR VISUAL ACUITY DISTRIBUTION IN GIRLS, (N=205).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	197	197	96.1	96.1
2	6/9	6	203	2.9	99.0
3	6/12	0	203	0	99.0
4	6/18	0	203	0	99.0
5	6/24	0	203	0	99.0
6	6/36	1	204	0.5	99.5
7	6/60	1	205	0.5	100
8	< 6/60	0	205	0	100

TABLE XIII. NEAR VISUAL ACUITY DISTRIBUTION IN RIGHT EYES, (N=419).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	390	390	93.0	93.0
2	6/9	16	406	3.8	96.8
3	6/12	6	412	1.4	98.2
4	6/18	2	414	0.5	98.7
5	6/24	0	414	0	98.7
6	6/36	2	416	0.5	99.2
7	6/60	2	418	0.5	99.7
8	< 6/60	1	419	0.25	100

TABLE XIV. NEAR VISUAL ACUITY DISTRIBUTION IN RIGHT EYES, (N=419).

VISUAL ACUITY RATING		F.	CUM. F.	%	CUM. %
1	> 6/6	393	393	93.8	93.8
2	6/9	20	413	4.8	98.6
3	6/12	2	415	0.5	99.1
4	6/18	2	417	0.5	99.6
5	6/24	1	418	0.25	99.8
6	6/36	1	419	0.25	100
7	6/60	0	419	0	100
8	< 6/60	0	419	0	100

TABLE XV. FREQUENCY DISTRIBUTION OF THE NEAREST EQUIVALENT SPHERE IN THE SAMPLE.

NEAREST EQUIV. SPHERE	RANGE	MALE		FEMALE		TOTAL		% TOTAL (RE)
		R	L	R	L	R	L	
-6 D	-6.00 to -6.75	0	0	3	2	3	2	0.7
-5 D	-5.00 to -5.75	0	0	0	0	0	0	0
-4	-4.00 to -4.75	2	0	0	1	2	1	0.5
-3	-3.00 to -3.75	0	4	1	1	1	5	0.25
-2	-2.00 to -2.75	3	2	4	1	7	3	1.7
-1	-1.00 to -1.75	19	16	18	21	37	37	8.9
0	-0.75 to +0.75	170	164	154	148	324	312	77.7
1	+1.00 to +1.75	17	26	20	28	37	54	8.9
2	+2.00 to +2.75	1	1	2	2	3	3	0.7
3	+3.00 to +3.75	0	1	3	1	3	2	0.7

TABLE XVI. FREQUENCY DISTRIBUTION OF CYLINDRICAL COMPONENT OF THE REFRACTIVE ERROR FOUND IN THE SAMPLE.

CYL. POWER (DIOPTER)	MALE		FEMALE		TOTAL		% TOTAL (RE)
	R	L	R	L	R	L	
0.00	138	145	146	148	284	293	67.8
0.25	38	32	23	19	61	51	14.5
0.50	31	31	20	24	51	55	12.2
0.75	6	2	7	5	13	7	3.1
1.00	1	3	4	3	5	6	1.2
1.25	0	1	1	2	1	3	0.2
1.50	0	0	2	2	2	2	0.4
1.75	0	0	1	2	1	2	0.2
2.00	0	0	1	0	1	0	0.2

TABLE XVII. DISTRIBUTION OF ASTIGMATISM IN RIGHT EYES, (N=134).

CLASSIFICATION	% TOTAL	% BOYS	% GIRLS
With The Rule	47	53	40
Against The Rule	28.4	28	29
Oblique	24.6	19	31

APPENDIX B:

CVSP Pupil Vision Screening Record Card.

**UNIVERSITY OF DURBAN WESTVILLE
DEPARTMENT OF OPTOMETRY**

PUPIL RECORD CARD

PERSONAL DETAILS :

Name :..... **Sex :**.....
School :..... **Age :**.....
Date (CVSP) :..... **Ref No :**.....
Date (PSP) :.....

A.VISUAL ACUITY (Snellen Acuity)

a) Distance : R

5	6	7.5	9	12	18	36	60	60
---	---	-----	---	----	----	----	----	----

L

5	6	7.5	9	12	18	36	60	60
---	---	-----	---	----	----	----	----	----

OU

5	6	7.5	9	12	18	36	60	60
---	---	-----	---	----	----	----	----	----

b) Near : R

5	6	7.5	9	12	18	36	60	60
---	---	-----	---	----	----	----	----	----

L

5	6	7.5	9	12	18	36	60	60
---	---	-----	---	----	----	----	----	----

OU

5	6	7.5	9	12	18	36	60	60
---	---	-----	---	----	----	----	----	----

B. BINOCULAR STATUS (Eye Co-ordination)

a) Near Point of Convergence

Break :

≤ 10	> 10
------	------

Recovery :

≤ 15	> 15
------	------

b) Distance Cover Test

Tropia :

Y	N
---	---

Phoria :

 ESO EXO

Lat : >

6	6	5	4	3	2	1	0	1	2	3	4	5	6	>6
---	---	---	---	---	---	---	---	---	---	---	---	---	---	----

Vert:

0	1	2	3	4	>4
---	---	---	---	---	----

F. SUMMARY

1. If child has failed then tick the appropriate box or boxes.

a) Visual Acuity	Fail	Pass
b) Binocular Status	Fail	Pass
c) Perception Status	Fail	Pass
d) Refractive Error	Fail	Pass
e) Organic	Fail	Pass

2. Send letter to parent. Yes No

3. Send letter to eye care professional. Yes No

G. VALIDATION

Autorefraction: R Va(equiv): R
L L

H. TEACHER QUESTIONNAIRE

1. Visual acuity	Fail	Pass
2. Eye Co-ordination	Fail	Pass
3. Refractive Error	Fail	Pass
4. Perception	Fail	Pass
5. Organic	Fail	Pass

I. CORRELATION

1. VA (SHN) - - - -	Fail	Pass
2. VA (DSAT) - - - -	Fail	Pass
3. VA (equiv) - - - -	Fail	Pass
4. CSVP - - - -	Fail	Pass

Score Sheet

No. _____

Name _____ Age _____ M/F _____ Date _____

Examiner _____

Screening Series

Plate No.	Normal	R-G Defect
5	3	8
6	2	9
7	4	invisible
8	7	4
9	8	7
10	4	3
11	2	4
12	7	5
13	8	invisible
14	3	6
Total		

Classification Series

Plate No.	Protan	Deutan
15	8	3
16	5	7
17	4	8
18	9	4
19	3	5
Total		

Result : Normal
 Protan
 Deutan
 Others

- NB: 1) Nos. 1-4 are demonstration plates.
2) Encircle the number read by the subject.
3) When two numbers are identified, encircle either of the two that is better read.
4) Obtain the sum of the circles in each column and if normal response is 8 or more, the subject is determined as normal.
5) Classify as protan or deutan according to the greater number of the circles in those columns.

[Standard Pseudoisochromatic Plates IGAKU-SHOIN]

APPENDIX C:

Vision Screening Report.

Eye Care Professional's Report To The School.

Report To Parent.

School Health Nurse Report.



University of Durban-Westville

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4000 SOUTH AFRICA
TELEGRAMS: 'UDWEST'
TELEX: 6-23228 SA
FAX: (031)820-2383
☎ (031)820-9111

DEPARTMENT OF OPTOMETRY

Vision Screening Report

Name of pupil/student:..... School:
Address:
.....
.....

Dear

The above named pupil/student has not performed satisfactorily on our vision screening tests in the school.

Our results indicate the possibility of visual difficulty in the areas checked below;

- 1) visual acuity: _____
- 2) Refractive error: _____
- 3) Co-ordination: _____
- 4) Accommodation: _____
- 5) Perception (Stereopsis, colour vision): _____
- 6) Organic: _____

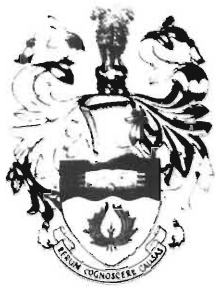
We believe that it is in the best interest of the pupil/student to have a full visual evaluation by an eye care professional.

Please find attached the following:

- 1. Letter to the parent
- 2. Letter to the eye care professional, which should be returned upon completion to your department for the purpose of record and follow-up.

We thank you for your co-operation.

Date: Signature:



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DEPARTMENT OF OPTOMETRY

Report to parent

Name of pupil: School:
Address:
.....
Nurse:
Ref. No:

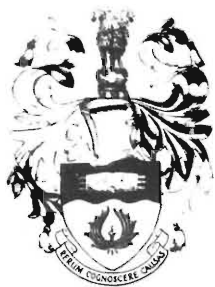
Dear Parent

Your child is being referred for professional vision evaluation because of your child's poor visual performance on our school vision screening programme. Since these tests are designed to be non-conclusive and indicate only an approximate measure of visual performance, we strongly believe that it is in the best interest of you to have a full visual evaluation by an eye care professional to see if treatment is necessary. We believe that your child will be helped if this matter is given your attention as soon as possible.

Your signature on the form overleaf, will authorize your child's eye examiner to return the important information to the school nurse.

We thank you for your co-operation and hope that we have been of service to you and your child.

Date: Signature:



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DEPARTMENT OF OPTOMETRY

School Health Nurse Report

Name of pupil: School:
Address:
Nurse:
Ref. No:

Dear Nurse

The above named child has not performed satisfactorily on our vision screening tests in the school.

Our results indicate the possibility of visual difficulty in the areas checked below;

- 1) Visual acuity: _____
- 2) Refractive error: _____
- 3) Co-ordination: _____
- 4) Accommodation: _____
- 5) Perception (Stereopsis, colour vision): _____
- 6) Organic: _____

We believe that it is in the best interest of the child to have a full visual evaluation by an eye care professional.

Please find attached the following:

- 1. Letter to the parent.
- 2. Letter to the eye care professional, which should be returned upon completion to your department for the purpose of record and follow-up.

We thank you for your co-operation.

Date: Signature: