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PREVALENCE OF STRABISMUS

&

ASSOCIATED RISK FACTORS:

THE SYDNEY CHILDHOOD

EYE STUDIES

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DECLARATION STATEMENT

This thesis is submitted to the University of Sydney in fulfilment of the requirement is for the Doctor of Philosophy.

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in full or in part, for a degree at this or any other institution.

Signature: 

Date: 31st March 2013

(Sharimawati Hj Sharbini)

ABSTRACT

Knowledge of the natural history of strabismus and accurate prevalence is fundamental to justify the operation of visual screening programmes and prevent vision loss in children. This thesis will focus on prevalence of strabismus and the methodological issues arising within previous studies which affect the accuracy of reported prevalence's. From our own study of Sydney children we will report the prevalence of strabismus. This thesis will also document risk factors for strabismus, and parental awareness of strabismus and its subtypes. It can be clearly seen the variations in reported prevalence of strabismus across studies are affected systematically by the methods used for the assessment of strabismus (*see tables 1.2-5*). A careful review of previous studies has revealed that there are some systematic variations in findings of the prevalence of strabismus dependent on population sampled and methodology used, with prevalence increasing the more selective the population when compared to population-based studies. In contrast deviation from an apparent gold standard for strabismus/tropia assessment, namely cover test by an appropriately trained professional, appear to reduce the level of strabismus detected. Inclusion of previously diagnosed strabismus cases should also be included when reporting the prevalence. A comprehensive literature review revealed that much of the variation in estimated prevalence's of strabismus/tropia is associated with these deviations from these gold standard methodologies. From this perspective, priority areas for future research have been identified.

Analysis of data from our own studies revealed that the risk factors for esotropia are different than those for exotropia. We found that esotropia is primarily associated with antenatal events. The strong association of strabismus with active maternal smoking during pregnancy has been consistently reported, and was confirmed in our study. This is an important public health message to convey to future mothers, and could lead to an overall reduction in strabismus and its associated morbidities. In contrast, exotropia was associated with indicators of low SES such as no parental home ownership, low parental education and/or no parental employment.

It is also our conclusion that parental awareness of strabismus and other significant ocular disorders such as refractive error and external eye abnormalities is poor and cannot reliably replace vision screening. Almost two-thirds of children in our studies would go untreated and suffer the permanent yet avoidable consequences, adding a powerful argument for the continuation of vision screening.

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CHAPTER 1

SYSTEMATIC LITERATURE REVIEW ON PREVALENCE & RISK FACTORS OF STRABISMUS

1.1 INTRODUCTION

Strabismus is a frequent common childhood ocular disorder affecting of the order of 2 - 3% of the population[1-11.] It has been shown to cause amblyopia (reduced vision due to stimulus deprivation)[12-16] and is significantly associated with refractive errors[2,13,17]. Strabismus will require intensive therapy, including surgery, and treatment for strabismus can be a significant cost to health systems and individuals. Amblyopia increases the risk of becoming visually impaired in later life [18] and has been associated with decreased quality of life [19] and other co-morbidities, such as an increased number of falls and consequent fall related injuries such as hip fractures, in later life [20.] Early detection of ocular disorders in children, such as strabismus, refractive error and amblyopia is therefore essential to maximise visual potential and prevent possible visual impairment in later life [21].

There are also psychosocial costs associated with strabismus and its treatment. Children who wear glasses or eye patches are more likely to be physically or verbally bullied. Such bullying occurs irrespective of the child's social class and other factors such as, the level of maternal education[22]. Psychosocial difficulties relating to socially noticeable strabismus persist into teenage and adult years[23]. Children with esotropia are perceived more negatively than those with exotropia [24].

Strabismus, where manifest, can therefore adversely affect many aspects of a patient's life such as their self-image, confidence, ability to interact with social peers and also their ability to form romantic attachments. Patients with strabismus often have a tendency to introversion. Consciousness of strabismus has been noted to lead to patients avoiding social situations that bring to the fore their apparent disability [25] [26]. A case control study reported that social phobia (a psychiatric co-morbidity) was significantly higher in strabismic patients when compared with a control group, affecting their social, family and professional life. Strabismic patients showed greater interpersonal sensitivity scores and demonstrated significantly higher depression scores [27]. The negative implications of strabismus are

significant. In one study it was reported that a majority of the patients with strabismus interviewed disclosed a willingness to trade a portion of their life expectancy in return for a cure for strabismus, and/or, its associated effects[28].

Surgical correction, which improves cosmetic appearance, has been reported to improve psychological and physical functioning [23] including general, social anxiety and avoidance [29]. Ninety% of treated patients with strabismus recorded positive improvements in self-esteem and self-confidence[25]. Correction of strabismus can, therefore, provide significant psychosocial benefits, even when the hope of improving visual function is not present [24]. Prevention of strabismus is an even more important goal if possible.

1.2 CLASSIFICATION OF STRABISMUS

Strabismus has traditionally been classified according to the direction of manifest deviation. Such deviations include, esotropia, – an inward deviation of one or both eyes; exotropia – an outward deviation of one or both eyes; hyper/hypotropia – an upwards or downward deviation of either eye or cyclotropia – a torsional deviation of one or both eyes. Other classifications include fusional status (constant and intermittent strabismus) or by comitancy (concomitant or incomitant). Concomitant strabismus is defined by the angle of ocular deviation, which remains virtually the same when either eye is used for fixation and in all directions of gaze. Incomitant strabismus is defined when the angle of deviation varies according to the eye used for fixation or in different directions of gaze. Other types of classification include developmental (e.g. strabismus associated with retinopathy of prematurity), congenital (infantile esotropia), those associated with other syndromes (albinism, Down's syndrome) and those associated with specific diseases (cerebral palsy, neurodevelopmental). Another factor that has been used to categorize strabismus is the size of the angle of deviation. Those measuring less than 10 prism dioptres are defined as microtropia.

Table 1.1 Illustrates further sub-classifications of concomitant strabismus based upon the system of classification employed by Anson and Davis [30]. Concomitant strabismus is first divided in accordance with the direction of deviation encountered and has been defined so as to include detailed etiological subsets such as refractive errors. Others have adapted this system of classification[30-32]. Another study subdivided strabismus cases into isolated (idiopathic) or those associated with neuro-developmental disorders [31]. When reporting the prevalence of strabismus from population-based samples all strabismus categories ought to be included. In a number of studies this approach has not been adopted[33-35]. It may be advantageous from a public heath point of view to report the prevalence of strabismus associated with neurodevelopmental problems separately, since this group ought to be targeted for mandatory checks of their visual status, including the detection of strabismus, due to the high prevalence of ocular abnormalities in these children. Our preference, for this reason, has been to report the prevalence of strabismus associated with neuro-developmental anomalies separately where the appropriate data is available. Other studies have categorized strabismus according to the age of onset of strabismus and considered infantile strabismus[30,36]. Since our interest lies in the overall prevalence of strabismus throughout the population, a more expansive approach will be adapted within this study. This approach will include infantile, congenital and non-pathological acquired forms of strabismus. The category of microtropia also needs to be included. Where studies that have not used gold standard methods to ascertain strabismus cases, this particular form of strabismus is less likely to be detected. All these factors will be noted in this review.

The gold standard for the ascertainment of strabismus/tropia cases is assessment with cover test at near and distance, with and without glasses if worn, performed by appropriately trained professionals such as orthoptists and paediatric ophthalmologists. The reported prevalence rate should include strabismus cases that have been previously diagnosed and treated/ surgically corrected. In addition the gold standard for an epidemiological study is a population based sample rather than a clinical sample. A large population based sample is also

preferred compared to a school-based sample as children with severe ocular conditions may attend special schools and thus be excluded. Nevertheless where most children attend school it would be expected that the prevalence rates obtained from a school based sample would be close to those obtained from a population based sample. But, ideally all children living within a selected area should be enumerated and tested aiming for a high participation rate. In addition, large samples are needed for conditions with low prevalence like strabismus, which has an approximate prevalence rate of 5% of the total population, in order to have sufficient statistical validity.

This thesis will focus upon primary childhood strabismus which is predominantly concomitant and not cases of strabismus secondary to disease or to insult such as trauma, tumours, toxin, infection and surgery. Since our interest lies in ascertaining the presence of non-acquired strabismus throughout the population, this study will include infantile, congenital and non-pathological forms of strabismus with later onset as well as microtropia.

1.3 PREVALENCE

Questions have been raised as to whether the prevalence of childhood strabismus, particularly in developed countries, is in decline. This may particularly concern esotropia[36-39]. Several theories have been postulated to account for this decline, such as early intervention with refractive correction [38] and surgery. Other anecdotal suggestions include improvements in health care, maternal nutrition, and perinatal child health care. Genetic counselling may have also led to a reduction in the number of children born with severe hereditary congenital abnormalities that are generally known to carry an increased risk of strabismus. However a study on the incidence of infantile strabismus over 30 years did not detect significant changes, and the number surgical treated in each year remained similar[36].

The wide range in reported prevalence of strabismus across studies clearly varies systematically with the methodology for the assessment of strabismus and the population

sampled. The prevalence of strabismus has been reported in a wide range of samples, including population-based, school-based and clinical-based, samples of children who have failed an initial basic screening test and samples from specific populations with conditions known to be associated with strabismus *(see Table 1.2 – 1.5),* and the prevalences reported have been highly variable. In contrast, comparable studies that have met the gold standard of strabismus assessment, where ideally everyone eligible within the large unbiased population based samples are tested by a trained professional (orthoptists, paediatric ophthalmologist etc.) using appropriate tests for the ascertainment of strabismus cases (cover test; Near & distant, with & without glasses if worn), have in fact reported a very consistent prevalence of strabismus *(see Table 1.2 – 1.3).*

Studies have adopted a range of tests to ascertain strabismus cases *(see Table 1.2 – 1.4).* These included indirect methods such as determining strabismus cases via questionnaires, parental reports, interview and retrospective analysis of hospital records. Direct methods employ a variety of tests to examine strabismus such as the Krimsky and/or Hirschberg test (examination of corneal reflections), photorefraction, or a cover test, including a full cover/uncover test and alternate cover test. The level of training and experience of the person performing the test to ascertain strabismus was another factor that differed greatly across studies and was seen to contribute to the varying prevalence rates reported. Experienced practitioners include paediatric ophthalmologists and orthoptists. Medical students, nurses and teachers, may or may not be appropriately trained or have enough experience to perform the tests accurately to elicit all types of strabismus, particularly those which are small and intermittent, and this is partly reflected in variations in the prevalence rates reported.

1.3.1 Population-based Studies

Large cross-sectional population based studies *(table 1.2)* that have met the gold standard for the assessment of strabismus prevalence with the cover test performed by experienced practitioners were used to ascertain strabismus cases, have predominantly studied

populations of European Caucasian origin, and have on average reported slightly higher rates of strabismus (mean 3.6%; a range of 2.3 – 5.3%) [3,5,7,11,22,40,41]when compared to those reported by comparable school based studies (mean; 2.1%; a range of 1.4 – 2.5%) [1,42-45]. The slightly higher prevalence of strabismus in population based studies compared to school based studies is consistent with the idea that the gold standard for an epidemiological study is a sample that is population based. School based samples may exclude children with other conditions which have been documented to be associated with strabismus who attend special schools, which may explain the lower values reported from school-based studies.

Two of these population based studies reported strabismus prevalence of <3.0% (table 1.3)[22,31,46,47]. Williams et al attributed their lower prevalence of strabismus (2.3%) to an under-representation of children with low socio-economic status (SES) that may therefore have not captured the full prevalence of exotropia for example[11]. Horwood et al have reported 2.5%[22] but only reported on strabismus cases present in the child's habitual state. This would exclude certain types of strabismus such as fully accommodative esotropia, which may not be manifest when the child is wearing glasses.

Two other population based studies that did not use the gold standard of cover test by trained personnel, have also reported lower prevalence of strabismus. Pathai and colleagues reported 2.1% [31] but ascertained their strabismus cases through questionnaires, so participants were not actually examined. Here cases not readily noticed by parents such as microtropia and intermittent strabismus may have been missed. An even lower prevalence (1.6%) was reported by Kohler et al [47] where the cover tests were done by nurses who may not have had adequate training or experience and therefore may have missed more subtle types of strabismus..

1.3.1.1 Population-based Studies; Other ethnicities.

Large cross-sectional population-based studies which have sampled ethnicities other than European Caucasians and met the gold standard for assessment of strabismus prevalence (*table 1.2.1*)[6,48-53] have reported an average prevalence of strabismus of 2.9% (2.1 – 4.9%). It can be clearly seen in table 1.2.1 where ascertainment of strabismus was not using a cover test

performed by an appropriately trained professional in these other ethnic groups, that the reported prevalence of strabismus was much lower (0.4 – 0.5%)[54,55]. One study using both population based sampling and cover test, reported a very high prevalence of strabismus (9.86%)[56]. This could be attributed to the high prevalence of hyperopia and astigmatism in their sample, which are known to be closely associated with strabismus. However, the majority of cases reported were near exotropia, so an association with hyperopia is less likely.

When studies are broken down into specific ethnic groups, some patterns emerge but observations are limited by the number of surveys in each group and the varying methods used to ascertain strabismus. Three studies sampled populations of South Asian ethnicity. Two of these studies reported a significantly lower prevalence of strabismus (0.4% and 0.5%)[54,55] than the study by Pokharel et al (2.1%)[50]. This is readily explained as the studies that reported a low prevalence both ascertained their strabismus cases by using the Hirschberg test, which is less likely to elicit an intermittent strabismus, particularly of the accommodative type, and the test was performed by ophthalmic assistants and laypersons. In contrast the study by Pokharel et al used cover test performed by an ophthalmic team in line with the gold standard. .

It is also of particular interest that the three studies that have sampled East-Asian populations have all reported that a large proportion of their strabismus cases were exotropic, ranging from 63.0 - 100.0% of [6,51,57]. One study [52] reported a much lower prevalence (0.8%) compared to two other studies; 2.8% [51] and 3.9% [6]). This may be attributed to missing the later onset intermittent exotropia, as Chia et al sampled a much younger age range of 6 – 72 months compared to the two other studies that sampled an older age range of 5 -15 years [6,51]. The authors of these two studies also reported that most of the cases were intermittent exotropia (63.0%).This will be discussed further in section 1.3.5.

1.3.1.2 Population-based Studies; Samples examined are subsets of the whole population.

Studies particularly examining predominantly European Caucasian children who have failed an initial basic screening test and have all reported a consistent lower prevalence of strabismus ranging from 1.6 -2.1% (Average; 1.8%) [4,40,58-60]. This likely to be because the initial screening was not either specifically directed at detecting strabismus or based on predominantly self-report and visual acuity, which again will not detect more subtle cases and those forms of strabismus that may not have associated amblyopia, such as intermittent exotropia. When looking at the reported rate of strabismus of studies examining subsets of the population sampled the reported prevalence can be as low as 0.25% [61]

1.3.2 School-based Studies

The reported prevalence of strabismus within school-based studies *(table 1.3)* which employed methods that met the gold standard of strabismus assessment and sampled a population predominantly of European Caucasian ethnicity [1,42-45] as previously stated are slightly lower (average 2.1%; 1.4 – 2.5%) than population-based (mean 3.6%; a range of 2.3 – 5.3%). One large school based study based in New Brunswick, USA [62] reported a higher prevalence of strabismus (3.98%) but included in their definition large phorias. The reported prevalence from school-based studies that met the gold standard and sampled other ethnicities (Table 1.3.1)[8,10,28,63-67]is only marginally lower (average: 2.3%) when compared to population-based studies that also sampled other ethnicities [3,5,6,49-51,68] (table 1.4 & 1.4.1; average: 2.6%). Two large school-based studies which sampled Australian children of comparable ages examined strabismus using cover test performed by orthoptists, reported very similar prevalences of strabismus of 2.8% from the Sydney Myopia Study (SMS)[13] and 2.5% from the study in Queensland by Macfarlane et al [1].

1.3.2.1 School-based Studies; Biased samples

Other school-based studies conducted on predominantly European-Caucasian samples, that have also met the gold standard of strabismus assessment but did not randomly select the schools or the subjects self-selected themselves by attending a school outing such as a visit to a clinic or university (table 1.5), reported a higher prevalence of strabismus averaging 3.4%[69-72]. Other school-based studies that sampled other ethnic populations have biased their samples in a number of ways including, selecting schools from low SES areas[73], , reporting from a subset of those who have failed a previous vision screening [74,75] and using a retrospective analysis of school vision screening records[76]. Consequently such studies have reported an inconsistent prevalence of strabismus ranging from (1.0 – 6.0%; table 1.5.2).

1.3.2.2 School-based Studies; using other methods to ascertain strabismus cases.

The school-based studies which have relied upon other tests to ascertain cases of strabismus, have also given inconsistent results, whether they have used surveys or questionnaires, (0.01-0.9%) [77], self-report (1.6%) [78], the Krimsky and/or Hirschberg methods (0.7 – 1.0%) [79 80 81]. Similarly the studies where tests were performed by trained lay persons, such as teachers (0.5%)[82], have all reported lower rates of strabismus, ranging from 0.5% – 1.6%. This lower rate of strabismus may be attributed to a failure to detect small-angled and/or intermittent strabismus or the exclusion of previously treated strabismus *(see table 1.5.1).* Interestingly, two school-based studies [15,83] that ascertained their strabismus cases using cover test only for near, performed by health technicians have both reported a higher prevalence of strabismus (3.1 – 3.2%).

Large school-based samples often fall short when compared with population-based studies. In addition to the potential to exclude children with a high level of disabilities, who are known to have a higher rate of strabismus, they can be biased if schools selected for convenience. School-based studies are more representative where the sample is randomly selected from a large enough sample of schools to cover all sectors of a society without any bias within the sample grouping, to either low or high socio-economic groups within a

population. Studies that do not sample a representative cross-section of all sectors of the population cannot reflect the true population prevalence of strabismus and may in fact underestimate it particularly if the sample is small and/or biased to particular socio-economic populations.

1.3.3 Clinic-based Studies

Clinic-based studies are likely to over-estimate strabismus prevalence *(see table 1.5)*. Those that assessed strabismus in such samples when of predominantly European-Caucasian ethnicity and using the gold standard methods for testing have generally reported prevalence of strabismus values ranging from 3.8 – 11.8% (Average; 5.7%) [4,84-86] [26]. It is important to note that comparable clinic-based studies in Africa[87,88] and Jordan [35] these have reported a much lower prevalence of strabismus (0.5 – 0.8%)(*table 1.4).* One study that examined children who were referred to a hospital for non-ophthalmic reasons reported a very low rate of strabismus (see table 1.4) (0.5%) [35].

When the studies assessed samples with known ophthalmic conditions or systemic conditions that may predispose to strabismus, the reported prevalence of strabismus was significantly higher again, 7.9% - 47.0% (average; 23.4%)[89-93], particularly when compared to those studies that have sampled clinic-based samples without taking into account any particular condition (average; 5.7%)[4,84-86] [26].. Prevalence of strabismus in studies of children with severe visual impairment has been reported as high as 19.0% [94] [95] while in studies of children with neuro-developmental conditions, prevalence of strabismus can rise to 26.8%[91]. Particular conditions such as Down's Syndrome (>35.0)[96] and Cerebral Palsy (50.0%) [97,98] have reported particularly high prevalences of strabismus. Hydrocephalus presents a similar high prevalence of strabismus[99].

Case–control studies enable the comparison of population samples (controls) with 'cases' of a particular disease or condition. If the case is not strabismus itself, but rather another separate condition logically, if the prevalence of strabismus is higher in the 'cases'

group compared to the 'control' group, the particular disease or condition studied may be associated with strabismus. Two similar case-control studies *(see table 1.5)* that examined clinic-based samples of predominantly European-Caucasian populations compared children born prematurely to a control sample representing the "normals" from their population (children born full-term). These studies reported in their control samples a prevalence of 3.2% [100] and 3.0%, respectively[101]. As could be expected, these findings for the 'normals' were very consistent with those reported from population-based samples (average; 3.8%) while that amongst the cases of pre-mature children were much higher 16.2 to 20.1%).

1.3.4 Age of population sampled

The age of the participants in a study can also impact upon the detected prevalence of strabismus. Sampling a population that is too young may not detect certain types of strabismus with delayed onset such as accommodative esotropia. The onset of other subtypes such as intermittent exotropia may be delayed even further, and thus the prevalence in a younger population may be under-reporting the final prevalence of strabismus in an adolescent population. It is known that congenital esotropia is, by definition, present at birth, accommodative esotropia appears at the age of 2 -3 years and most exotropia, particularly intermittent exotropia, becomes manifest between the ages of 6 -10 years. Conversely, if a population is older, cases of strabismus that have been successfully treated may also be present in the population examined, which would decrease the reported prevalence if these cases were not documented through the use of questionnaire data or retrospective examination of health records. One study by Chia et al which sampled a younger age range of 6 – 72 months, reported a much lower prevalence (0.8%) compared to two other comparable ethnically matched studies where the age range of their sample was 5 -15 years (average; 3.4%)[6,51]. It is possible that later onset strabismus, possibly predominantly exotropia, may have been missed.

1.3.5 Ethnicity and ratio of esotropia: exotropia prevalence.

Evidence from previous studies that sampled populations from different ethnic backgrounds is also seen to affect the prevalence of certain types of strabismus in a systematic way. Population and school-based studies of predominantly European Caucasian populations have reported a higher prevalence of esotropia than exotropia, with the ratio of esotropia to exotropia ranging from 5.4-1.2 : 1 [5 7 11 3 1 4,10,13]. In contrast, in studies that examined other ethnicities, the proportion of esotropia and exotropia can be reversed, with the ratio of exotropia to esotropia in these samples reaching as high as 7.0-1.4 : 1 [57 6,8,39,48,56,102]. This trend appears to be most consistent within populations of East Asian ethnicity[39,57,102]. All 3 large East Asian population-based studies and that have met the gold standard for the assessment of strabismus have reported a this high prevalence of exotropia[6,51,57].

Studies that sampled subjects with African ethnicity can be further subdivided into those who sampled African Americans, where there is considerable admixture with European populations. These reported an average prevalence of strabismus of 2.7% (range 2.1 – 3.5%) [3 5,48]. In contrast, in African populations living in Africa, with little if any admixture, are reported as having a much lower average prevalence of strabismus of 1.3% (range 0.7 – 2.4%)[53,87,88] (Table 1.2.1 and 1.4) with esotropia being more prevalent compared to exotropia. The studies by Chumbley[87] and Eballe[88] both sampled clinical populations which usually over estimates the prevalence. However they both reported low prevalence of strabismus (0.8 and 0.7% respectively). It is not clear whether this represented a genuine ethnic difference, and more studies are clearly needed.

Therefore prevalence of strabismus varies according to age and ethnicity. East Asians are more prone to exotropia when compared to European Caucasians. Africans appear to lie somewhere in between but more similar to European Caucasian than East Asians, as more esotropia cases are reported compared to exotropia. In one study there is no difference in the prevalence of exotropia between European Caucasians (1.3%) and African Americans (1.2%)[3].

The reason for this ethnic difference is not readily apparent but has been thought to support the heredity of strabismus[103,104]. It has, in turn, been argued that differences detected within sample groupings with different ethnicities may be attributable to other, sample independent based factors such as environmental influences. For example, dietary influences have been postulated. Ing and Pang [105] who undertook a study with a mixed Caucasian/Asian sample living within the same geographical vicinity reported incidences of esotropia: exotropia ratios of 3.0 : 2.0 amongst the Caucasian and in contrast 1.0 : 2.0 within the Asian population. This parallels findings for strabismus and heterophoria from the SMS study [106]..

1.4 AETIOLOGY AND RISK FACTORS

Concomitant strabismus is categorized by non-restrictive, non-paralytic ocular misalignment of the same magnitude in all directions of gaze and is not associated with any systemic abnormality. A number of theories have been postulated as possible explanations of the aetiology of childhood concomitant strabismus but in each instance, these theories have been noted to carry certain exceptions /caveats.

In 1827 Anthony White suggested that strabismus was caused by muscular defects and that a myotomy could correct the deviation. Donders [1864] suggested a connection between eso-deviations with hyperopia and exo-deviations with myopia. He postulated that the primary cause of strabismus was a defect in the accommodation-convergence link. Donder's findings were refuted by both Javal in 1864 and later by Worth in 1903, who reported that some exo-deviations have associated hyperopia and eso-deviations with myopia and further there was also a group of individuals with strabismus who were emmetropic. Javal and Worth's conclusions suggested the aetiology may be more attributable to a defect in the fusion faculty. Worth postulated with the development or strengthening of the fusion faculty, strabismic patients could be trained to straighten their eyes. Other theories postulated a psychological aetiology [107].

It was previously reported from the SMS data that children with strabismus are significantly more hyperopic when compared to children without strabismus[13]. However whether this was due to the number with accommodative esotropia within the strabismus group was not assessed. Strabismus was also significantly associated with all types of refractive errors. Children with combinations of strabismus and anisometropia were reported to have the greatest potential for developing amblyopia[13]. Abrahamsson [78] conducted a longitudinal study measuring the change in refraction from ages prior to the onset of strabismus up to a point after they had developed strabismus. He found that in cases of esotropia, the children had significant amounts of hyperopia in the deviating eye at the onset, which failed to emmetropise and increased over time. However, refractive error associated with exotropia remained approximately unchanged. Interestingly they also found that anisometropia very often develops after the onset of strabismus, particularly for cases of esotropia compared to exotropia[108,109].

1.5 GENETICS

Previous family and twins studies have supported the heredity of strabismus. This has led to the attempt to identify specific genes and investigations of those particular genes that may elicit strabismus. However, strabismus is aetiologically heterogeneous, and although the genetic loci of many rare forms of strabismus and those associated with syndromes have been identified, for the most common type of strabismus, which is the isolated concomitant strabismus occurring in childhood, none are yet known.

1.5.1 Family Studies

Paul and Hardage (1994), reviewed the available literature on the heredity of strabismus and reported familial rates from eleven published studies that averaged the contribution of inheritance to 30.6% (13.0-66.0%). They postulated that these figures are a minimum estimate since variations of phenotypic expression are usually excluded by most studies. There is a wide variation on reported inheritance rates within the literature, which can

be attributed to varying definitions of strabismus. Methodological influences, such as whether the tests were performed by a trained professional, as well as sample based influences, (the size of the population sampled and whether or not the family members were actually examined or just interviewed or self-reported[103]), were also postulated. Michaelidas [104] found that the risk of strabismus increased 3- 5 times if a first degree relative had a positive history. It was also suggested that the genetic component varies with different forms of strabismus.

1.5.2 Twins Studies

Comparison of disease rates in monozygotic (MZ) and dizygotic (DZ) twins can be a valuable tool in trying to elucidate the contribution of heredity in the development of strabismus[103,110,111]. However, they cannot completely rule out the role of environmental risk factors [110], nor can they determine the mode of inheritance [111]. Twin studies depend on many assumptions, which may not be entirely true. One is the assumption that MZ twins are assumed to be 100% genetically identical. However asymmetrical division has been known to occur, leading to a variation in the development and disease manifestation between MZ twins[111].

Higher concordance rates reported in MZ twins (73%) as compared to (DZ) twins (35%)[110], are consistent with a strong genetic predisposition, as MZ twins share more of the same genes and are often thought of as identical, as opposed to the more limited genetic commonality of DZ twins, who can even be of different genders. Further, higher strabismus prevalence has been reported in DZ twins when compared with first order siblings. This finding on the other hand is suggestive of an environmental role such as prenatal risk factors, as DZ and siblings share similar distributions of genetic material, but DZ twins can be generally assumed to have shared a more common prenatal environment, when compared to their siblings [110,112]. In addition, a higher prevalence of strabismus within first degree siblings (13.4%) when compared with the normal population (3.0 – 5.0%) further supports a hereditary component to the development of strabismus [109,110,113-116], although again environmental factors related to families cannot be ruled out.

In the attempt to quantify genetic and environmental contribution to strabismus, Paul and Hardage (1944) reviewed previous literature on twins, and in addition they conducted a new study combining phoria and strabismus prevalence. In their study, they found a significantly greater (p =0. 003) correlation for the MZ twins (r = 0.65) compared to DZ twins (r = 0.33) for eso deviations only, with a calculated heritability of 64% even after controlling for other confounding factors. A further factor that needs to be taken into account in twin studies is that twins have been reported to have low birth weights when compared to single births of comparable gestation age. High proportions (48.0 - 56.6%) of multiple births are born weighing less than 2500g as compared to 6.0 - 8.0% of singleton births[110,117]. A number of studies have reported high prevalence rates of strabismus in children with low birth weight (6.4 – 9.1%)[2,3,103,110,118], which may also be true for twins.

Wilmer, *et al*, also reviewed previous literature to separate the role of genetic and environmental contributions to the risk of strabismus and in their own study examined latent (phoria) and manifest strabismus separately. They chose three previous studies in which children were between the ages of 4 to 7 years[114,116,119] and whose methods of ascertainment were similar and further took into consideration ascertainment bias and included concordant non-affected twin pairs. They calculated an overall concordant rate of 54% in MZ twins and 14% in DZ twins with an overall prevalence of 6.4%. In their review they found no evidence of environmental factors causing strabismus, independent of a pre-existing genetic liability, and suggested that environmental factors served merely to exacerbate the condition. In contrast, they found no difference in the familial similarity of phoria in either MZ or DZ twins. Environmental factors were therefore considered to be sufficient to cause most phoria without any pre-existing genetic predisposition. There are some difficulties with methodology as their sample, although large, was not population based and the Hirschberg test was used to ascertain strabismus, while the study by Orlebke e*t al*, relied on parental reporting which is not considered to be accurate in detecting strabismus cases [110,119,120]. Another valuable study that

looked at each twin pair who were reared apart, reported that each twin developed esotropia of similar clinical characteristic and magnitude at approximately the same age [121].

These studies support strong evidence of a genetic contribution to eso-deviations, particularly manifest infantile esotropia. Environmental factors were suggested to be adequate to elicit phoria but strabismus may need a pre-existing genetic liability. Further genetic studies to identify gene locus for strabismus in, particular infantile esotropia would be most valuable. It is important that future large population-based epidemiological studies of strabismus must employ consistent methodologies that meet the gold standard and take into account various factors that are known to influence the prevalence of strabismus, before conclusions are made and applied to the general population.

1.5.3 Susceptibility Loci

Less is known about the pathogenesis of concomitant strabismus as compared to incomitant strabismus [104]. One study [122] suggested multiple susceptibility *loci* for concomitant strabismus (4q28.3 and 7q31.2). Another linkage study by Parikh [123] has identified the susceptible locus on chromosome 7p22.1 and indicated genetic heterogeneity in strabismus [110]. Further genome wide linkage studies of appropriate families are required. Maumenee [124] has suggested that strabismus is inherited through two autosomal dominant genes *via* a multi-factorial inheritance rather than a Mendelian model. However, as strabismus is likely to be a multi-factorial disease, the likelihood of establishing a single or even a handful of susceptible genetic loci for this complex condition remains uncertain.

1.5.4 Difficulties in twins& family studies

1.5.4.1 Phenotypic & Definition Variation

In the study of heredity of strabismus, it is difficult to clearly identify those with and without the condition due to phenotypic variation and overlap (for example, large exophoria should be included as a variation of intermittent exotropia) [125]. For children with congenital esotropia, a higher rate of familial conditions that may be considered as phenotypic variations have been reported, including microtropia (8.0%)[126] and mono-fixation syndrome(7.7%)[127].

These variations may be attributable to one gene with variable penetrance and expression. It has also been suggested that a continuum from normal to abnormal exists such as abnormal phoria leading to microtropia, leading to loss of fusion and finally a manifest strabismus, therefore suggesting a multi-factorial aetiology of strabismus [103]. Furthermore environmental factors may produce phenotypic copies [125].

1.5.4.2 Methodology and sampling of populations in twin studies

For a true prevalence of strabismus to be obtained in twins studies, both should be examined using the cover test performed by a trained professional, as has been previously reiterated, for prevalence rates in population-based studies. Clinical bias can occur when samples are chosen from patients who attend a certain hospital or medical records are examined retrospectively. Familial biases may be difficult to avoid, logically when one twin is affected with the condition studied, families are more willing to participate and volunteer the other twin for examination compared to families where neither of the twins are affected with the condition studied[128].

1.5.4.3 Zygosity

Accurate zygosity assignment is important in the calculation of the heritability of a disease. DNA fingerprinting and blood-work is the most accurate way to establish zygosity. Other methods, such as the examination of foetal membranes, are less accurate (25.0 - 30.0% accurate), as dichorionic twins can be either DZ or MZ who separated early. Family opinions combined with similar physical attributes such as iris and hair colour are usually 95.0% correct, although discordant MZ twins maybe wrongly reported as DZ twins. These cases often provide important clues as to the aetiology of diseases.

1.5.5 Esotropia

Infantile esotropia, which has been thought to be a genetic error present at birth, has been reported to be the most common type of strabismus (1.0 – 2.0% of population). Cohn (1904), found that 22.7% (n = 183) of cases of esotropia had a relative with strabismus and familial prevalence of esotropia has been variably reported to be between 13.0 to-

65.0%[113,125,129]. Podgor [114] reported that the odds of developing esotropia were doubled if a sibling had esotropia as well. Chimonidou [130] found 42.9% of the strabismus cases in their study had infantile esotropia and these were highly concordant in siblings (96.5%). In their sample of twins the age of onset and associated refractive error were the same.

Abrahamson reported an even higher increase in the risk of developing esotropia (4 - 6 times) if there was a family history of either > +3.00D hyperopia or esotropia. Dobson and Seris [131] reported that 38.0% of cases of esotropia were associated with moderate hyperopia (>4.00D). Massinn reported that more than half of cases of esotropia are accommodative in nature, but that the degree of hyperopia does not indicate whether the esotropic deviation would be constant or intermittent. Hyperopia is thought to be transmitted dominantly with strong penetrance, seldom skipping a generation [132]. While hyperopia alone was determined to be insufficient to cause strabismus [125], an uncorrected moderate to high hyperopic refractive error is a well-known risk factor for strabismus.

In a longitudinal study [109] children who had >+4.00D hyperopia at 6 months of age that remained unchanged for the next 2 years developed esotropia while those with the same amount of refractive error but whose refraction grew towards emmetropia did not develop esotropia. It was therefore suggested that the genetic determination of esotropia might be related to failure of the process of emmetropisation.

Hofsetter (1947) reported a high degree of concordance of the AC/A ratio in monozygotic twins. Mash has suggested that this may also contribute to the genesis of strabismus. Three conditions which have been suggested to increase the probability of esotropia development are (i) a parent with esotropia, (ii) a familial history of esotropia and (iii) a history of one or both parents with low vergence ability and significant hyperopia[133-135]. They have postulated that these factors may be associated with the genetic determinants of strabismus rather than any secondary effects of strabismus. Fusional range has also been reported to be genetically influenced and has been proposed to contribute to genetic strabismus

liability [110]. Current opinion is, therefore, that accommodative esotropia is transmitted, via a multi-factorial inheritance associated with hyperopia.

1.5.6 Exotropia

The genetic aspects of exotropia are less defined when compared to those of esotropia. Observations that exotropia is more common in non-Caucasian ethnicity have been advanced to support a genetic trait to the condition [125]. Amongst exotropes, 36.8% have been reported to have a positive family history of the condition consistent with a recessive mode of inheritance [129]. In contrast, Waardenburg [136] cited several studies, which reported exotropia to be transmitted directly through generations implying a dominant transmission. Massin reported 50.0% of exotropes were myopic along with a high prevalence of myopia in families of exotropes [132]. Podgor [114] found that the chances of developing exotropia did not increase if the sibling was from the same multiple birth.

1.6 SENSORY STRABISMUS

Strabismus may be caused by the reduction or loss of visual acuity due to pathology such as anomalies of the retina or ocular adnexa, or cataract or optic neuropathy as well as significant refractive error. Other predisposing factors for the development of strabismus can include retinal dystrophies in conditions such as Kearns-Sayre syndrome[104], absence of the development of a foveal pit and/or undeveloped or absent binocular vision due to incomplete decussation of optic nerves at the optic chiasm in ocular albinism. Disruption to the neural development, particularly the Vlth cranial nerve, at the nucleus or pathway may further lead to mechanical changes of the extraocular muscles such as seen in Miller syndrome. A high proportion (40.0 – 60.0%) of patients with general brain diseases such as Downs's syndrome, cerebral palsy, and hydrocephalus also present with strabismus.

1.7 OCULAR SYNDROMES ASSOCIATED WITH STRABISMUS; CFEOM, DUANE'S, MOEBIUS & BROWN'S

1.7.1 Congenital Ocular Fibrosis of Extra Ocular Muscle (CFEOM)

Conditions of congenital restrictive ophthalmoplegia affect muscles, oculomotor and trochlear nerve distribution and can cause bilateral ptosis, infraducted globes and marked strabismus[112]. Congenital Ocular Fibrosis of Extra Ocular Muscle (CFEOM) are known to include Duane's and Brown's syndrome [125]. The pattern of inheritance is usually autosomal dominant inheritance with linkage to FEOM1 locus. Smaller pedigrees harbour mutations in the FEOM3 gene [112]. Deletion and mutation of mitochondrial DNA has also been reported. Tissues with high metabolic demands, such as the retina and extra ocular muscles, are commonly affected giving rise to variable phenotypes[104,125].

1.7.2 Duane's Syndrome

Duane's syndrome accounts for 1-4% of strabismus patients[137]. Persons with Duane's Syndrome typically show limited abduction with widening of palpebral fissure and a retraction of the globe on adduction with a narrowing of the palpebral fissure. Up-shoots and down-shoots of the eye in these positions of gaze are also observed [138]. It is considered a congenital fibrosis syndrome resulting from distinct but analogous developmental defects of the ocular central nervous system with absent or defective cranial nerves[138,139]. Despite this anomaly of ocular motility, an area of binocular singe vision may exist for these patients.

Duane's can be categorised as type I, II and III. Patients classified as Type I will manifest an esotropia in forced primary position with limited abduction and little or no adduction deficit. Type II is an exotropia in primary position with limited adduction. Type III has limited abduction and adduction, hence may have esotropia or an exotropia in primary position depending on the imbalance of the abnormal innervation [137].

The heredity of Duane's Syndrome has been widely examined and 90.0% of cases are known to have a familial predisposition [140]. In approximately 10.0% of cases, Duane's occurs

as an autosomal dominant characteristic. Other cases are often sporadic [103,125,140], although they may also occur as an autosomal recessive disorder [138]. In 2.0 - 8.0% of people with Duane's Syndrome another family member has the same condition and 22.0% have a first degree relative with some form of strabismus and 17.5% have a more distant relative with strabismus [125]. Genetic mapping of families with Duane's Syndrome has identified chromosomal *loci*: 2q31, 8q13 and 22q11 [138] while 4q27-31 and 8q12.2 – q21.2 have also been proposed as another potential *loci*, [140]. In a cross-section study of a large family, 25 of the 110 family members had Duane's Syndrome. A further study of 68 patients with Duane's Syndrome reported 46.0% had a first degree relative with associated ocular abnormalities [138].

The aetiology of Duane's Syndrome was first thought to be fibrosis of the extra ocular muscles. Attributions have since been ascribed to an anomaly in the development of cranial nerves, the absence of Abducens nucleus and associated 6th nerve on the side of the abnormality in ocular movement, while there is also evidence of aberrant innervations [104,125,140]. Other variations include Marcus Gunn jaw winking syndrome and Crocodile tears, where significant misrouting of innervation has been reported [104]. Rarer associations include Okihiro syndrome, Rubinstein and Klippel-Feil syndrome [140]. Duane's syndrome has also been reported in children with hydrocephalus and accompanying hearing anomalies [140]. All these disorders have been associated with significant phenotypic variation[139]. There are also clinical overlaps with congenital esotropia, confirming previous suggestions of an association with the mosaic Trisomy 8, which has been proposed may be allelic and may be due to a gene on chromosome 8 [141].

1.7.3 Moebius Syndrome

Moebius Syndrome is associated with paralysis of the 6th and 7th cranial nerves resulting in lateral gaze palsy and facial paralysis and occasionally the 5th and 8th cranial nerves may be impacted. They may also occur on account of a number of skeletal defects. The presenting sign is a large angle (> 50 prism dioptres) of congenital esotropia. In a retrospective study, 38.0% of children with Moebius syndrome have esotropia. This syndrome is frequently associated with feeding and sucking problems [140]. Traboulsi [125] and Maumenee [124] have conversely reported aplasia of the medial rectus and lateral rectus muscles and suggested a mesodermal dysgenesis, rather than muscle denervation, as the aetiology of strabismus seen in Moebius syndrome.

1.7.4 Brown's Syndrome

Brown's syndrome usually manifests as an ipsilateral limitation of elevation, most marked in adduction. It may also show a down-drift of the eye on adduction. Typically, as most individuals with Brown's Syndrome have straight eye alignment in the primary position of gaze, they retain binocular single vision. In some cases this will be facilitated by the adoption of an abnormal head posture, commonly chin elevation, which is also true for some patient's with Duane's. The heredity of Brown's syndrome has been far less reported. Unlike Duane's syndrome, Brown's can be acquired. The proposed pattern of inheritance has been suggested to be autosomal recessive or autosomal dominant with reduced penetrance [138]. So far two possible genetic candidates, FEOM3 locus and FEOM2 gene have been excluded[138,142]. Interestingly mirroring cases have been reported in monozygous twins [143]. Familial clusters and high concordance rates in monozygotic twins have also been reported for Brown's Syndrome, usually transmitted *via* autosomal dominant inheritance [104]. It has also been observed that IVth nerve palsy and associated strabismus tend to cluster within single-family units suggesting that the responsible gene or genes may affect the development of cranial nerves themselves [138].Most cases of congenital Brown's Syndrome are constant and do not spontaneously resolve or improve. Some may require surgical intervention. These

characteristics may be contrasted with acquired Brown's Syndrome, which have a tendency to be intermittent and may spontaneously resolve and respond to medical treatment [144]. It is generally regarded as an isolated developmental abnormality involving the trochlear complex, which includes the trochlear, the tendon sheaths, the superior oblique muscle and the trochlear nerve [104].

1.8 OTHER CRANIOFACIAL SYDROMES ASSOCIATED WITH STRABISMUS

Strabismus has also been associated with other known inherited syndromes, in particular craniofacial disorders involving multiple developmental and physical anomalies. Mechanical restrictions of eye movements are common. Wide epicanthus can appear like strabismus (pseudo-strabismus). Premature closure of cranial sutures or bony malformations can create asymmetry of the skull, may also affect the shape and size of the globe as well as change the elasticity of extra ocular muscles. Secondary Fibrosis of extra-ocular muscle have been proposed as one of the causes of strabismus.

These syndromes commonly show an autosomal dominant trait (Apert's, Crouzon's Treacher-Collins, Franschetti, hemifacial microbomia and Waardenburg syndromes) [103]. Large proportions (42.0 %) of craniofacial patients undergoing strabismus surgery have been reported to have a total absence of extra-ocular muscle. The degree of misalignment often depends upon the severity of skeletal deformity [103].

Some craniofacial disorders involve defects of different chromosomes with similar strabismus phenotypes. For example, Apert's Syndrome has been associated with esotropia, exotropia and hypertropia. Kearns-Sayre syndrome has been reported to be associated with mitochondrial gene deletion as well as structural defects in extra ocular muscle mitochondria. Muscle fibre is highly oxidative and fatigue resistant which is depending upon an extensive capillary network. This takes time to mature and is most susceptible to alterations in innervation, both neural and vascular.

1.9 GLOBAL SYNDROMES COMMONLY ASSOCIATED WITH STRABISMUS

1.9.1 Down's Syndrome

Down's syndrome is a condition associated with an abnormality of the chromosomes due to a trisomy of chromosome 21 [145] (94%), translocation (4%), and mosaicism (2%) [146]. Children with Down's syndrome have a higher risk of developing a number of ocular defects. Common ocular manifestations include strabismus, refractive error, reduced visual acuity, poor contrast sensitivity, insufficient accommodation [145,147,148], decreased fusional capacity [147], short sloping palpebral apertures, nystagmus and peripheral atrophy of iris stroma [145]. Children with Down's syndrome also have a significant reduction in central corneal thickness, thinner lens, lower lens power and significantly shorter axial length[148]. The usual link between esotropia and hyperopia has been shown to be absent in Down's syndrome children and high myopia co-exists with esotropia [147].

1.9.2 Albinism

Albinism is an inherited disorder characterized by the reduction or absence of melanin in the hair, skin and/or eyes. This is largely due to deficiency of the melanin producing enzyme tyrosinase [149 150]. The *TYR* gene codes for tyrosinase, which is located in melanocytes that produce melanin. Melanin is essential for the retinal pigmented epithelium which plays a role in normal vision development. Albinism is divided into two main categories, ocular albinism (OA) in which only the eyes are affected and oculocutaneous albinism (OCA) where the skin and eyes are hypopigmented [150].

Ocular albinism is mainly transmitted as a sex-linked or autosomal recessive disease associated with the OA1 gene[151-153]. Female carriers show minor signs whereas affected males have a tendency to manifest a constellation of signs [152]. Patients with OA are often fairer than their unaffected siblings and may have macromelanosomes [154]. Macromelanosome are granular pigmented lesion occurring most frequently in the skin and eyes of persons with x-

linked ocular albinism[155]. Oculocutaneous albinism (OCA), a heterogeneous group of autosomal recessive disorders with variable phenotypic expression characterized by congenital hypo-pigmentation of the skin, hair, and eyes[151,153,154]. Mutations in the *TYR* gene have been identified in people with oculocutaneous albinism type 1.

OA and OCA exhibit similar ocular manifestation, although the severity of symptoms can vary according to the type of albinism and race[152,154], severity of de-pigmentation [154] and severity of tyrosinase defect [151]. Reduced visual acuity is present at birth ranging from 20/20 to 20/400. This may remain stable, but sometimes may improve with age. Reduced visual acuity can be attributed to several factors such as foveal hypoplasia, strabismus, high refractive error and / or nystagmus [152]. Of these, foveal hypoplasia may be the most significant factor contributing to reduced visual acuity. In addition, 14.0% of those with albinism have significantly high refractive error (>10.0 dioptres), with mixed astigmatism being the most common type reported [153]. Reduced levels of photopigment in retinal pigment epithelium (RPE) causes light to scatter within the eye causing photophobia and also contributes to the reduced visual acuity in albinism.[154] [151] . Deficient pigmentation may cause abnormal decussation of optic nerve fibres due to the misrouting of the retinogeniculate projections, leading to a predominantly monocular representation of the central visual field in each occipital cortex, lack of binocular vision and possibly strabismus[151,152,154].

Increased incidences of strabismus have been reported for individuals with albinism (50.0%) particularly accommodative esotropia[151,153]. Abnormal decussation of optic nerve fibres and the absence of a foveal pit may limit the capacity for fusion [152,154] . Lack of binocular and poor stereoacuity may be secondary to abnormalities of the optic pathways [152]. As a consequence, fine grade stereoacuity is absent though some gross stereoacuity may be present due to projections from the temporal retinal periphery, where fibres remain correctly routed, or *via* inter-cortical of intra-cortical communications *via* the *corpus callosum*. Function is, however, debatable [154].

Variable nystagmus, pendular, jerk or latent, may be present at birth or as early as 2 - 3 months. This has been attributed to an anomaly of the visual pathway and foveal hypoplasia [154] [152]. Nystagmus onset correlates with the degree of fovea/ hypoplasia [151,152]. Near visual acuity may be better as nystagmus tends to dampen on convergence[152].

Visually evoked potentials have been used as a diagnostic tool to confirm albinism by identifying the crossed asymmetry that signifies the abnormal decussation of the nerve fibres at the optic chiasm, except in cases of Rufous Oculo Cutaneous Albinism (ROCA) [154]. People with albinism have also been observed to exhibit visual inattention up to 3 – 8 months of age, which reflects a form of delayed visual maturation, usually not attributable to the maturation of the visual cortex [154]. Decreased hearing has also been associated with some forms of x-linked ocular albinism [152]. Treatment options for the ocular complications of albinism include; strabismus surgery for esotropia or exotropia if present, as well as surgery for nystagmus that aims to reduce the amplitude of the nystagmus in the primary position of gaze, with a consequent improvement of visual acuity and/or a reduction of a bothersome head posture. These are performed in conjunction with correction of refractive error and tinted lenses to reduce photophobia. Laser photocoagulation for coexistent retinal disease can be an option but must be undertaken with caution since the laser needs pigment to be absorbed. [152]

1.10 OTHER RISK FACTORS ASSOCIATED WITH STRABISMUS

Risk factors associated with strabismus can be potentially modifiable if environmental in origin or they can be endogenous (genetic, heredity factors). It is important to note that it is often hard to explicitly separate these two categories since they most likely work in tandem in the development of strabismus. In 1901 Worth had proposed that strabismus was brought about by defective fusion, while Chavasse considered the disruption of normal development of ocular components during a critical period of between 0 – 8 years old to be crucial. Currently the aetiology of strabismus is thought to be complex and multi-factorial; a combination of endogenous (genetic) and exogenous (environmental) factors[104,112,123].

Population-based studies, which have examined associations with strabismus [3,11,13,31,40,156,157] have reported associations with low SES, low birth weight, prematurity and ethnicity. Other risk factors include familial hereditary associations [115,158,159], ante-natal complications [13,159,160] and various neuro-developmental conditions [96-99,161,162].

1.10.1 Low Economic Status (SES)

To date no studies have reported on the direct impact of child and maternal nutrition to the prevalence of strabismus. Comparing the prevalence of strabismus in populations from high and low SES, particularly in economically developed countries, could be potentially revealing. One study which has examined prevalence of strabismus in populations from low SES populations and has also met the gold standard of testing has reported a much higher rate of strabismus (9.7%) in the low SES group when compared to other more heterogeneous populations [56]. Other studies reported a much lower rate of strabismus (0.5 – 1.6%) [73,163], though these studies may be subject to some methodological criticism since the gold standard for strabismus ascertainment was not adhered to. Setting aside difficulties associated with variable methods for determining cases of strabismus, it is arguable that children from low SES are at an increased risk of strabismus but adding to the complex nature of this analysis, this relationship may not be consistent for all forms of strabismus. A study by Chew, *et al* [3] has associated exotropia with indicators of low SES, but the SMS [13] did not find any such association in their younger sample, aged 6 years. Yet the SMS found that children with exotropia had a significantly lower mean birth weight when compared to those without strabismus, which may indicate poor maternal nutrition and/or smoking which tend to be associated with lower SES groups. Low SES is likely to affect a wide range of pre- and post-natal factors, such as maternal and/or a child's nutrition, parental education and the frequency of use of health services, all of which may have some impact on the genesis of strabismus. More defined factors need to be elucidated in well-designed studies in order to determine the precise association of low SES with strabismus.

1.10.2 Maternal Exposure to Smoking, Low Birth Weight & Prematurity

Another risk factor consistently reported to be associated with strabismus is maternal smoking during pregnancy[3,156,157,159,164-171]. Even low levels of maternal smoking have been associated with esotropia [166]. The period during which the mother smoked has been observed to be a factor, with maternal smoking within the third trimester being particularly associated with strabismus [156 169 31]. Maternal smoking has also been reported to cause abnormal hyperopic shifts in refraction [168] and reduced stereoacuity[169]. Cigarette smoke is thought to be toxic to ocular tissue when transmitted across the placenta [164].

Where esotropia and exotropia have been examined separately, a link between maternal smoking and esotropia has been established in three studies [156 169 171] and with exotropia in two [11,166], one of which found the association with exotropia only for high levels of maternal smoking (>20 cigarettes per day) [3 157,165,166,169]. The SMS has also reported a higher rate of strabismus in children whose mother smoked during pregnancy (4.2%) when compared to those children whose mother did not (2.6%)[13]. However, this association did not reach significance, possibly due to the small number of cases[13]. More studies need to be undertaken to examine the dose response relationship of maternal smoking and prevalence of strabismus. It has been suggested that cigarette smoke may be directly toxic to ocular tissue [164].

One case-control study has reported an association between strabismus present at birth and mothers whose partners smoked indoors, but no association between maternal smoking during pregnancy after adjustment for a variety of confounding factors [157]. However, a number of studies have failed to find any association between exposure to *passive* smoking during pregnancy and strabismus [168] or more specifically with esotropia[169]. Others have found that *passive* smoking, in addition to maternal smoking, appeared to increase the risk of developing esotropia [156]. Stone, *et al* have suggested that maternal smoking is associated with both hyperopia and strabismus but through different mechanisms. They noted that hyperopic shifts

in refraction were seen in children exposed to both maternal and *passive* smoking during pregnancy, whilst strabismus was only associated with maternal smoking. However, Christian *et al* associated maternal smoking with hyperopia only where strabismus was present [165]. The pattern of association of hyperopia, strabismus and maternal smoking is not at all clear and needs to be examined more closely and in particular in possible association with accommodative esotropia.

It is well known that low birth-weight and maternal smoking during pregnancy are strongly associated [172]. It could therefore be argued that the association of maternal smoking and strabismus may be confounded by low birth weight. However, we found that the association between esotropia and maternal smoking was independent of birth weight, as has been found in other studies [3 156,165]. While some studies have found an independent association between strabismus and low birth weight[101,173-177]. At least one study suggested that there was an association between maternal smoking and strabismus that was dependent upon on birth weight [31]. The difficulty in separating these factors and their respective contributions to strabismus has largely confounded this area of investigation. In addition, self-reporting of smoking during pregnancy is known to underestimate the prevalence of maternal smoking when compared to more objective measures [178].

To add to this difficulty, premature birth has also been linked to both low birth weight and maternal smoking [172]. Several studies have associated strabismus with prematurity [3,13,31,101,175,177,179-181]. The extent to which strabismus is attributable to low birth weight per/se or to prematurity is difficult to determine since these two factors are inexorably interlinked. The Millennium Cohort Study [31] attempted to establish the relative contributions of prematurity and low birth weight, and speculated that prematurity may play a more important role in the development of strabismus than retardation of in-utero growth. However, in this study the strongest association with strabismus was apparent when both prematurity and low birth weight were present [31]. A possible pattern of association of strabismus with maternal smoking maybe *via* low birth weight, due to intra-uterine growth retardation [182-184 185 186 187].

It maybe that children with intra-uterine growth retardation (therefore low birth weight) may also have a relatively smaller eyes [101] [179,188] and therefore may possibly be at greater risk of developing higher than normal hyperopic refractive error, as is commonly associated with accommodative esotropia [108,189,190]

Other factors that are closely linked with prematurity that may have increased risk of strabismus include retinopathy of prematurity (ROP)[9,101,175,191-193]. A case-control study examined the association of strabismus with low birth weight, prematurity and ROP separately and found that all three risk factors independently led to the development of strabismus, and suggested that each of these risk factors may operate via different mechanisms[9]. Pathai concluded, however, that prematurity played a more significant role in the development of strabismus than in-utero growth. In contrast a number of other studies have suggested that the association between maternal smoking and esotropia is independent of birth weight. (SMS)[3] [156,165]. Hakim, *et al* [156] reported that although the association between maternal smoking and esotropia is independent of birth weight for those children born weighing less than 2,500g and also those born weighing more than 3,500g the risks of strabismus were more significant but they were not able to explain this U-shaped pattern of association. Low birth weight children without ROP have been found to have significantly smaller eyes but did not have the expected high hyperopic refractive errors. It has been suggested that initially they may have had a high hyperopic refractive error but that the early strong developmental drive reducing neonatal refractive error, known as emmetropisation, overcame the reduced axial length [101]. However, the SMS has previously associated maternal smoking with hyperopia [17].

In evaluating the relative contribution of prematurity and low birth weight, data should be stratified into children with and without retinopathy of prematurity (ROP) as ROP is a well-known risk factor for strabismus[9,101,175,191-193]. Those studies which have compared children who were born prematurely and who have or have not developed ROP, have reported a high rate of strabismus (>20.0%) in children with ROP and a higher than population normal rate of strabismus in those premature children who do not have ROP [101,175,176,181,191-195].

1.10.3 Admission to the Neonatal Intensive Care Units (NICU)

Although admission to NICU is has been associated to strabismus, particularly esotropia[31,173], this may not be a causal relationship. Rather it may represent a surrogate for a range of risk factors that are linked to both strabismus and admission to NICU, which will confound the association. Reasons for admission to NICU include prematurity, low birth weight and a variety of perinatal complications [13,159,160]. Perinatal complications associated with strabismus reported elsewhere include alcohol consumption during pregnancy, maternal illness, complications during labour, assisted or caesarean delivery, respiratory difficulties, jaundice and/or infection within the first week of life [31].

1.11 CONCLUSION

The first chapter of this thesis will focus on reviewing previous data reported on the prevalence of strabismus and provide an explanation as to why the reported rates differ so markedly across studies. Prevalence varies amongst populations and has been reported to be from as low as 0.01% in young Japanese children [196] to as high as 26.8% in children with neuro-developmental anomalies [91]. In examining the data in table 1.3 – 1.5 it became readily apparent that prevalence values were much more consistent when gold standard techniques for epidemiology and ascertainment were adhered to. The compositional traits include age, ethnicity as well as study design (school, population based) Variations within these parameters have operated to confound the comparison between studies when trying to determine a true picture of the population prevalence of strabismus across time. In order to determine whether the prevalence of strabismus has varied over time it is necessary to take these two parameters into account. There are now reasonably consistent estimates of the prevalence of strabismus for populations of European Caucasian origin, and a consistent pattern of predominance of esotropia over exotropia. More studies are needed to give useful estimates of the prevalence of strabismus in all other ethnic groups, although it is clear that in East Asian populations, exotropia is more common than esotropia.

The experimental chapters of this thesis will report the analysis of data from two studies, namely the Sydney Myopia Study (SMS) and the Sydney Paediatric Eye Disease Study (SPEDS). Taking into account the information of what the gold standard for ascertainment of strabismus cases, the prevalence of strabismus from these two studies will be reported. An extensive statistical analysis will hopefully identify risk factors associated with strabismus. Particular importance will be placed on factors which are potentially modifiable such as maternal smoking. This thesis will assess the associated risk factors for the strabismus subtypes separately concentrating on esotropia and exotropia, while controlling for other confounding risk factors.

1.12 TABLES & FIGURES

Table1.1: Sub-classification of concomitant strabismus [30]

Subtype	Definition
Primary Esotropia	
Accommodative Esotropia	Esotropia associated with hyperopic refractive error.
Intermittent Esotropia	Esotropia only present at either near or distant fixation, without refractive correction.
Constant Esotropia	Esotropia present at both near and distance fixation without any refractive error.
Micro-Esotropia	Small angle esotropia, usually < 10 prism dioptres, with functional binocular vision but not bifoveal. May be associated with a slight decrease in visual acuity in affected eye
Primary Exotropia	
Intermittent Exotropia	Exotropia only present at either near or distant fixation.
Constant Exotropia	Exotropia present for both near and distance fixation.
Micro-Exotropia	Small angle exotropia, usually < 10 prism dioptres, with functional binocular vision but not bifoveal. May be associated with a slight decrease in visual acuity in affected eye

Abbreviations

CT	COVER TEST
H	HIRSCHBERG
Q	QUESTIONNAIRE
EC	EUROPEAN CAUCASIAN
AFR	AFRICAN
HIS	HIPANIC
SA	SOUTH ASIAN
ME	MIDDLE EAST
EA	EAST ASIAN
ND	NOT DISCLOSE

Table 1.2 Population-Based studies that sampled predominantly European-Caucasian ethnicities have met the 'gold standard' for assessment of strabismus prevalence showing the test used for strabismus ascertainment and professional who performed it.

No	YEAR	AUTHOR	STUDY TYPE POPULATION BASED	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)						
				TEST	PERSON PERFORMING TEST	AGE (yrs)	FEMAl (%)	SIZE (n)	Country origin	EC	AFR	HISP	SA	ME	EA	MIXED/ OTHER
1	1974	Graham[40]	POPULATION BASED	CT	Orthoptist	5 – 6	ND	4784	UNITED KINGDOM	5.3						
2	1997	Chew[3]	POPULATION BASED LONGITUDINAL	CT	Paediatrician	0 - 7	ND	39227	USA	5.1,	3.5					4.3
3	2001	Kvarnstrom[197]	POPULATION BASED	CT	Paediatrician	4	ND	3126	SWEDEN	3.1						
4	1976	Wick, B[198]	POPULATION BASED	CT	Ophthalmic student	5 - 10	ND	398	USA	3.9						3.7
5	2009	Friedman D[5]	POPULATION BASED	CT	Ophthalmic team	0.5 - < 6	52.4	2546	USA	3.3	2.1					
6	2005	Horwood, J[22]	POPULATION BASED	CT	Orthoptist	7.5-8.5	ND	6036	UK	2.5						
7	2008	Williams[11]	POPULATION BASED	CT	Ophthalmic team	7	49.2	7538	UNITED KINGDOM	2.3						
8	1973	Kohler & Stigmar [47]	POPULATION BASED	CT	Nurse	4	48.0	2 447	SWEDEN	1.6						
9	2010	Pathai[31]	POPULATION BASED	Q	Ophthalmic team	3	49.4	14980	UNITED KINGDOM	2.1						

Table 1.2.1 Population-Based studies that sampled other ethnicities have met the 'gold standard' for assessment of strabismus prevalence showing the test used for strabismus ascertainment and professional who performed it.

	YEAR	AUTHOR	STUDY TYPE POPULATION BASED	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)						
				TEST	PERSON PERFORMING TEST	AGE (yrs)	FEMALE (%)	SIZE (n)	Country origin	EC	AFR	HISP	SA	ME	EA	MIXED/ OTHER
10	2000	Pokharel[50]	POPULATION BASED	CT	Ophthalmic team	5 - 13	ND	5067	NEPAL				2.1			
11	2004	He [6]	POPULATION BASED	CT	Ophthalmic team	5 – 15	48.1	4364	CHINA						1.9%-N, 3.0%-D, >80% XT	
12	2000	Zhao[51]	POPULATION BASED	CT	Ophthalmic team	5 – 15	48.9	5884	CHINA						2.8	
13	2010	Chia [57]	POPULATION BASED	CT	Ophthalmic team	0.5 - 6	47.6	3009	SINGAPORE						0.8	
14	2008	MEPEDS[48]	POPULATION BASED	CT / H	Ophthalmic team	0.5 - 6	ND	6014 (3007)	USA		2.5	2.4				
15	2003	Naidoo[53]	POPULATION BASED high crime rate area	CT	Ophthalmic team	4890	5 - 15	ND	AFRICA		2.4					
16	1969	Mann, I[199]	POPULATION BASED	CT / H	Ophthalmic team	ND	ND	333	NEW ZEALAND							2.6
17	2000	MAUL[56]	POPULATION BASED	CT AT NEAR	Ophthalmic assistant	5 - 15	54.9	5303	USA			9.7				
18	2002	Murthy[54]	POPULATION BASED	H	Ophthalmic assistant	5 - 15	ND	6447	INDIA				0.5			
19	2003	Nirmalan[55]	POPULATION BASED	H	Lay person	< 15	ND	10605	INDIA				0.4			

Table 1.2.2 Population-Based studies that sampled subsets of the population assessed that have met the 'gold standard' for assessment of strabismus prevalence showing the test used for strabismus ascertainment and professional who performed it.

No	YEAR	AUTHOR	STUDY TYPE POPULATION BASED	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)						
				TEST	PERSON PERFORMING TEST	AGE (yrs)	FEMALE (%)	SIZE (n)	Country origin	EC	AFR	HISP	SA	ME	EA	MIXED/ OTHER
19	1993	Fischbach[59]	POPULATION BASED SUBSET OF THOSE WITH DECREASED VA	CT	Ophthalmic team	6 - 7	48.0	854	USA (low SES)	1.6		0.9				
20	1978	Kohler & Stigmar [60]	POPULATION BASED partial cohort – previously screened	CT	Ophthalmologist	4 - 5	ND	2178 - 1530	SWEDEN	1.8						
21	2004	Lim[200]	POPULATION BASED screening program – SUBSET OF FAILED SCREENING	CT	Ophthalmologist	3 - 5	ND	36973 7116-failed home test - VA retest, 2058-REFERRED FINAL 894	KOREA						0.15	
22	1980	Friedman Z[201]	POPULATION BASED – low SES child welfare clinics	CT	Optometrist	1 – 2.5	ND	38000	USA							1.3
23	2009	Jamali[202]	POPULATION BASED but excluded those with intellectual disability	CT	Optometrist	6	49.2	815	IRAN					1.2		
24	2009	Kattouf [33]	POPULATION BASED intervention program	CT / H	Lay person	<0.5 - <7	51.0	4298 BLACK 1863 HISP 2110 OTHER	USA			1.6				
25	2009	Khandekar[203]	POPULATION BASED screening, referral	H	Lay person	3 - 6	ND	1433540	IRAN					0.25		
26	1991	Edwards[204]	POPULATION BASED Longitudinal	Photography – WITH CYCLO	ND	>0.75	52.3	158	HONG KONG						1.6 XT	
27	2008	Karlica, D[205]	POPULATION BASED + eye clinic retrospective + preterm vs. term	ND	Ophthalmologist	ND	ND	20045 2882 preterm	CROATIA	4.0						

Table 1.3 School-Based studies that sampled predominantly European-Caucasian ethnicity, which have met the 'gold standard' for assessment of strabismus prevalence. Showing the test used for strabismus ascertainment and professional who performed it.

No	YEAR	AUTHOR	STUDY TYPES SCHOOL BASED	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)						
				TEST	PERSON PERFORMING TEST	SIZE (n)	AGE (YRS)	FEMALE (%)	Ethnic / Country origin	EC	AFR	HIS	SA	ME	EA	MIXED/ OTHER
1	2003	Barry, J. C[43]	SCHOOL-BASED 121 Kindergartens	CT	Orthoptist	1114	3	ND	GERMANY	1.8						
2	2008	Abdi, S[42]	SCHOOL-BASED Stratified cluster	CT	Ophthalmic team	216	6 - 12	51.4	SWEDEN	1.4						
3	1949	Tyser, P. A[44]	SCHOOL BASED	CT	Ophthalmic team	460	15 - 5	46.3	UNITED KINGDOM	2.4						
4	1987	Macfarlane[1]	SCHOOL BASED	CT	Ophthalmic nurse	877	7 - 9	ND	AUSTRALIA	2.5						
5	2003	Zaba, J. N[45]	SCHOOL BASED	CT	Optometrist	5316	3 -6	ND	USA	2.3						
6	1986	Woodruff[62]	SCHOOL BASED Included phoria	CT	Optometrist	10464	6	ND	CANADA	3.9						
7	1980	Laatikainen, L[69]	SCHOOL BASED Random selection of representative school-aged children	CT	Ophthalmologist	411	7 - 15	ND	FINLAND	4.6						
8	2005	Aring[70]	SCHOOL-BASED CONVENIENT SAMPLE	CT	Orthoptist	143	4 - 15	47.0	SWEDEN	3.5						
9	2002	Junghans[71]	SCHOOL BASED but biased by self selection	CT	Optometrist Interns	2697	3 -12	45.1	AUSTRALIA	3.0						
10	2010	Garvey*[72]	School -based low SES (Head Start)	CT	Ophthalmic team	909	3 - 9	ND	AMERICA	2.5						

Table 1.3.1 School-Based studies that sampled other ethnicities, which have met the 'gold standard' for assessment of strabismus prevalence. Showing the test used for strabismus ascertainment and professional who performed it.

No	YEAR	AUTHOR	STUDY TYPE SCHOOL BASED	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)						
				TEST	PERSON PERFORMING TEST	SIZE (n)	AGE (YRS)	FEMALE (%)	Ethnic / Country origin	EC	AFR	HIS	SA	ME	EA	MIXED/ OTHER
11	2000	Gupta, M[64]	SCHOOL BASED	CT	Ophthalmic team	310	4 - 12	44.8	INDIA				2.9			
12	2009	Gupta, M[63]	SCHOOL BASED	CT	PhD student with ophthalmic training	1561	6 - 16	47.9	INDIA				2.6			
13	2003	Ohlsson[10]	SCHOOL BASED	CT	Ophthalmologist	1035	12 - 13	56.0	MEXICO			2.3				
14	2008	Lu[8]	SCHOOL BASED	CT	Ophthalmologist	1129	6 - 14	0.4	CHINA						2.5	
15	2009	Reddy, S. C[26]	SCHOOL BASED	CT	Ophthalmic team	1214	7 - 12	ND	MALAYSIA						2.5	
16	2007	He [66]	SCHOOL BASED	CT	Ophthalmic nurse	2454	7 -15	48.7	CHINA						1.6	
17	2009	Unsal, A[67]	SCHOOL BASED	CT	Ophthalmic team	1606	6 - 17	46.3	OTHER					1.7		
18	2010	Yekta, A[28]	SCHOOL BASED	CT	Optometrist	2638	12.5	50.0	OTHER					2.0		

19	1996	Prealan & Novak[15]	SCHOOL BASED	CT AT NEAR	Health technicians	680	PRESCHOOL – 2ND GRADE	48.4	USA	3.1				
20	1998	Prealan & Novak, 1998[83]	SCHOOL BASED	CT AT NEAR	Health technicians	285	4 – 6	ND	USA	3.2				3.8
21	1995	Auzemery, A[206]	SCHOOL BASED	ND	Ophthalmic team	1081	8 – 14	ND	AFRICA	1.1				
22	1981	Cohen, J[81]	SCHOOL BASED	H	Optometrist Interns	651	3 - 4	346.0	USA	1.0				
23	1998	Lithanderr[79]	SCHOOL BASED	H	Medical student	6292	6 -7 AND 11 - 12	ND	OMAN			0.87		
24	1997	Kalikivayi[80]	SCHOOL BASED	H	ND	4,029	3 - 18	41.7	INDIAN		0.7			
25	1992	Al Faran, M.[82]	SCHOOL BASED, random selection students from 15 schools	ND	Teacher	3590	ND	0.0	Middle East			0.5		
26	2007	Matsuo [77]	SCHOOL BASED	Q	Teacher	84619	6 – 12	ND	JAPAN				0.99	
27	1996	See, L. C[78]	SCHOOL BASED	SELF REPORT		862	1ST 3RD 6TH GRADES	ND	CHINA				1.62	

Table 1.3.2 School-Based studies that sampled subsets of the population assessed that have met the 'gold standard' for assessment of strabismus prevalence showing the test used for strabismus ascertainment and professional who performed it.

No	YEAR	AUTHOR	STUDY TYPE SCHOOL BASED	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)						
				TEST	PERSON PERFORMING TEST	SIZE (n)	AGE (YRS)	FEMALE (%)	Ethnic / Country origin	EC	AFR	HIS	SA	ME	EA	MIXED/ OTHER
28	2002	**Bardisi[75]	SCHOOL-BASED 20 Kindergartens SUBSET FAILED SCREENING	CT	Ophthalmic team	629	3 - 5	ND	SAUDI ARABIA					6.0		
29	1994	**Abolfotouh, MA[74]	SCHOOL-BASED random selection boys, subset VA ≤6/9	CT	Ophthalmic team	971	ND	0.0	SAUDI ARABIA					3.0		
30	2009	Lai, Y. H[76]	Retrospective analysis of screening in 4 preschools	CT	Ophthalmic team	618	3 - 6	49.2	TAIWAN						1.0	
31	2003	Nepal[73]	SCHOOL BASED 3 Low SES schools	CT	Optometrist Interns	1100	5 - 16	54.0	INDIA				1.6			
33	2008	Drover[58]	SCHOOL BASED referral	H	Optometrist	946	MEAN AGE 4.2	ND	CANADA	4.3						
34	2000	**Wedner[163]	SUBSET WHO HAVE FAILED SCREENING	H	Teacher	1386	7 - 19	ND	AFRICA		0.5					
35	2007	**Ajaiyeoba [207]	SCHOOL BASED , randomised schools, then students	ND	ND	1144	4 - 24	55.0	NIGERIA		3.0					

Table 1.4 Clinic based studies that reported on the prevalence of strabismus describing its population and methods of ascertainment.

No	YEAR	AUTHOR	STUDY TYPE CLINIC BASED	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)				
				TEST	PERSON PERFORMING TEST	SIZE (n)	AGE (YRS)	FEMALE (%)	Country origin	EC	AFR	SA	ME	EA
1	1967	Adelstein, [84]	CLINIC BASED - RETROSPECTIVE	CT	Ophthalmic team	3243	<1 - 6	46.0	United Kingdom	4.3				
2	1989	Kendall, J. A*[85]	CLINIC BASED - RETROSPECTIVE	CT	Orthoptist	2598	<10	ND	United Kingdom	4				
3	2005	Donnelly*[4]	CLINIC BASED - RETROSPECTIVE	CT	Orthoptist	1582	7-8	46.8	United Kingdom	3.98				
4	1997	Stidwill[86]	CLINIC BASED - RETROSPECTIVE	CT	Ophthalmic team	60000	ALL AGES	ND	United Kingdom	3.8				
5	1977	Chumbley,[87]	CLINIC BASED - RETROSPECTIVE	CT	Ophthalmologist	3350	<15	ND	Africa: Rhodesia/Mashonaland		O.8			
6	2009	Eballe[88]	CLINIC BASED	CT	Ophthalmologist	422	6 - 15	52.4	Africa		0.7			
7	1998	Bremmer[193]	CLINIC BASED	CT / H	Ophthalmic team	3030	3Months	ND	USA	6.6				
						2449	1			11.8				
9	2003	Maaita[35]	CLINIC BASED	CT / H	ND	1725	6 – 14	ND	JORDAN				0.5	

Table 1.4.1 Clinic based studies that reported on the prevalence of strabismus in populations with condition that may predispose to strabismus.

No	YEAR	AUTHOR	STUDY TYPE DISEASE RELATED	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)				
				TEST	PERSON PERFORMING TEST	SIZE (n)	AGE (YRS)	FEMALE (%)	Ethnic / Country origin	EC	AFR	SA	ME	EA
9	1999	Holmstrom [89]	PREMATURITY & ROP	CT	Orthoptist	199	3.5	52.0	SWEDEN	13.5				
10	2007	Nielsen[91]	DEVELOPMENTALLY DELAYED	CT / H	Ophthalmic team	915	4 - 15	ND	DENMARK	26.8				
11	2007	Stephens [93]	DOWN'S SYNDROME	CT	Ophthalmic team	81	<16	ND	UNITED KINGDOM	47.0				
12	2002	O Connor [101]	OW BIRTH WEIGHT	CT	Ophthalmic team	293	10-12	ND	UNITED KINGDOM	20.1				
13	1997	Darlow [90]	LOW BIRTH WEIGHT	CT	Lay person	296	7 - 8	ND	NEW ZEALAND (Include Maori)	22.0				
14	2003	Bogdanici[92]	LOW SOCIOECONOMIC STATUS	ND	ND	254	8.09 +/- 2.88	ND	ROMANIA	7.9				

Table 1.4.2 Case control studies that reported on the prevalence of strabismus describing its population and methods of ascertainment.

No	YEAR	AUTHOR	STUDY TYPE CASE CONTROL	STRABISMUS ASCERTAINMENT		SAMPLE				PREVALENCE OF STRABISMUS (%)				
				TEST	PERSON PERFORMING TEST	SIZE (n)	AGE (YRS)	FEMALE (%)	Country origin	EC	AFR	SA	ME	EA
15	2006	Holmstrom [100]	CASE CONTROL Low Birth Weight	CT	Orthoptist	216 cases 217 controls	10	52%, 53%	SWEDEN	16.2 3.2				
16	2002	O Connor [101]	CASE CONTROL Low Birth Weight	CT	Ophthalmic team	293 cases 169 Controls	10 -12	ND	UNITED KINGDOM	20.1 3.2				
17	2004	Gronlund, M. A[208]	CASE CONTROL	CT	Ophthalmic team	72 adoptees 99 Controls	4.8 – 10.5	adoptees 43%	SWEDEN	32.0 2				
18	1990	Stayte [209]	CASE CONTROL	CT	Ophthalmic team	6634	<2 YRS	ND	UNITED KINGDOM	Population- 1.5, High Risk - 3.84, Low Risk - 0.99				

Table 1.5 Prevalence rates of strabismus, esotropia, exotropia and hypertropia in patients with Down's syndrome reported from previous studies.

Author	Strabismus % (n)	Esotropia % (n)	Exotropia % (n)	Hypertropia % (n)
Stephen[210]	47.0 (81)			
Jaeger[147]	41.3 (31)	37.3 (28)	2.7 (2)	1.3 (1)
Hiles [146]	34.0 (42)	28.0 (34)	6.0 (8)	
Lowe [211].	33.0 (22)	33.0 (22)	0	
Hestnes [212]	70.0 (18)			

CHAPTER 2 Participants & Methods

Sydney Myopia Study (SMS)
Sydney Paediatric Eye Disease Study (SPEDS)

2.1 SYDNEY MYOPIA STUDY (SMS)

2.1.1 Study Area:

Sydney is Australia's largest city. It comprises 21% of Australia's total population with a population of approximately 4.4 million [213]. It is a multi-ethnic society with the majority of the population being of European Caucasian origin, with nearly half (49.4%) the population having both parents born overseas. The median age of the population is 36 years and children of school age (5 to 19 years) comprise 18.7% of the population.

The SMS involved a random cluster sample of schools within the Sydney Metropolitan Area stratified by socio-economic status (SES) in accordance with census data compiled by the Australian Bureau of Statistics [2001 (ABS)]. The areas with the highest SES are reported within the northern and eastern suburbs, and also within areas around the Sydney harbour while the South Western suburbs of Sydney recorded the lowest SES locations[214]. Schools were placed into 10 strata based on the SES of the postcode in which they were located. Thirty-four primary schools and 21 secondary schools from across Sydney were selected with 5 primary and 2 high schools from the top SES decile. The remaining schools were randomly selected from the bottom nine SES deciles. A representative proportion of public and private/religious schools were included.

2.1.2 Recruitment and Participants:

The SMS recruited two age cohorts; children studying in Year 1, (5-7 years), and in Year 7, (12-13 years), covering key periods in ocular development. All information sessions were conducted upon consent of the Principal of each school with separate sessions for teachers, parents and students. Information packages were sent to all eligible students comprising an information sheet, consent form and a comprehensive questionnaire for the family to complete (see Appendix 1). Written consent from at least one parent, as well as the participating child's verbal consent was a prerequisite for participation in the examinations. Parents who refused an

initial invitation were re-contacted and given a full explanation of the purpose of the study in order to encourage participation. Children who were unable to attend an initial appointment were offered alternative dates at other study locations in nearby schools where necessary. Data was collected throughout 2003 - 2005 and 1739 Year 1 children with a mean age 6.7 years (78.9% response), and 2353 Year 7 children with mean age 12.7 years (75.3% response) participated. Approximately 50.6% of all participants were males.

2.1.3 Questionnaire and Blue Book (Appendix 1)

The SMS questionnaires (comprising 193 items) were completed by parents (Year 1) and completed by both the Year 7 students and parents. Socio-demographic information such as parental home ownership, ethnicity, education, occupation and age were collected. In addition maternal obstetric history, particulars of the child's birth, past and current medical histories as well as a thorough family history of any ocular disorder were collected. Questions about lifestyle were also asked with estimates of the time spent by each child engaging in close-up and outdoor activities. Questionnaires were translated into the three main languages other than English spoken within the Sydney Metropolitan Area (Chinese, Arabic and Vietnamese). Telephone interviews with translation were made available for those parents who preferred this option. Contact details of parents and three others were obtained to facilitate follow up.

2.1.4 Study Personnel and Ethical Approval

A team of ophthalmologists, other registered medical practitioners, optometrists and orthoptists collected the SMS data. Full time staff were available for administrative and study coordination. The Principal and other Chief Investigators supervised the overall functioning of the study. All staff were fully appraised of and trained in the study's protocols. Ethical approval for the study was obtained from the Human Research Ethics Committee, University of Sydney,

the New South Wales Department of Education and Training and the Sydney Catholic Education Office. The project adhered to the tenets of the Declaration of Helsinki.

2.2 SYDNEY PAEDIATRIC EYE DISEASE STUDY (SPEDS)

2.2.1 Study Area:

The Sydney Paediatric Eye Disease Study (SPEDS) was a population-based study. Three regions of metropolitan Sydney were defined; inner city, suburban and outer suburban strata based on the Sydney Statistical Divisions as set out by the Australian Bureau of Statistics. Within each of these regions, postcodes were stratified according to the SES of the region and those that had a proportion of children aged less than 5 years forming less than 2% of the population in a postcode were excluded. Four postcodes were randomly selected to represent outer, middle and inner metropolitan Sydney and a representative distribution of SES. Quaker's Hill and Acacia Gardens represented outer Sydney and Campsie and Dulwich Hill represented middle and inner Sydney respectively.

2.2.2 Recruitment & Participants

Trained research assistants door-knocked each house within the selected postcode to ascertain whether there were any eligible children living within the household and explain details of the study. Posters and information leaflets about the study and its purpose were distributed to local health care centres. In addition an invitation to participate was given to each household in which there was a child aged 6 months to 78 months. A total of 3333 age-eligible children were enumerated within this door-to-door census and their contact details recorded. The parents of these children were phoned at a later date to arrange an appointment time for their child/children to be examined. All examinations were undertaken at two locally based sites situated at Quakers Hill and Campsie, which had been specially adapted to act as temporary eye

clinics. Parents were also offered transport to these clinics upon request. Written parental consent was obtained prior to examination. Parents who initially refused were re-contacted at a later date to encourage participation.

Data was collected throughout 2007 – 2009. A total of 2461 children participated with an overall 73.8% response rate. Of this number 1391 children attended the Quakers Hill site (56%) whilst 1075 children attended the Campsie clinic and 56% of all participants at both sites were male. The mean age of the children was 41.3 months. Of the principal ethnic groups recorded, approximately 46% were European Caucasian, 21% were East Asian, and 13% were South Asian, whilst 9.0% were of Middle Eastern origin. 11.0% of the participants were from ethnic groupings outside of the afore-referred groupings.

2.2.3 Questionnaire and Child Personal Health Record (Blue Book)

The SPEDS questionnaire (176-item, see Appendix 3) was based on the questionnaire devised for the Multi-Ethnic Paediatric Eye Disease Study (MEPEDS) and the Baltimore Paediatric Eye Disease Study (BPEDS)[215,216] conducted in Los Angeles and Baltimore, USA respectively. The questionnaire designed for these studies was modified to be suitable for the Australian context. Socio-demographic information such as parental home ownership, education, employment and their child's ethnicity, medical and antenatal history, including maternal smoking during pregnancy, were derived from these self-administered questionnaires. Translated versions of the questionnaires and telephone interviews with or without a translator were also available to assist parents completing the questionnaire. A pre-paid envelope was provided for parents to return the completed questionnaires by post.

All children born in New South Wales receive a government issued Child Personal Heath Record, known at the time of birth of the study participants as the Blue Book, which records their neonatal and early childhood development. The child health nurses and medical practitioners issue these books when the child is born and are completed by hospital staff during

the post-natal stay in hospital and later. The children's blue books were photocopied with the parent's permission to provide a complete record of birth history and perinatal events such as birth weight, milestones achieved, and early illness and treatment. Birth weight was categorised as low if less than 2500g. Prematurity was defined as a gestational age of less than 37 weeks. Parental reports on admission to a neonatal intensive care unit, maternal illness and as to whether or not child was breast-fed were also recorded.

2.2.4 Study Personnel and Ethical Approval

The SPEDS team consisted of predominantly orthoptists with paediatric experience and registered medical practitioners who were all trained in the study's protocol, which was similar to that used by the Multi-Ethnic Paediatric Eye Disease Study (MEPEDS)[216]. Full time administrative and study coordination staff managed appointment times and collection of the questionnaires. Part-time research assistants were apprised of the study's objectives and appropriately trained to carry out door knocking and interviewing of members of the public in order to enumerate the children eligible for the SPEDS. The principal and other chief investigators supervised the overall functioning of the study.

Ethical approval for the study was obtained from the Human Research Ethics Committee, University of Sydney. All procedures used adhered to the tenets of the Declaration of Helsinki. Written and verbal informed consent was obtained from either the parent or guardian of each participant prior to any examination. All study personnel complied with state child protection legislation.

2.3 OCULAR EXAMINATIONS for SMS & SPEDS:

The SMS and SPEDS had a number of examination procedures that were common between the two studies and to avoid repetition these have been described once where the procedures were common to both studies. The complete examination booklets can be seen in appendix 2 for SMS and appendix 4 for SPEDS. All children underwent a comprehensive ocular examination of visual acuity, ocular movements, cover test for the detection of strabismus or heterophoria, stereoacuity, colour vision, followed by cycloplegic refraction, ocular biometry, slit lamp and fundus examination and dilated digital retinal photography where possible. Vertometry measurements using a Nidek Auto Lensmeter, Model LM-990 (Nidek Co., Ltd., Gamagori, Japan) were performed for all spectacles owned by the children and where possible, parent's glasses were also measured.

2.3.1 Visual Acuity (VA)

As a part of the detailed ocular examination, monocular visual acuity was measured using age appropriate vision tests, as specified. Children were encouraged to perform the most accurate and advanced recognition visual acuity test at all times. Only when the child was unable to be tested, were other tests performed that were more suited to the child's cognitive abilities. The child's reaction to occlusion of each eye was observed and compared, as children with poor vision in one eye object to the better eye being occluded. If the reaction is equal then visual acuity is likely to be equal in either eye. All visual acuity tests were performed on one eye at a time with the other eye occluded using an eye patch with elastic strap, or adhesive patch if required. For young children who excessively objected to either of these measures, a parent's hand was used, a procedure closely supervised by the orthoptist. This was performed with and without spectacle correction if spectacles were worn. A re-measure of visual acuity was performed in older children able to cooperate using a pinhole aperture (1.2mm) for those with visual acuity less than 6/9 or if there was 1-line (5 letter) difference between the two eyes.

In the SMS, distance visual acuity was tested using a logarithm of minimum angle of resolution (logMAR) chart. The chart was retro illuminated with automatic calibration to 85 candelas/m^2 (Vectorvision CSV-1000); Vectorvision, Inc, Dayton, Ohio) and read at 244cm and was a version of the Early Diabetic Treatment for Retinopathy Study (EDTRS) chart. For a small number of children unable to recognise the larger Sloan letter set of optotypes used in the EDTRS letter charts, a simpler set of the Sheridan Gardiner HOTV letter optotypes were used with a matching card. For each eye, visual acuity was recorded as the number of letters read correctly from 1 (6/60) to 70 (6/3). If the child was not able to read the chart at 244cm they were moved to a closer distance (minimum 91cm). If still unable to see the optotypes on the chart at that distance then counting fingers at 61cm, hand movements and perception of light were used [14,214].

As the SPEDS study encompassed children aged 6 years or less (6 – 72 months) other visual acuity tests more appropriate for their age were performed. All children aged ≥24 months were first tested using the Amblyopia Treatment Study (ATS) automated protocol system [217], using single HOTV letters surrounded by 4 flanking or crowding bars to form a virtual box around the test optotype. These were presented on the electronic visual acuity (EVA) tester [218] at 3m with a letter-matching card (ATS EVA). The ATS EVA protocol included a binocular pre-test at both near and at 3metres, then uniocular testing starting with the 0.8 (6/38) sized optotype. An initial screening phase determined the approximate threshold visual acuity, which was then confirmed. A brief reinforcement phase followed, and a final threshold phase was then conducted. Visual acuity was scored as the smallest optotype seen in either of the two threshold phases. Visual acuity scores were provided in 0.1 logMAR increments from 1.6 (6/240) to - 0.1 (6/5). Children unable to cooperate with visual acuity testing on the day of examination were given another appointment to retest their visual acuity. A Lea training pack was also prepared for selected children as well as for those rebooked for a visual acuity retest. This pack served to familiarise the child with the testing procedure and the concept of matching.

Children aged ≤60 months and who were able to complete the ATS EVA visual acuity test confidently were re-tested on the retro-illuminated HOTV LogMAR charts with a matching card if needed. All children aged ≥60 months were re-tested using the EDTRS (CSV) chart. As in the SMS study, all LogMAR charts (CSV-1000; Vectorvision, Inc.Arcanum, OH) were retro-illuminated and placed at a distance of 244cm. The LogMAR testing protocol adopted a similar, standardised approach to testing paralleling the ATS EVA method of refining the threshold VA. Testing ended when the child incorrectly identified three or more letters on a given line. Threshold monocular visual acuity was measured as the number of letters read correctly and recorded in LogMAR units, with each letter worth 0.02 LogMAR.

For pre-verbal children aged less than 24 months or for those children who were unable to undertake other visual acuity recognition tests, resolution/grating acuity using the Teller Acuity Cards™ II (Vistech Consultants Inc. & Stereo Optical Co.) preferential looking technique was performed [219] Visual acuity was tested with both eyes open and then each eye in turn. Where a child or infant was unable to perform any other vision test, the child's eye movements in response to a rotating Opto-Kinetic Nystagmus drum (OKN) held at 50cm were observed as an indication of the presence of vision.

2.3.2 Ocular Alignment

The assessment and measurement of ocular alignment was the same for both the SMS and SPEDS studies and for all ages. Initial assessments of ocular alignment were made by observing the corneal reflections (Hirschberg method), with and without spectacle correction. The detection of any manifest nystagmus was also made at this time. Strabismus was confirmed or elicited using a cover/uncover test performed by orthoptists. A movement of the uncovered eye to take up fixation denotes strabismus. If no strabismus was detected, an alternating cover test was performed to enable detection of heterophoria or any strabismus present after dissociation. This was performed at 1/3m, using a Clement Clarke fixation stick, and at 6m using

a detailed poster for the fixation target and/or a large letter on the LogMAR chart. This was undertaken both with and without spectacle correction if worn. As part of the SPEDS routine protocol the child's pupil size and reaction to light were also assessed. The swing torch test was performed to detect any relative afferent pupillary defect. The child's iris and hair colour was also noted.

A prism cover test was employed to measure the size of deviation, strabismus or heterophoria. The strength of the prism was increased until reversal of the deviation was observed, and then the prism strength was reduced until no movement was detected. Both horizontal and vertical deviations were measured. The Krimsky test was undertaken to measure angles of deviation, if accurate measurements were not obtained using the prism cover test.

2.3.3 Ocular Movements and Fusion

All children in both studies had their ocular movements fully assessed in nine positions of gaze so as to ensure the integrity of the extraocular muscles. Ductions and versions were observed as the child fixated on a light whilst maintaining their head stationary position. Cover tests were performed in all extreme positions of gaze and any under/overaction and/or restriction were recorded. "A" or "V" patterns were regarded as significant when the angle of deviation increased by more than 10 prism dioptre from the primary position of gaze or where a latent deviation became manifest in the elevated or depressed position of gaze.

Children in the SMS and older children in the SPEDS studies also had both their accommodation and near point convergence measured using the RAF (Royal Air Force) rule. Binocular accommodation was measured using N5 print as the target. The target was slowly brought closer towards to the child. The point at which the child first reported blur was recorded. A similar procedure was undertaken to measure the near point of convergence, but the target was a black dot with a line drawn through it. Near point of convergence was defined as the

distance (recorded in centimetres) from the child's eyes where the dot first appeared double. For the younger children in SPEDS who were unable to perform the RAF rule test, near point convergence was recorded as the distance from the child's eye to the point at which the child was first unable to maintain looking at the fixation target with both eyes. Both accommodation and convergence near point measurements were repeated three times, to elicit fatigue if present.

Motor and sensory fusion were tested for each eye in turn using a 4^{Δ}D test which provided an objective assessment of bifoveal binocular function (fusion) especially for subjects with suspected microstrabismus (deviations measuring $\leq 10^{\Delta}$D) and/or central suppression. Additionally for the children in SPEDS a 15^{Δ}D test was performed. A positive result was recorded where the child initially experienced diplopia and then overcame the prism to maintain binocular single vision.

2.3.4 Stereopsis

All children in both the SMS and SPEDS were tested using the Lang's II stereo test (Lang-stereotest, Forch, Switzerland) held at 33cm perpendicular to the facial plane of the child. The child was instructed to not move their head when viewing this test. Further assessment of stereoacuity was then conducted in all children who passed the Langs II screening. The TNO test (Lameris Ootech BV Nieuwegian, The Netherlands) was used for all children in the SMS. This test consists of 7 plates of which 3 were for screening (1980 seconds of arc), 3 for quantitative purposes (15 to 480 seconds of arc) and a suppression plate. For the younger children examined in SPEDS other age appropriate stereoacuity tests were employed. Children aged >30 months were tested with the Randot Pre-School Test. The Stereo Smile II was undertaken for children aged ≤30 months or younger or for those who were unable to perform the Randot test.

2.3.5 Colour Vision Test

Congenital colour vision defects typically affect 8 – 10% of males and 0.4 – 0.5% of females. The Ishihara (Kanehara Trading, Tokyo, Japan) and the City University (TCU test, 3rd edition, Keeler Ltd., Windsor, UK) colour vision tests were used in the SMS. The Ishihara is widely used to screen for red-green colour deficiency and the TCU grades the severity of red-green deficiency but also identifies significant tritan colour deficiency. In SPEDS children aged >30 months old colour vision was tested using the Waggoner® colour vision test. This test consisted of easy screening plates. If the child failed the Waggoner screening test and was able to cooperate and understand the instructions, the City University and/or Ishihara were performed.

2.3.6 Anthropometry

All children had their basic anthropometry measures recorded, which included height (cm), waist (cm), head circumferences (cm) as well as weight (kg), body mass index (BMI) and body fat percentage which was measured by a body composition Analyser (model TBF-300; Tanita, IL, USA) where possible. Two measures of systolic and diastolic blood pressure and heart rate were taken using the Intellisense™ OMRON digital automatic blood pressure monitor (model HEM-907; OMRON Healthcare, Singapore).

2.3.7 Cycloplegia

In both the SMS and SPEDS, cycloplegia was obtained by 2 cycles of one drop each of cyclopentolate (1.0% for children >24 months; 0.5% for children <24 months) and tropicamide (1%), administered 5 minutes apart following an initial drop of amethocaine hydrochloride (0.5%) for corneal anaesthesia. An additional drop of cyclopentolate was given if the pupil was still reactive. Phenylephrine hydrochloride (2.5%) was only administered if the child had dark irises to maximise mydriasis. Parents and teachers were informed verbally as well as given

written documentation on the effects of cycloplegia including blurred vision, photophobia, and pupil dilation that may persist until the next day. Parents were advised that the wearing of hats and sunglasses could alleviate these temporary side effects.

2.3.8 Cycloplegic Refraction

In SMS, cycloplegic refraction was measured using the Canon autorefractor (model RK-F1; Canon, Tokyo, Japan) 25-30 minutes after the administration of the last eye drops. The corneal radius of curvature and inter-pupillary distance (IPD) was also recorded. This machine recorded 5 valid refraction measurements in each eye, and one keratometry measure and IPD for each child. Objective retinoscopy (Welch Allyn, NY, USA) was done for those who were not able to maintain fixation. A non-cycloplegic refraction was done for children who refused any cycloplegic drops (<1%).

In SPEDS cycloplegic auto-refraction was first performed using a hand held Retinomax K-Plus 2 autorefractor (Nikon Corporation, Tokyo, Japan), and/or the Canon RK-F1 table-mounted autorefractor (RK-F1 Auto Ref- Keratometer; Canon, Tokyo, Japan) 20-25 minutes after the final eye drops were administered. Streak retinoscopy was performed if Retinomax readings with confidence ratings of >8 were not obtained in both eyes after multiple attempts. Again a non-cycloplegic refraction was done for any child or parent refused eye drops.

2.3.9 Slit lamp and Fundus Examination

Slit lamp (Haag-Streit; Koeniz, Switzerland) examination was performed for all children where possible to check for any abnormalities of the anterior structures of the eye, which included the eyelids, lacrimal system, conjunctiva and cornea, as well as the internal structures, which include the iris, ciliary body and lens. A fundus examination using an ophthalmoscope to assess the macula, optic disc, media and peripheral retina was also done for all children.

2.3.10 Ocular biometry

Optical Coherence Tomography, Stratus OCT3^{TM} (Model 3000; Zeiss, Meditec Inc., CA, USA) was performed wherever possible. It delineates the cross-sectional morphologic features of the fovea and optic disc, the retinal layers and anatomic variations in retinal and retinal nerve fibre layer thickness. The child fixates on a green light within the machine. Mydriatic Digital 60^0 Fundus Photographs were taken for all children using the Canon 60^0 fundus camera (MODEL CF-60Uvi, Canon Inc., and Tokyo, Japan. A detailed protocol of this has been published[214].

2.4 DEFINITIONS

Strabismus in this study was defined as any heterotropia detected at near and/or distance fixation and included those present at the time of examination, as well as those previously diagnosed and that were confirmed by a history of therapy or surgical correction.

Microstrabismus was defined as a deviation measuring less than 10 prism dioptres in the presence of gross binocular vision on the Lang II test. Deviations of this magnitude without any demonstrable binocular vision were simply classified as strabismus

Amblyopia was defined using the Multi-Ethnic Paediatric Eye Disease Study (MEPEDS) criteria, and divided into unilateral and bilateral subtypes[216]. Children with co-existing fundus or anterior segment abnormalities precluding normal vision were not considered amblyopic. Previously diagnosed amblyopia was included as having amblyopia. Letters from treating ophthalmologists were obtained to confirm cases of amblyopia when possible.

- ***Bilateral amblyopia*** was defined as the best presenting, VA < 20/50 (Snellen equivalent 6/15, LogMAR score 0.4) in children aged < 48 months, and < 20/40 (Snellen equivalent 6/12, LogMAR score 0.3) in children aged ≥ 48 months.

- ***Unilateral amblyopia*** was defined as a 2 line difference in presenting VA between two eyes with 20/32 or worse in the worse-seeing eye, in addition to at least one of the following amblyogenic factors:

    A. Constant or intermittent strabismus,
    B. Previous strabismus surgery,
    C. Anisometropia consistent with the worse eye (≥ 1.00D SE anisohyperopia, ≥ 3.00D SE anisomyopia, or ≥ 1.50D anisoastigmatism), and/or
    D. Evidence of past or present visual axis obstruction for at least one week (e.g. cataract, pseudophakia, aphakia, significant corneal opacity, ptosis, or eyelid haemangioma).

Myopia was defined as spherical equivalent (SE) refraction of -0.50 D or more.

Hyperopia was defined as SE refraction of +2.0 D or more, and was deemed significant at +3.0 D or more.

Astigmatism was defined as cylinder of 1.0 D or more.

Anisometropia as SE refraction difference between the 2 eyes of at least 1.0 D.

Absence of significant ametropia was defined as SE refraction of more than -0.50 D to less than +2.0 D.

Maternal smoking was defined if the child's mother reported that they had smoked at any time during pregnancy.

Passive smoking was defined if another person who smoked lived in the same house as the mother whilst she was pregnant. Parents were also asked how many cigarettes they smoked on a daily basis.

Parents also were asked to extract birth data from their children's health record booklet.

Low birth weight was defined as < 2500g, and

Prematurity was defined as gestation of <37 weeks.

Ethnicity was assigned only when both parents were from the same ethnic group.

Socioeconomic status was based on parental home ownership, parental education and parental employment status.

- ***Low SES*** was classified as follows:
    - Neither parent owned their home;
    - Low parental education level; categorised if neither parent had tertiary or higher education;
    - No parental employment; defined when neither parent are employed.

Extreme paternal and maternal ages were determined if either the mother or father were older by two standard deviations from the mean parental age.

2.5 STATISTICAL ANALYSIS

Keyword protected databases were constructed using Microsoft Access database software, (Microsoft, Redmond, WA) and statistical analysis was performed using SAS and Stata software (V8.2, SAS Institute; V6.0, Stata Corp). Questionnaire and examination variables were coded, and analysed. All statistical analyses were performed using Statistical Analysis System software, version 8.2 (SAS Institute, Cary, NC).

Univariate analysis of demographic, socio-economic and ante-natal risk factors and their associations with strabismus T-tests were used to compare means for continuous variables, and chi-square tests were used to compare proportions of categorical factors in the strabismic and non-strabismic groups, and Fisher's exact test was used to calculate p values for comparing strabismus prevalence. Multi-variable adjusted logistic regression models were constructed to assess associations of strabismus while adjusting for age, gender, ethnicity, and SE when relevant. Odds ratios (OR), and 95% confidence intervals (CI) are reported. One case of non-comitant strabismus (6th cranial nerve palsy) was excluded from the analysis of risk factors.

CHAPTER 3

Prevalence & Risk Factors of Strabismus in a Population-Based Sample of Australian Children Aged 6 – 72 Months

Sydney Paediatric Eye Disease Study (SPEDS).

3.1 INTRODUCTION

Knowledge of the natural history and prevalence of strabismus, including accurate estimates of its prevalence in both "at-risk" and normal populations, is fundamental to the justification and operation of programmes screening for eye conditions in order to prevent vision loss in children. Strabismus is known to be associated with amblyopia, which if untreated persists to adulthood. [220,221] While loss of vision in one eye may not cause visual impairment in itself, it has been shown to generate an increased risk of blindness and visual impairment in later life [18].

The Sydney Paediatric Eye Disease Study (SPEDS) examined vision, refractive error, strabismus and ocular problems in a representative sample of Australian children aged 6 -72 months old. The aim of this thesis chapter is to report the prevalence of concomitant strabismus, esotropia and exotropia and their subtypes in this large population-based sample using the gold standard methodology to detect strabismus and to compare the findings of this study with those studies that have used similar methodology in predominantly pre-school populations.

The characteristics of the participants recruited were already described in the previous chapter and the methods of testing were identical to those used in the SMS study. It is important to note that in SPEDS the children examined were younger than the children examined in SMS. SPEDS is a large-scale population-based study, whilst the SMS was a school-based study.

3.2 RESULTS

3.2.1 Participants:

2462 children participated in the study (53.0% - Male; with 78.3% - overall participation rate) from the selected postcodes. 1391 participants were examined at the Quakers Hill site and 1075 participants from the Campsie site. The ethnicities identified were 45.9% (n = 1131) European Caucasian, 20.9% (n = 516) East Asian, 13.2% (n = 326) South Asian, 9.0% (n = 221) Middle Eastern and 11.0% (n = 271) other or mixed ethnicities. Mean age was 41.3 months (95% Confidence Interval 40.4 – 42.2 months).

3.2.2 Prevalence of strabismus:

Table 3.1 indicates that strabismus was detected in 82 children (3.3%). Of these, 26 (1.1%) had esotropia, 51 (2.1%) had exotropia. There was only one case of vertical strabismus, and hence the rest of the statistical analysis will be concentrated on the horizontal strabismus. Prevalence of strabismus by type in the whole population and in male and females and the different categories of strabismus are also shown in *Table 3.1*. There was no significant difference in the prevalence of strabismus (p = 0.3) between females 3.85 (n = 43) and males 3.05 (n = 39), even when esotropia (Female 1.2% n = 43; Male 0.9% n = 12; p = 0.5) and exotropia (Female 2.3% n = 26; Male 1.9% n = 25; p = 0.5) were examined separately. Strabismus seemed more prevalent in children of South Asian ethnicity 4.0% (n = 13) followed by the European Caucasian 3.5% (n = 39), other ethnicities 3.3% (n = 16) and finally the East Asian ethnicity 2.5% (n = 13). Univariate analysis showed no statistical difference in the prevalence of strabismus, esotropia and exotropia between the ethnicities (p = 0.7, 0.4, 0.8 respectively), as shown in *Table 3.2*.

Table 3.1 Prevalence of strabismus & subtypes across the different gender

	All [n=2462] n (%)*	Female [n=1159] n (%)*	Male [n=1307] n (%)*	P value
Strabismus	82 (3.3)	43(3.8)	39(3.0)	0.3
Esotropia	26 (1.1)	14(1.2)	12(0.9)	0.5
Exotropia	51(2.1)	26(2.3)	25(1.9)	0.5
Vertical only	1(0.04)	1(0.09)	0(-)	
Microtropia**	3(0.1)	1(0.1)	2(0.2)	
Prevalence by subtypes				
Esotropia				
Partially Accommodative	3(0.1)	2(0.2)	1(0.1)	0.5
Fully accommodative	3(0.1)	2(0.2)	1(0.1)	0.5
Nonaccommodative	20(0.8)	10(0.9)	10(0.9)	0.7
Exotropia				
Constant	19(0.8)	10(0.9)	9(0.7)	0.6
Convergence weakness	12(0.5)	6(0.5)	6(0.5)	0.8
Divergence excess	20(0.8)	10(0.9)	10(0.9)	0.7

One case, a female with esotropia was excluded due to incomplete data
**(%) are calculated as the percentage of total the column represents (all, female and male)*
*** Direction unknown but have failed the 4Δ, slight difference in visual acuity*

Table 3.2 Prevalence of strabismus & subtypes within the different ethnic groups.

	EC* [n=1131] n (%)	EA* [n=516] n (%)	SA* [n=326] n (%)	Other* [n=491] n (%)	P value
Strabismus prevalence	39 (3.5)	13(2.5)	13(4.0)	16(3.3)	0.7
Esotropia	14 (1.2)	2(0.4)	4(1.2)	6(1.2)	0.4
Exotropia	24(2.1)	9(1.8)	8(2.5)	9(1.9)	0.8
Vertical only	0(-)	1(0.2)	0(-)	0(-)	
Microtropia**	1(0.1)	1(0.2)	1(0.3)	0(-)	
Prevalence by subtypes					
Esotropia					
Partially Accommodative	2(0.2)	0(-)	0(-)	1(0.2)	
Fully accommodative	1(0.1)	1(0.2)	1(0.3)	0(-)	
Nonaccommodative	11(1.0)	1(0.2)	3(0.9)	5(1.0)	
Exotropia					
Constant	8(0.7)	4(0.8)	4(1.2)	2(0.4)	
Convergence weakness	7(0.6)	0(-)	2(0.6)	3(0.6)	
Divergence excess	9(0.8)	5(1.0)	2(0.6)	4(0.8)	

One case female, esotropia was excluded due to incomplete data
**EC- European Caucasian, EA- East Asian, SA- South Asian, Others include Middle eastern and those who had mixed ethnicities as well as minor groups*
**(%) are calculated as the percentage of total the column represents (EC, EA,SA & Other)*
*** Direction unknown but have failed the 4Δ, slight difference in visual acuity*

3.2.3 Risk factors associated with strabismus.

There were no significant age differences in the prevalence of strabismus *Table 3.3*. There were significantly more strabismus cases in children with low birth weight (7.9%) compared to those children with normal birth weight (3.4%) [p = 0.01; Odds Ratio (OR) 2.8, Confidence Interval (CI) 1.0-7.3]. Surprisingly, illness and problems during pregnancy were associated with lower strabismus prevalence (2.1%) when compared to those who had no prenatal complications (4.2%) [p = 0.03; OR 0.48, CI 0.25-0.92). Breastfeeding was significantly associated with a lower risk of strabismus (3.1%) compared to those who were not breastfed (5.3%) [p = 0.05; OR 0.57, CI 0.3-1.1]. Children who had a family member with strabismus (10.8%) were 4 times more like to develop strabismus compared to those children with no familial history (2.4%) [p = 0.0009; OR 4.17, CI 0.8 – 9.67). This was true for those children who had a family history of strabismus in their biological mother (11.4%) [p = 0.007; OR 4.47, CI 1.5 – 13] and even more significant for those with a biological brother who had a history of strabismus (25.0%) [p = 0.0004; OR 11.61, CI 3.0 – 44.0].

Table 3.3: Multi-variate analysis of age as a risk factor

	Strabismus			
Risk factor	n	(%)	**OR (95% CI)**	**p value**
6-<12	6	2.1	0.42 (0.16, 1.10)	0.12
12-<24	12	3.1	0.63 (0.28, 1.38)	0.08
24-<36	10	2.4	0.49 (0.21, 1.11)	0.2
36-<48	13	3.5	0.71 (0.33, 1.54)	0.08
48-<60	14	3.8	0.77 (0.36, 1.64)	0.4
60-<72	10	2.9	0.58 (0.25, 1.32)	0.2
≥72	14	4.9	Ref	ref

**1 case was excluded due to missing age data and 2 further cases of strabismus were also excluded due to missing parameters*

Determinants of low SES were also found to be significantly associated with an increased risk of strabismus, particularly parental employment. Children with both parents who did not have employment at the time of examination had a higher prevalence of strabismus (8.4%) compared to with both parents employed (3.2%; p = 0.004, OR 0.4, CI 0.2 – 0.7) and when only one parent was employed (2.9%; p = 0.001, OR 0.36, CI 0.2 – 0.7).

3.2.4 Risk factors associated with esotropia & exotropia separately

The only risk factor that was associated with esotropia from this data set was family history of esotropia in any family member (4.9%). This was particularly true for the males in the family, biological father (7.7%) as well as in a biological brother (10.0%). In contrast exotropia was associated with a family history of in the child's biological mother (8.8%, p = 0.006) and not in the biological father. Exotropia was also associated with a positive family history in the child's biological brother (18.2%, p = 0.0009) and in any family member (6.4%, p = 0.01). These statistical analyses can be seen in *table 3.4.*

Table 3.4 Multi-variate analysis of familial history as risk factors for Eso & Exotropia

	Esotropia				Exotropia			
Family history in:	n	(%)	OR (95% CI)	p value	n	(%)	OR (95% CI)	p value
Biological mother	1	3.1	3.70 (0.47, 29)	0.2	3	8.8	5.78 (1.65, 20)	0.006
Biological father	1	7.7	8.2 (1.004, 67)	0.049	0	0	-	-
Biological sister	1	6.2	6.64 (0.81, 54)	0.07	0	0	-	-
Biological brother	1	10	11.01 (1.30, 93)	0.03	2	18.2	15.08(3.05,74)	0.0009
Any family	3	4.9	5.91 (1.64, 21)	0.007	4	6.4	4.10 (1.38, 12)	0.01
No family	13	0.9	ref	ref	25	1.6	ref	ref

** 6 cases of esotropia and 17 cases of exotropia were excluded due to missing family history data.*

Determinants of low SES were only associated with exotropia and not with esotropia. A higher prevalence of exotropia (6.6%) was found in the sample of children whose parents were not employed compared to when both parents were employed (2%, p = 0.003; OR 0.29, CI 0.1 – 0.7) and when only one parent was employed (1.8%, p = 0.003; OR 0.25, CI 0.1 – 0.6). Lower levels of Parental education was also found to be significantly associated with exotropia with a significantly higher prevalence of exotropia (3.1%) reported in children with parents who had lower than a university degree education compared to those children with parents who have gone to university (1.6%, p = 0.05; OR 0.52, CI 0.3 – 1).

Another interesting risk factor significantly associated with strabismus was breast-feeding, however, analyses of this association with the different types of strabismus, esotropia became insignificant, whilst associations with exotropia was almost (p = 0.09) significant.

3.2.5 Multivariate analysis of significant factors

Multivariate analysis controls for all factors that were found significantly associated with strabismus, esotropia and exotropia were attempted to see if the associations remain significant and independent of each other. This analysis could only be done for all the strabismus cases combined, and exotropia alone. The number of esotropia cases was too small to statistically analyse after controlling for the other associated factors. Cases with a family history in any direct family members were combined as one.

Family history remained significantly associated with an increased prevalence of strabismus (p = 0.003; OR 3.9, CI 1.6 – 9.3) and exotropia (p = 0.03; OR 3.6, CI 1.2 – 11.0). No parental employment (neither parent had employment) also remained significant for both strabismus (p = 0.004; OR 0.28, CI 0.12 – 0.67) and exotropia (p = 0.005; OR 0.19, CI 0.06 – 0.6). Therefore there was an increased prevalence of strabismus and exotropia in the group of children whose parents were both unemployed compared to those children whose parents both had employment as well as those who at least had one parent employed.

3.3 DISCUSSION

3.3.1 Prevalence of Strabismus

The prevalence of strabismus in this population-based study was 3.3%, which is slightly higher, compared to the prevalence from the school based study SMS where the reported prevalence was 2.8%[13] and 2.7% in the 6 and 12 year-old children respectively. This may be due the fact that SPEDS was a population-based study and the SMS was a school based study. This is consistent with the prevalence rates (≥3.0%) reported by other large population-based studies that have ascertained strabismus cases using methods that met the gold standard[3-7,9,51]. One longitudinal birth-cohort study of predominantly European Caucasian children that used similar methodologies has reported a lower prevalence of strabismus (2.3%). The authors attributed this to an under-representation of children with low socio-economic status (SES) in their study [11].

3.3.2 Risk factors associated with strabismus.

In our analysis age, gender and ethnicity were not found to be significantly associated with the prevalence of strabismus, esotropia and exotropia *(Table 3.1, 3.2 & 3.3)*. However, we have found that risk factors that were significantly associated with esotropia differed from those associated with exotropia. We also found this difference of association between the two major subtypes of strabismus from the SMS data sample.

Low birth weight almost tripled the risk of strabismus (7.9%) in this sample of children, but not when esotropia and exotropia were considered separately. The same associations were previously found in the SMS[13]. Previous literature has also reported high prevalence rates of strabismus in children with low birth weight (6.4 – 9.1%)[2,3,101,103,110,118,173-177]. Surprisingly prenatal difficulties and illness were negatively associated with a lower strabismus prevalence, but when the subtypes were considered separately this association only remained significant for exotropia, perhaps due to the smaller number of cases of esotropia (n = 26). This suggests that

prenatal events are not a risk factor for exotropia, but maybe for esotropia. This supports the results we reported from the SMS data *(Chapter 4)*.

This association became insignificant when other significant confounding factors were controlled for. Further investigation needs to be done to establish the relationship between prenatal events and esotropia. It was reported from analysis of the SMS data that maternal smoking as well as prenatal risk factors which led to the child being admitted to the neonatal intensive care unit (NICU) were significantly associated with esotropia. The data from this study also supports that breastfeeding was associated with a significantly lower prevalence of strabismus, but this association did not remain significant when esotropia and exotropia were considered separately.

Familial history was significantly associated with strabismus. Paul and Hardage (1994) reviewed literature from eleven published studies that have reported increased familial rates, which averaged to 30.6% (13.0-66.0%) [103]. An increased prevalence of esotropia was associated with family history of the condition in the biological father, brother and was almost significantly associated with family history in biological sister ($p = 0.07$). This may be due to the small number of esotropia cases within this sample. Exotropia on the other hand was only significantly associated with familial traits when the condition was seen in the child's biological mother and brother. Direct family history remained strongly associated with strabismus and exotropia even after controlling for other significant confounding factors. This analysis was not done for esotropia as the number of cases was too small. These results suggest that there may be a significant hereditary element independently associated with the development of exotropia and possibly esotropia. Michaelidas found that the risk of strabismus increased 3- 5 times if a first degree relative had a positive history.

In our study, exotropia was not associated with the antenatal factors measured. However, exotropia was associated with determinants of low SES such as, no parental employment and low parental education. Conversely, esotropia was associated with a range

of antenatal factors, but not with indications of low SES. Another determinant of low SES, no parental home ownership, was also found to be associated with exotropia within the SMS sample. This association has been found in one other study [3]. In contrast, a longitudinal study on predominantly European Caucasian children aged seven years[11], significantly associated determinants of low SES with esotropia. However, it was mentioned that there was an under-representation of children with low SES. Another factor that may have skewed their result could be due to the low proportion of exotropia (21%), in comparison to our studies (SMS, 49% & SPEDS 62%) and other studies of predominantly European Caucasian children (30-45%) [5,7,222,223]. This suggests that there may be significant problems with the ascertainment of strabismus in the ALSPAC study. Determinants of low SES are likely to include a variety of factors such as; maternal and/or child nutrition, parental education and frequent of use of health services. Poor maternal nutrition may possibly lead to significantly lower mean birth weight of children with exotropia, as compared to those without strabismus or with esotropia in our studies. More precise definitions of these indicators of SES are needed to clearly determine the nature of its association with strabismus.

CHAPTER 4

Maternal Smoking during Pregnancy & Other Pre-Natal Variables Are Risk Factors for Strabismus in School Children

Sydney Myopia Study (SMS)

4.1 INTRODUCTION

Strabismus is a frequent childhood ocular disorder (2 - 3%), [3-11,13,222] that can cause amblyopia [221] and require intensive therapy, including surgery. Amblyopia can also increase the risk of becoming visually impaired in later life, [18,221] and has been associated with decreased quality of life [19] and other co-morbidities, such as an increased number of falls and hip fractures. [224] Identifying risk factors for strabismus could increase its likelihood of earlier detection potentially reducing the costs associated with strabismus and strabismic amblyopia and improving the outcomes of therapy.

Studies examining risk factors for strabismus [3,13,31,156,225] have identified non-modifiable factors such as ethnicity, heredity [159] and neuro-developmental conditions [99]. Other factors that could potentially be modifiable include low socio-economic status (SES), low birth-weight or prematurity and antenatal complications[13,159]. One modifiable risk factor that has consistently been associated with strabismus is maternal smoking during pregnancy, [3,156,159,164-169,171]. Maternal smoking during pregnancy has also been reported to be associated with a more hyperopic refraction. [168] A dose-response relationship with strabismus and maternal smoking has been established within a number of studies for smoking levels greater than 20 cigarettes per day, [3,165,166,169] although one study reported that esotropia was associated with even light smoking (5-10 cigarettes per day)[166]. The trimester in which the mother smoked, particularly the third trimester, was also associated with strabismus. [31,156,169]

The Sydney Myopia Study (SMS) has examined vision, refractive error, strabismus and ocular problems in two age groups (6 years and 12 years) of representative samples of Australian school children. This study previously reported that pre-term birth was associated with strabismus in 6-year-old children[13]. This chapter reports prevalence of both esotropia and exotropia in the 12-year-old sample, and in the combined age group, the relationship of strabismus with maternal smoking (both active and *passive*), other antenatal factors and the influence of birth parameters.

4.2 PARTICIPANTS AND METHODS

4.2.1 Participants:

The SMS randomly selected 34 primary and 21 secondary schools from across metropolitan Sydney, stratified by SES according to data from the Australian Bureau of Statistics (ABS) 2001 census. Detailed information on methods used in this study is included in chapter 2.

4.2.2 Ocular Examinations:

Visual acuity was measured using a LogMAR chart (CSV-1000; Vectorvision, Inc. Arcanum, OH). Orthoptists performed both alternating and cover/un-cover tests at 1/3m, and at 6m. These tests are both done with and without spectacle correction, if worn. The presence of strabismus was determined if any consistent movement of the uncovered eye to take up fixation was observed on the cover/un-cover test. Measurements of deviation were done by prism cover testing. A 4 $^{\Delta}$D test provided an objective assessment of the presence of suspected microstrabismus (deviations measuring $\leq 10^{\Delta}$D) and/or central suppression. Cycloplegic auto-refraction was done on the auto-refractor (RK-F1; Canon, Tokyo, Japan).

4.2.3 Definition of Strabismus

Strabismus was defined as any movement detected of the eye to take up fixation on near and/or distance cover test, or a history of strabismus treatment reported by the parents (refer to chapter 2). Microstrabismus defined as a deviation measuring less than 10 prism dioptres in the presence of gross binocular vision on the Lang II test. Deviations of this magnitude without any demonstrable binocular vision were simply classified as strabismus. Table 2.1 *(chapter 2)* shows further classifications of esotropia and exotropia within their main sub-types that were selected to be included in the study.

4.2.4 Questionnaires (Appendix 1)

Parental home ownership, education, employment and the child's ethnicity, medical and antenatal history were derived from self-administered questionnaires and health record booklets. SES was classified from information on parental home ownership, education level and employment. Active maternal smoking was defined if the child's mother reported that she smoked during pregnancy at any time. *Passive* maternal smoking was defined if another person who smoked lived in the same house as the mother whilst she was pregnant. Parents were also asked how many cigarettes they smoked per day. Parents were also asked to extract birth data from their children's health record booklet.

4.3 STATISTICAL ANALYSIS

Strabismus reported included cases present at the time of examination, as well as those previously diagnosed. One case of non-comitant (6th cranial nerve palsy) was excluded from the analysis of risk factors. Univariate analysis of demographics, socio-economic and antenatal risk factors and their associations with strabismus, exotropia and esotropia were performed for the 6-year-old sample.

Since there was no statistically significant difference in the prevalence of strabismus between the 6 and 12-year-old samples, the data were combined to provide a larger number of strabismus cases and to provide greater statistical power. Risk factors previously identified to be significantly associated with strabismus in the 6-year-old sample (low birth weight, prematurity, admission to a NICU and lack of breast feeding) as well as those uniquely identified in the 12-year-old sample (exposure to maternal and passive smoking and lack of home-ownership) were all re-analysed for the combined sample (6 & 12-year-old). Firstly uni-variate analyses were done to elicit any associations with the prevalence of strabismus and also with esotropia and exotropia separately for the combined sample (6 &12-year-old). Then multivariate analysis was also done for the combined sample, adjusting for any confounding factors of the associations found. Odds ratios (OR) and 95% confidence intervals (CI) are presented.

4.4 RESULTS

4.4.1 Subjects:

Of the 6-year old children, 2238 were eligible and 1740 children (77.7%) had parental consent to participate, as well as completed questionnaire and examination data. Their mean age was 6.7 (range: 5.5 - 8.4 years) and 49.4% were female. Of the 12-year old children, 3144 were eligible and 2353 (74.8%) were given parental permission to participate and had complete questionnaire and examination data. Their mean age was 12.7 (range: 11.1–14.4 years) and 49.4% were female.

4.4.2 Prevalence of strabismus:

Table 4.1 shows that 48 (2.8%) 6-year old children had concomitant strabismus, of whom 28 (1.6%) had esotropia and 20 (1.2%) had exotropia, as reported previously[13]. After excluding one case of incomitant strabismus, comitant strabismus was detected in 63 (2.7%) 12 year-old children and of these 29 (1.2%) had esotropia and 34 (1.5%) exotropia. There were 7 children classified as having microstrabismus in the 6-year old sample, and 16 in the 12-year old sample. There were no associations with gender ($p = 0.2$) or ethnicity ($p = 0\ .6$)[2]. There was no significant difference in the prevalence of strabismus between the two samples ($p = 0.88$) or in the proportion with esotropia ($p = 0.31$) or exotropia ($p = 0.41$). Amblyopia was present in 76 (1.9%) in the combined sample, including 32 (1.9%) in the 6 year-old sample and 44 (1.9%) in the 12 year-old sample.

Table 4.1: Prevalence of strabismus & its subtypes in the combined, 6 & 12 year-old samples

	Combined n (%)	6 year-old n (%)	12 year-old n (%)	p-value*
Strabismus	111 (2.7)	48 (2.8)	63 (2.7)	0.88
Esotropia	57 (1.3)	28 (1.6)	29 (1.2)	0.31
Exotropia	54 (1.3)	20 (1.2)	34 (1.5)	0.41

** p-value for the difference in prevalence of strabismus and its subtypes between the 6 and 12-year-old samples*

4.4.3 Associations with strabismus in the 6- and 12 year old samples, considered separately

Age, gender and ethnicity were not significantly associated with strabismus in the 12-year age group. Children with exotropia had a lower mean birth weight (3,144 ± 593.1g) than children without either exotropia or esotropia (3,352 ± 563.2g, p = 0.039). This association persisted after adjusting for ethnicity (p=0.042), since children of East Asian ethnicity were found to be generally smaller than those of European Caucasian ethnicity. However, low birth weight (< 2500g) was not significantly associated with strabismus. Children with low SES also had a significantly increased risk of strabismus (p = 0.036); this was significant for exotropia separately (p = 0.004) but not for esotropia (p = 0.985).

Children of mothers who smoked during pregnancy ('active' maternal smoking) had a significantly increased likelihood of strabismus (p = 0.029). This association remained significant for esotropia (p = 0.001) but not for exotropia (p = 0.986). In addition, exposure to *passive* maternal smoking during pregnancy was also significantly associated with esotropia (p = 0.045). Esotropia was also marginal associated with admission to an NICU (p = 0.051).

4.4.4 Associations with strabismus in the combined 6 & 12 year-old samples

As the prevalence of strabismus and the proportions with esotropia and exotropia did not significantly differ in the two age samples, these were combined to further examine risk factors. Univariate analysis revealed that exposure to active maternal smoking ($p = 0.012$), low birth weight ($p = 0.011$), admission to a NICU ($p = 0.0002$) and lower SES, reflected by lack of home ownership ($p = 0.030$), were significantly associated with strabismus.

After adjustment for the risk factors (*Table 4.2 & 4.3*) previously identified in the 6 year-old sample (low birth weight, prematurity, admission to a NICU and lack of breast feeding) as well as those uniquely identified in the 12 year-old sample (exposure to maternal and *passive* smoking and lack of home-ownership), the factors that remained significantly associated with strabismus were exposure to be maternal smoking (OR 1.7, CI 1.3-5.1), low birth weight (OR 2.2, CI 1.2-4.3) and admission to a NICU (OR 2.6; CI 1.3-5.1). No antenatal factors were significantly associated with exotropia. Exotropia remained, however, significantly associated with a lack of home-ownership, after multivariate adjustment (OR 2.2, CI 1.1-4.4).

For esotropia alone, the antenatal risk factors remaining significantly associated after adjustment, were exposure to active maternal smoking during pregnancy (OR 2.6, CI 1.3-5.1), and admission to a NICU (OR 2.8, CI 1.0-7.3). Exposure to *passive* maternal smoking showed a trend towards more esotropia, which was not statistically significant after multi-variate adjustment ($p = 0.29$). The prevalence of exotropia was not significantly associated with either active or *passive* maternal smoking (*Figure 4.1*).

Table 4.2 Multi-variate analyses of risk factors in children aged 6 & 12 years with & without strabismus.

	Strabismus n (%)	No Strabismus n (%)	OR(95% CI)
SOCIO-ECONOMIC FACTORS			
No Home Ownership	19 (32.8)	434 (21.3%)	1.44 (0.84 - 2.48)
PERI-NATAL FACTORS			
Low birth weight (< 2500g)	11 (12.4)	188 (5.9)	**2.25 (1.16 - 4.34)***
Premature birth (≤ 36 weeks)	5 (10.6)	128 (7.8)	1.25 (0.34 - 4.53)
Admission to NICU	15 (14.6)	201 (5.7)	**2.57 (1.28 - 5.14)***
Not breast fed	80 (77.7)	2934 (81.6)	1.18 (0.96 - 2.02)
PRENATAL FACTORS			
Exposure to active maternal smoking	23 (21.9)	485 (13.4)	**1.77 (1.3 - 5.1)***
Exposed to *passive* maternal smoking	18 (17.3)	488 (13.2)	0.82 (0.42 - 1.64)

** Significant risk factors*

Each risk factors was adjusted for all other significant risk actors; low birth weight, prematurity, admission to NICU, not breast fed, exposure to maternal smoking, exposure to passive smoking and No-homeownership

Figure 4.1 Prevalence of esotropia & exotropia in children exposed or not exposed to smoking during pregnancy

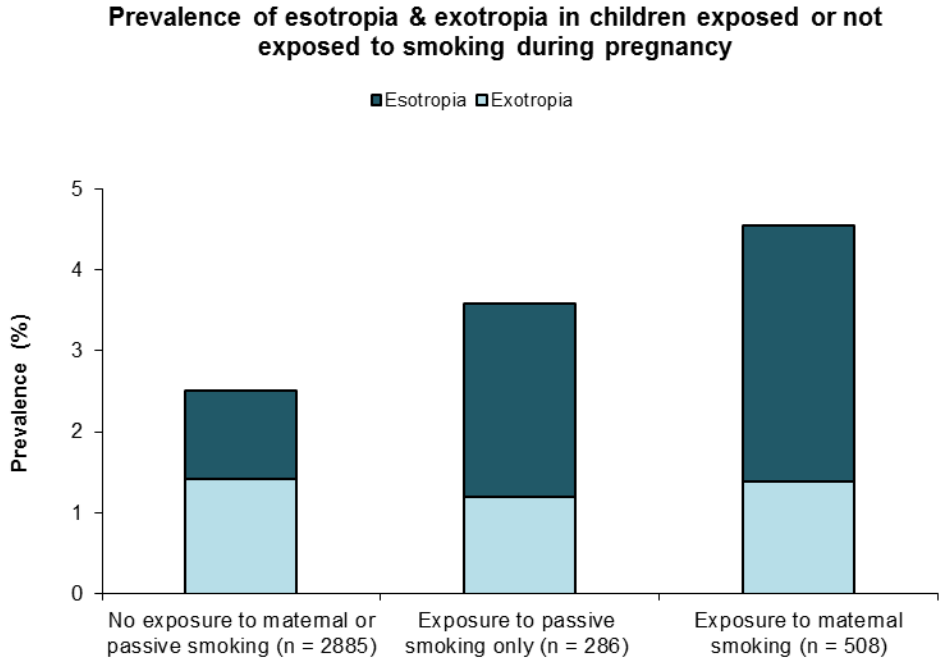


Table 4.3 Multi-variant analyses of risk factors in children aged 6 & 12 years with & without Esotropia. / Exotropia

	Esotropia Present n (%)	No Esotropia n (%)	OR(95% CI)	Exotropia Present n (%)	No Exotropia n (%)	OR(95% CI)
SOCIO-ECONOMIC FACTORS						
No Home Ownership	6(21.4%)	447(21.6%)	0.84(0.34 - 2.06)	13(43.3%)	440(21.3%)	**2.23(1.12 - 4.43)***
PERI-NATAL FACTORS						
Low birth weight (< 2500g)	6(13.9)	191(5.9)	2.41(0.98 - 5.84)	5(10.9)	189(5.8)	2.06(0.79 - 5.35)
Premature Birth (≤ 36 weeks)	5(27.8)	128(7.7)	2.95(0.60 - 14.54)	0(0.0)	129(7.8)	
Admission to NICU	9(18.0)	203(5.8)	**2.76(1.04 - 7.31)***	6(11.3)	205(5.8)	2.37(0.89 - 6.28)
Not Breast Fed	40(78.4)	2959(81.5)	1.18(0.55 - 2.53)	40(76.9)	2955(81.5)	1.2(0.57 - 2.53)
PRENATAL FACTORS						
Exposure to Maternal Smoking	16(30.8)	490(13.4)	**2.6(1.3 - 5.1)***	7(13.2)	495(13.6)	0.94(0.35 - 2.53)
Exposed to *Passive* Smoking	12(23.5)	433(13.6)	1.11(0.46 - 2.69)	6(11.3)	496(13.8)	0.56(0.19 - 1.71)

***** *Significant factors*

Each risk factors was adjusted for all other significant risk actors; low birth weight, prematurity, admission to NICU, not breast fed, exposure to maternal smoking, exposure to passive smoking and No-homeownership

4.5 DISCUSSION

The prevalence of strabismus within this combined age sample (2.7%) is consistent with other cross-sectional school-based studies, which have employed cover testing, as performed by experienced practitioners in Australia (2.5%) [222], or other populations (2.3% to 2.7%) [8,10,223]. The 12 year old children within our sample had slightly more exotropia than previously reported for the 6 year old children but this difference was not statistically significant, while the combined sample overall had slightly more esotropia than exotropia (51.4%). Studies of predominantly European Caucasian populations have consistently reported a higher prevalence of esotropia than exotropia, with ratios ranging from 5.4-1.2:1 [3-5,7,10,11,13,222]. By contrast, studies of other ethnic groups have found the proportion of esotropia to exotropia reversed, with exotropia more predominant. This trend is most consistent in populations of East Asian ethnicity [68, 71,187]. This is confirmed by our findings of (predominantly) esotropia within the sample of children of European Caucasian ethnicity, and exotropia in those of East Asian ethnicity. These results parallel the previously reported prevalence of esophoria and exophoria in the same sample [226]. The basis of this ethnic difference is not clear.

We found that prenatal risk factors associated with strabismus were different for esotropia and exotropia. For esotropia, we found a strong association with maternal smoking during pregnancy and admission to neo-natal intensive care units (NICU) in the combined sample. However, exotropia examined separately, was not associated either with maternal smoking or other antenatal factors, but was associated with an indicator of low SES.

The major antenatal association of strabismus within this study was self-reported active maternal smoking during the pregnancy but not *passive* maternal smoking. We had previously reported a higher rate of strabismus in children whose mothers smoked during pregnancy (4.2%) as compared with those children whose mothers did not smoke (2.6%) in the 6-year old sample. This association, however, did not reach statistical significance, possibly due to the small number of cases[13]. While maternal smoking has been found to be associated with strabismus in a number of studies [3,159,164-168], a link between strabismus and *passive* smoking has not consistently been established in other studies [156,168,169].

When esotropia and exotropia have been examined separately, an association between maternal smoking during pregnancy and esotropia has been established in three studies [156,169,171] and with exotropia in two [11,166]. In our study we found the association was present only with esotropia, and persisted after adjustment for a range of other risk factors, including low birth weight. Although exposure to *passive* maternal smoking during pregnancy appeared to increase the prevalence of esotropia in our study, this however became non-significant after adjustment.

The mechanism by which maternal smoking during pregnancy could influence the development of strabismus is not clear. It has been suggested that cigarette smoke may be directly toxic to ocular tissue [164]. Another plausible pattern of association of strabismus with maternal smoking could be via, low birth weight, due to intra-uterine growth retardation[185,187]. These children as a consequence tend to have relatively smaller eyes [9,179] and therefore be at greater risk of developing a higher than usual hyperopic refractive error, which could particularly be associated with accommodative esotropia [189,190]. However, it has also been reported that while low birth weight children without ROP have significantly smaller eyes than usual, they may not have an expected high hyperopic refractive error [9], thus demonstrating the strong developmental drive toward emmetropisation.

We previously reported that maternal smoking was associated with hyperopia in both age samples [17]. However, Stone and colleagues [168] found that while maternal smoking was associated with both hyperopia and strabismus, they suggested it might be due to different mechanisms. They noted that hyperopic shifts in refraction were seen in children exposed to both active and *passive* maternal smoking during pregnancy, whilst strabismus was only associated with active maternal smoking. Similarly, Christianson and colleagues associated maternal smoking with hyperopia only when strabismus was present [165]. The pattern of association between maternal smoking and strabismus, ocular biometry and refraction, is unclear and requires further investigation, particularly for any possible association with accommodative esotropia.

In our combined sample, after adjustment for a range of risk factors, low birth-weight was associated with strabismus overall, but not with esotropia or exotropia separately. Other studies have

also found an association between strabismus and birth-weight[9,101,173,175]. low birth-weight and maternal smoking during pregnancy have been strongly associated [172] and thus lead to the increase in the prevalence of strabismus. Our analysis found that the association between esotropia and maternal smoking to be independent of birth weight, as confirmed by other studies [3 156,165]. Hakim *et al* [156] reported that although the association between maternal smoking and esotropia was independent of birth weight, the risk was greatest for those children with a birth weight of less than 2,500g and for those with birth weights of more than 3,500g. They were not able to explain this U-shaped pattern of association with birth weight.

We also found that strabismus, and its sub-type esotropia but not exotropia, was associated with admission to NICU, which has also been reported by other studies[31,173]. Although reasons for admission to NICU can include prematurity and low birth-weight, this association with strabismus and with esotropia remained significant after adjustment for a range of risk factors including prematurity and low birth weight. Many other perinatal complications can also precipitate admission to NICU care[13,159,160]. Complications that have been associated with strabismus include; alcohol consumption during pregnancy, maternal illness, complications during labour, assisted or Caesarean delivery, respiratory difficulties, jaundice and/or infection within the first week of life [31].

Children born prematurely tend to have a low birth-weight when compared to those born close to, or at, full-term. Maternal smoking during pregnancy is also known to be associated with prematurity [172]. Some studies have associated strabismus with prematurity [3,9,31,175,179], and we also previously reported this association in our 6 year-old sample [13]. However, within the 12 year-old and combined samples, this association was not significant after adjustment for a range of associated factors, including birth weight. The extent to which strabismus is attributable to low birth-weight, *per se*, or to prematurity is difficult to assess, since these two factors are highly interlinked. The Millennium Cohort Study has attempted to establish the relative contribution of prematurity and low birth-weight, and has speculated that although prematurity plays a more important role in the development of strabismus, the strongest association is apparent when both prematurity and low birth-weight are present [31].

It is also important to note that when evaluating the relative contribution of prematurity and low birth-weight, data ought to be stratified by the presence or absence of retinopathy of prematurity (ROP), a well-known risk factor for strabismus [9,175,191]. In our sample, there was only one case of ROP in the 6 year-old sample and none within the 12 year-old sample, which could partially explain the lack of association with prematurity in our study. Those studies which have compared children with prematurity and with or without a history of ROP, report a high rate of strabismus (>20%) in children with ROP but also a higher than normal rate of strabismus (5-16%) in children without ROP [9,101,175,191]. A series of case-control studies that separately examined the association of strabismus with low birth-weight, prematurity and ROP, found that all three factors independently led to the development of strabismus, which was suggested to occur through different pathways [101,175].

In our study, exotropia was not associated with a range of antenatal factors, but was associated with an indicator of low SES. This association has been found in one other study [3]. A longitudinal birth-cohort study of predominantly European Caucasian children aged seven years[11], also found an association with esotropia. However, this study was under-represented by children with low SES after 7 years follow-up, and also had a very low proportion of strabismus cases with exotropia (21%), in comparison to our study (49%) and other studies of predominantly European Caucasian children (30-45%) [5,7,222,223]. Low SES is likely to encompass a wide range of factors including maternal and/or child nutrition, parental education and frequency of use of health services. A possible manifestation of poor maternal nutrition could be reflected in the significantly lower mean birth weight of children with exotropia, as compared to those without strabismus or with esotropia in our study. More specific definitions of factors associated with SES, as well as associations within and between the various indicators of SES would need to be elucidated to determine the precise nature of low SES association with strabismus.

In conclusion, our study has found that esotropia is associated with risk factors that appear to be directly related to antenatal events. The strong association of strabismus with active maternal smoking during pregnancy has been consistently reported, and was confirmed in our study. Conveying information about the increased likelihood of strabismus is an important public health

message to convey to future mothers and could lead to an overall reduction in strabismus and its associated morbidities.

CHAPTER 5

Parental Awareness of Ocular Disorder in 6-Year Old Children

Sydney Myopia Study (SMS)

5.1 INTRODUCTION

Early detection of ocular conditions and disease in children, such as strabismus, refractive error and amblyopia is vital to maximize visual potential and prevent possible visual impairment in later life [1]. From birth the visual system starts to develop in response to visual stimuli and continues to develop rapidly thereafter. The most critical period for development of the visual system is from birth to 4-5 years [227]. Any disruption within this critical period may result in the development of various ocular disorders such as amblyopia, refractive errors, loss of stereoacuity and secondary strabismus. Clear vision begins to develop by six weeks of age and needs to be maintained till visual maturity is reached at approximately 8 years of age to allow full development of binocular vision and depth perception. Prior to this age, the visual process is malleable. However, after the visual system has matured, improvement of visual acuity in response to treatment is unlikely[227,228] .

There has been an overall reduction in government-sponsored vision screening programs. In New South Wales school screening programmes that had universal reach have been replaced by screening at pre-school age, which is dependent on attendance at a pre-school and on parental referral which has been suggested may be sufficient to detect these disorders [229,230].

In the previous chapters it has been shown that ascertainment of strabismus cases is not always accurate, even by people with some level of training. If a parent does not recognise the presence of a disorder they will not be inclined to seek treatment. Lack of parental awareness has also been linked to poor compliance of treatment [227], therefore even when ocular disorders are detected on screening, a child's condition may remain untreated or only partially treated [228].

In a retrospective study assessing the treatment and non-treatment of amblyopia as well as parental knowledge of the condition [227], 3 groups of participants with differing levels of treatment were compared. The first group contained those who had amblyopia treatment prior to kindergarten screening while Groups 2 and 3 were those who had amblyopia and refractive error diagnosed during the screening. The study reported that strabismus was significantly associated with

amblyopia, however only parents of only four children in Group 1 (previously treated for amblyopia) were aware of strabismus while no parents in the other two groups were aware of strabismus. Overall awareness of strabismus and amblyopia was strongest in group 1 (40%) but much lower in the other groups (12.3%). This suggests that even within those parents previously exposed to treatment for amblyopia in their child had poor knowledge of strabismus. Another study [231] showed that not only was parental awareness of their child's condition important but parental knowledge on the importance of the critical period of visual maturity and understanding of treatment options was equally important to ensure compliance with treatment.

5.2 METHODS

The data for this chapter is based 1739 Year 1 children (mean age 6.7) who formed the younger sample of children from the Sydney Myopia Study (SMS), a random cluster population-based-study of two age samples of school children (Year 1 & 7, 55 schools). This sample was chosen because at the time they were in Kindergarten (one year earlier) all school-based vision screening had ceased. Some of these children may have received pre-school vision screening. However, a significant proportion of children in the older sample would have undergone school-based screening in their Kindergarten year. This younger sample therefore provided an excellent opportunity to examine parental self-reporting of ocular disorders in relation to those condition detected by a comprehensive eye examination including cover test, visual acuity and cycloplegic refraction. Parental awareness of their child's ocular condition was assessed through detailed questions within a larger questionnaire that included items on the families' socio-demographic status, the child's medical history and questions regarding the family history of ocular disorders (*see Appendix1*). The methods used for this study are described in detail in Chapter 2.

Questions to assess parental awareness included an extensive history of any ocular sign and symptoms that the child may have exhibited in the past. Parents were asked whether they had noticed their child having difficulty whilst doing close work or when viewing an object in the distance,

whether or not the child is photophobic and if they squinted or closed one or both eyes whilst doing any particular activity.

Parents were also asked if they ever noticed any abnormal physical aspect of their child's eyes such as drooping of eyelids, other ocular related concerns and generally as Question 63 "Has anyone ever thought there might be a problem with your child's eyesight?" Information was also sought about whether or not the child had a previous eye examination. *See Appendix 1 for details of questions included*.

Parental awareness of their child having conditions such as amblyopia, strabismus, and refractive error was assessed by asking if they were ever told by a doctor as to whether their child had the condition. Details such as which was the effected eye, if they had received previous treatment, what kind of treatment (glasses, patching, eye drops, orthoptic and surgery) were all recorded. An extensive ocular history of the child's direct family was also assessed through the questionnaire. Details on the child's use of refractive correction (glasses) if worn included the age at which they started wearing glasses and what they used the glasses primarily for. If an eye specialist already saw the child, the contact details of the practitioner were requested as well as details of how often the child visited their eye practitioner.

5.3 RESULTS:

Of the 1739 children examined, 238 (13.7%) had at least one ocular condition detected during the examination carried out by the study team and 12 of these children had multiple conditions *(see Table 5.1)*. The most common type of visual disorder was reduced visual acuity in one or both eyes (n = 132; 55.5%). This included cases of amblyopia. Strabismus (n = 48, 20.2%) was the second most common occurring disorder. Cases of strabismus included those present at time of examination and also those reported by parents, which were confirmed by history of therapy including surgery. The next most common disorder was retinal conditions (n = 30, 12.6%). These ranged in severity, some as mild as a single peripheral retinopathy of prematurity scar and the most severe detected was a rare congenital eye condition called Coates disease, which is an abnormal development of choroidal blood vessels. Least occurring were abnormal external structures of the eye (n = 16, 6.7%), which also varied widely, from those immediately obvious such as ptosis (droopy eyelids) to more subtle defects such as remnant membranes at the edges of the pupil. Twenty-four children (10.1%) were found to be colour blind, see *Table 5.1*.

Table 5.1: Proportion of the children with ocular conditions

DISORDER TYPE	n	%
Reduced visual acuity (including Amblyopia; <6/12)	132	55.5
Strabismus**	48	20.2
Any retinal condition***	30	12.6
Colour Blindness	24	10.1
Abnormal external structure***(Lids, cornea, sclera, pupils)**	16	6.7

**1 case also had reduced visual acuity*
*** 9 cases also had reduced visual acuity*
**** 2 cases also had reduced visual acuity*

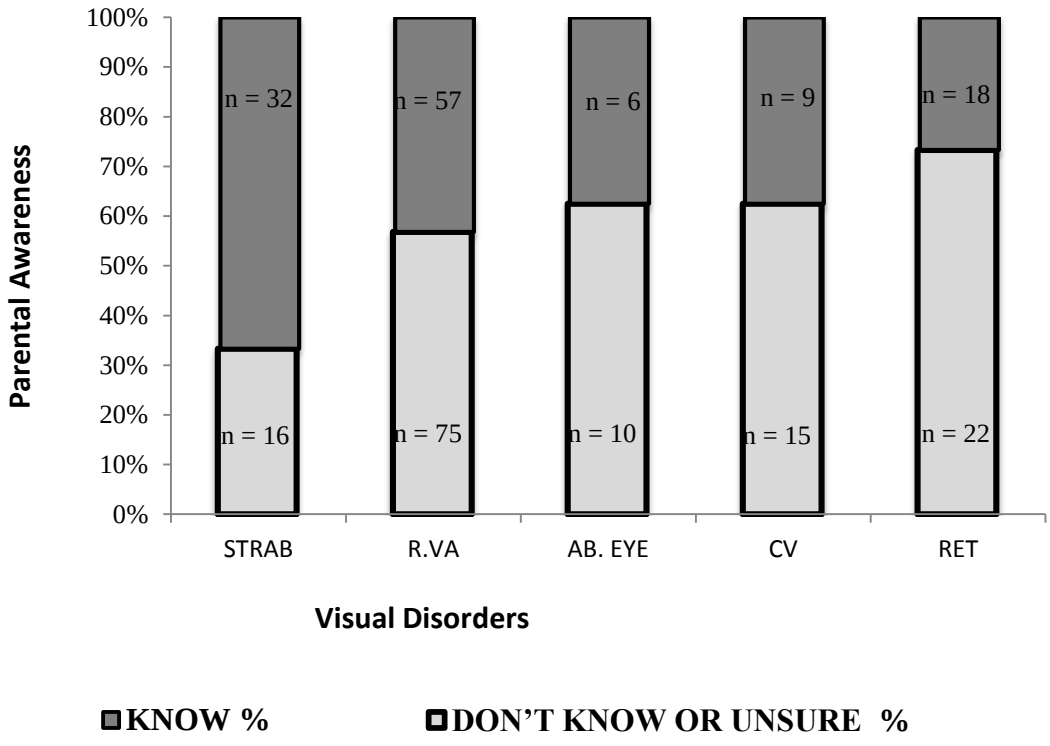
Parental awareness of their child's ocular condition varied according to the type of ocular disorder (*Table 5.2; Figure 5.1*). Parents were significantly more aware if their child had a strabismus

(66.7%) when compared to the other ocular conditions ($p < 0.05$) except when compared to those who knew their child had an abnormality or condition affecting an external ocular structure (37.5%). Conditions such as colour blindness (37.5%) and less visible condition such as retinal abnormalities (26.7%) were the conditions that parents were least aware of.

Table 5.2: Proportion of parents who were aware of their child's ocular condition

DISORDER	KNOW %	p Value
Strabismus	66.7	ref
Reduced visual acuity (including Amblyopia; <6/12)	43.2	0.005
Abnormal external structure **(Lids, cornea, sclera, pupils)**	37.5	0.1
Colour Blindness	37.5	0.04
Any retinal condition	26.7	0.0005

Figure 5.1: Proportion of parents who were un-aware and aware of their child's ocular condition.



STRAB – Strabismus

R.VA – Reduced Visual Acuity

AB.EYE – Abnormal External Eye Conditions

CV – Colour Vision

RET – Retinal Abnormalities

All parents of children who had previously had surgical correction for strabismus were aware of their child's ocular condition (n = 5). For all cases of strabismus, although there was a slight increase of awareness for strabismus measuring >10Δ (n = 22, 66.7%) when compared to strabismus measuring <10Δ (n = 3, 50.0%) and when comparing parental awareness of constant (n = 21, 72.4%) to an intermittent strabismus (n = 6, 57.1%), these differences were not statistically significant (p = 0.674; p = 0.123; respectively). These results are shown in *Table 5.3.*

Table 5.3: Parental awareness of strabismus stratified by cases that had previous strabismic surgery, size of strabismus and constancy

STRABISMUS	DON'T KNOW 0R UNSURE		KNOW	
	n	%	n	%
Had surgery	0	(0.0)	5	(100.0)
≥ 10Δ *¤	11	(33.3)	22	(66.7)
<10Δ *¤	3	(50.0)	3	(50.0)
Constant *	8	(27.6)	21	(72.4)
Intermittent *	8	(57.1)	6	(42.9)

** excluded cases who had previous surgery*

¤ 4 cases did not have any measurement

Some conditions that one may think would be obvious, such as reduced vision were also not readily noticed by parents, less than half (43.2%) of parents with children who had reduced visual acuity were aware of their child's condition. There were also no statistically significant differences in awareness of parents (50%) of children with bilateral (n = 34) versus awareness of unilateral reduced visual acuity (40.8%) in their children (n = 98), see *Table 5.5*. Major causes of reduced visual acuity include refractive error (n = 66, 50.0%) and amblyopia (n = 57, 43.2%). Nine children (6.8%) had reduced visual acuity due to other causes which included, nystagmus (n = 1), thin pupillary

membrane (n = 1), Coates disease (n =1), ROP scars (n = 5) and one child was not sufficiently cooperative to give an accurate visual acuity. This child's uncooperativeness may be attributed to their inability to see clearly because as soon as the child was allowed to bring the object closer and/or adopt a particular head posture, good cooperation was achieved. Of the 66 children with significant refractive errors, only 42.4% of parents were aware that their child had a refractive error (*Table 5.4*). Myopia was found in 17 children of whom only 17.6% (n = 3) of parents were aware of their child's refractive error and poor vision. More parents were aware if their child had astigmatism (n = 28 with 50.0% awareness) and the refractive state that the highest proportion that parents were aware of, was hyperopia (n =21, 52.4% aware). However, these differences in awareness were not statistically significant, possibly due to small numbers. Less than half of parents with amblyopic children (45.5%, n = 57) were aware of their child's condition. More parents were aware if the cause of amblyopia was strabismus (66.7%, n = 9,) compared to anisometropic amblyopia (41.7%, n = 48,), but again this difference was not statistically significant, possibly due to the low number of cases.

Table 5.4: Parental awareness of unilateral and bilateral reduced visual acuity

DISORDER	DON'T KNOW 0R UNSURE		KNOW	
	n	%	n	%
Reduced visual acuity	75	(56.8)	57	(43.2)
Unilateral	58	(59.2)	40	(40.8)
Bilateral	17	(50.0)	17	(50.0)

Table 5.5: Parental awareness of reduced visual acuity according to its major causes.

MAJOR CAUSES OF REDUCED VISUAL ACUITY	DON'T KNOW 0R USURE		KNOW	
	n	%	N	%
Refractive error causing visual impairment	38	(57.6)	28	(42.4)
Hyperopia (>+2.00DS)	10	(47.6)	11	(52.4)
Myopia (< -0.5DS)	14	(82.4)	3	(17.6)
Astigmatism (> 1.0DS)	14	(50.0)	14	(50.0)
Amblyopia	31	(54.4)	26	(45.5)
Anisometropic amblyopia	28	(58.3)	20	(41.7)
Strabismic amblyopia**	3	(33.3)	6	(66.7)
Other	6	(66.7)	3	(33.3)

*** 4 cases have a combination of anisometropic & strabismic amblyopia*

The World Health Organization (WHO) has set standard levels of impairment of visual function where the level of visual acuity is related to the degree of visual function being affected by the visual impairment of the better seeing eye. Mild visual impairment (level 1) is set at a visual acuity of 6/18, however, in our study 100% parental awareness was not achieved until the level of vision reached 6/30 in the better seeing eye, which is a much lower visual acuity than the cut off level set as the lower limit (6/18 to 6/60) by the WHO for functional mild visual impairment [232].

5.4 DISCUSSION

In this population-based sample of children, the most common type of ocular disorder was reduced visual acuity. The major causes of reduced visual acuity were refractive errors and amblyopia, which has been reported in previous studies[50,56,214,233,234]. Strabismus was the second most commonly occurring disorder. The least frequent ocular condition was abnormal external structures of the eye. Colour vision deficiencies were found to occur in 10% of the population, which is higher than previous reported estimates of around 6-8% of the population.

Strabismus can be very obvious, especially if the angle of the deviation of ocular alignment is large and constantly present and compared to other ocular conditions strabismus was more readily detected by parents. Parental awareness was shown to increase when their child's strabismus measured >10Δ and if the strabismus was constant, however, this increase did not reach significance, which may reflect small numbers of cases. This may require a larger study, perhaps taking place within existing vision screening programs to determine all the factors that may underlie parent awareness of strabismus. This is an important issue because if parental awareness of strabismus, a relatively visible condition, is not high (and in our study at age 6 years 1/3rd of these cases would be undiagnosed), this has significant bearing relying on parental reporting of ocular conditions as a substitute for vision screening as has been suggested [229]. Studies reporting prevalence of strabismus that relied on parental reporting [200] have also reported lower prevalence rates for strabismus (0.7%) compared to the prevalence rate of strabismus reported previously for SMS (2.8%)[13] and other studies that have used gold-standard cover test performed by experienced practitioners [3-7,9,51 8,10,28,44,45,64,65,235]

It is unfortunate but not surprising that parental awareness of less readily visible conditions such as reduced visual acuity and retinal pathology was not high, as these are conditions that may well impose a functional deficit. Parents did not become 100% aware of their child's poor vision until their child's visual acuity in the worse seeing eye was 6/30 or worse as their child may have one eye with normal or better visual acuity and thus appear asymptomatic. However, the difference of visual acuity between the two eyes will render these children amblyopic. The lack of parental

awareness will lead to the non-treatment of the amblyopia and increases the risk of visual impairment later in life [18].

Refractive errors were a major cause of reduced visual acuity in these children but myopic refractive errors, which are the most likely to detrimentally affect visual acuity [2,221] were the least likely to be detected by parents at this age. It could be anticipated that hyperopia, because of accommodative reserves able to be used to achieve clear vision, may give parents less cause to become aware of this condition, however, this was not the case [226,236]. However, both hyperopia and astigmatism have been associated with decreased educational attainment [237-241] and it could be that while this is a potential outcome of uncorrected hyperopic and astigmatic refractive errors at this young age, parents may not associate these difficulties with a vision condition such as refractive error.

Amblyopia, as a cause of uniocular visual impairment needs to be treated as early as possible and before visual maturity is reached at about 8 – 9 years of age. The two main causes of amblyopia are strabismus, which should be more physically obvious than anisometropia as the other major cause of amblyopia. While more parents did seem to be aware of strabismic amblyopia, parental awareness of these two types of amblyopia in their child was not statistically significantly different.

Since parents of the children with significant visual impairment in one eye appear to not be aware of their child's condition, it would be logical to assume that if both eyes suffered visual impairment this should increase parental awareness, as it would presumably be more symptomatically obvious. While there was a slight increase in parental awareness for bilateral visual impairment compared to unilateral reduced visual acuity, this did not reach significance. This may be attributed to the small numbers of cases. Thus further investigation is required not just of visual acuity but also assessment functional vision and how a child performs on activity based tests in order to fully understand why parents may "miss" their child's visual impairment. This may help the development of parental education campaigns.

Also somewhat surprising is that parents are not aware of their child's colour blindness because due to the nature of its inheritance. In most cases another family member would also have

been colour blind. But this condition may skip generations and therefore may go undiagnosed unless specifically tested. Early detection and awareness of colour blindness in a child may assist their early education, though there are no reports of long term educational impacts. Colour blindness does limit some vocational opportunities and again knowledge of this condition may be helpful to parents, teachers and the child. This provides further support for the need of proper visual screening.

Even with the pre-school vision-screening programs in place this study has shown that there is still an obvious need for parental education campaigns to target all childhood ocular disorders. The aim of such a programme would be to make parents realise the importance of getting their child's eyes checked at an early stage despite feeling or thinking that there is nothing wrong. It would also hopefully encourage parents to act upon any uncertainty they may have about their child's eyes and to be aware of the role of a family history of ocular conditions. Increased in parental education may also lead to the over reporting of cases, further supporting that the need of skilled screening. Importantly, we cannot recommend that parental reporting would be a reliable way to detect ocular conditions and based on our findings could not replace formal vision screening programs.

5.5 CONCLUSION

Nearly two-thirds of parents were either unaware or unsure of their child's ocular condition. Awareness of strabismus was slightly better compared with other ocular conditions, possibly due to the obvious appearance of a turned eye. Parents were slightly more aware of an external eye condition compared with a retinal disorder, which may be due to the visibility of the condition. Based on these findings, parental report and awareness of ocular conditions is poor and cannot reliably replace vision screening in ensuring children's eye conditions are detected.

CHAPTER 6 DISCUSSION

6.1 SUMMARY OF FINDINGS AND DISCUSSION

Early detection of ocular conditions and disease in children, such as strabismus (turned eye), and amblyopia (reduced vision due to stimulus deprivation) is vital to maximize visual potential and minimise visual impairment in later life [18]. Prior to visual maturity at the age of approximately 8 years old, the visual process is developing and malleable [227,228], and any disruption within this critical period may result in the development of various ocular disorders which may persist to adulthood [220,221]. Treatment at that stage can be intense and costly, including possible surgery. Other permanent co morbidities of strabismus and amblyopia are permanent loss of stereoacuity and various forms of psychosocial difficulties, which can persist to adult life, perhaps resulting in a limited choice of employment.

Particularly since Snowden and Stewart-Brown reported [242] that preschool vision screening by teachers or school nurses during ad-hoc school checks was adequate to detect significant visual disorders[242], and the progressive decline in many places of school screening, understanding the best approaches to early detection of vision problems have been a controversial issue.

6.1.1 Chapter 1

This thesis reviewed previous data that reported on the prevalence of strabismus in an attempt to answer the question of why these rates differ between studies, from as low as 0.01% in young Japanese children [196] to as high as 26.8% in children with neuro-developmental anomalies [91].

An examination of previous literature shows that there are two apparent major factors that consistently influence the reported prevalence of strabismus. The first is the population sampled and second, the methods adopted for the ascertainment of cases. Variation within these parameters confounds any attempt to determine the population prevalence of strabismus across time.

For the analysis, we have taken the epidemiological gold standard as population-based and population-representative samples. We have also taken the gold standard for ascertainment as cover/uncover tests at both near and distance performed by well-trained practitioners. Studies meeting

these standards have given rather consistent results for populations of European Caucasian origin. The prevalence of strabismus within school-based studies which employed methods that meet the gold standard were only marginally lower than those from population-based studies [8,10,28,44,45,64,65,235]. Clinic-based studies that employed the gold standard method generally overestimate the prevalence of strabismus (19.0%) [94 95] . Two case-control studies which examined clinic-based samples of predominantly Caucasian population, compared their "at-risk" sample (children born prematurely; 16.2 - 19.3%) to a "normal" control sample (children born full-term) from their population and reported prevalence of 3.2% [100] and 3.0% respectively [9,101] which were remarkably consistent with those reported from population-based samples.

In addition, we postulated that the gold standard for ascertaining strabismus cases should be a cover and uncover test for near and distance, with and without glasses when worn. Our analysis also shows that the level of experience of the practitioner performing the tests impacted upon the reported prevalence of strabismus. Reported prevalence values are especially low when untrained/unsupervised laypersons are involved. This may be due to their limited ability to detect all forms of constant strabismus, including small angled microtropia, as well as to elicit strabismus that is only present intermittently.

Definitions and categories of strabismus that are studied need to be clearly articulated prior to ascertainment of strabismus cases. Ideally studies should select an unbiased large sample of the population all of whom are to be examined. Samples should be representative of the diversity of socio-economic status, ethnicity in the population, and forms of strabismus related to other conditions should not be excluded. The age group of the sample studied is another factor that needs to be considered, and the age covered should be informed by the key periods of ocular development. On the basis of the results of the SMS and SPEDS studies, we also suggest that cases of strabismus which have been previously identified and treated should also be ascertained in studies concerned with prevalence estimation and risk factor analysis.

6.1.2 Chapter 3: Prevalence & risk factors within the SPEDS data.

The prevalence of strabismus within our population-based study (SPEDS) was 3.3%. This is slightly higher than the prevalence obtained from the school based study SMS (2.8%)[13] and also the prevalence obtained in the study of 6 and 12 year-old children in that study (2.7%). This was consistent to other large population based studies whose methods of strabismus ascertainment meet the gold standard of a cover test performed by a professional[3-7,9,51]. There were more cases of exotropia (n = 51, 2.1%) than esotropia (n = 26, 1.1%) in the SPEDS sample. Though we found no significant association of strabismus with gender, ethnicity and age, it is possible that the lower proportion of children of European Caucasian ethnicity in the SPEDS population accounts for a lower prevalence of esotropia in this sample, compared to SMS.

Low birth weight almost tripled the risk of strabismus [p = 0.01; Odds Ratio (OR) 2.8, Confidence Interval (CI) 1.0-7.3]. This association has also been reported in the analysis of the SMS data (chapter 4)[13]. The data from SPEDS supports the benefits of breastfeeding, since there was a small but significantly lower prevalence of strabismus in these children [p = 0.05; OR 0.6 CI 0.3 – 1.1]. This association did not remain significant, when esotropia and exotropia were considered separately. The lack of association may, however be attributable to the small number of cases in each category.

Familial history was significant for both esotropia and exotropia. A multi-variate analysis controlling for other significant confounding factors was done. Family history remained strongly associated with an increased prevalence of strabismus [p = 0.003; OR 3.9, CI 1.6 – 9.3] and exotropia [p = 0.03; OR 3.6, CI 1.2 – 11.0]. The analysis for associations between family history and esotropia was not possible due to the small number of cases. In the univariate analysis, the history of the condition in different direct family members showed an association with esotropia and exotropia. This suggests that there is a significant hereditary element associated with the development of exotropia and esotropia, although in the case of esotropia this may also be associated with inheritance of a moderate to high hyperopic refractive error.

Analysis of the data from SPEDS also revealed an association between exotropia and indicators of low SES, even after controlling for other confounding factors. This association was not shown for esotropia. Indicators of low SES cover a variety of factors such as maternal and/or child nutrition, parental education and the frequency of use of health services. More precise definitions of these indicators of SES are needed to clearly determine the nature of its association with strabismus.

6.1.3 Chapter 4: Prevalence & risk factors within the SMS data

Analysis of the SMS data revealed that prenatal risk factors significantly associated with strabismus were different for esotropia and exotropia. These findings were similar to those found in the analysis of the SPEDS data as reported within the previous chapter. The prevalence rate of strabismus was 2.8% in the 6-year-old sample, including 29 (46%) with esotropia and 34 (54%) with exotropia. The prevalence rate of the 12-year-old sample (2.7%) has already been published [2].

Low birth weight was significantly associated with a 2-fold increase in the risk of strabismus (Odds ratio, OR 2.3; 95% confidence interval, CI 1.2-4.3) similar to that found in the analysis of the SPEDS data. Interestingly when the two factors; maternal smoking (OR, 2.6; 95% CI, 1.3-5.1) and admission to the neonatal intensive care unit (NICU) (OR, 2.8; 95% CI, 1.04-7.3) were considered separately the risk of developing esotropia nearly tripled. An association between maternal smoking during pregnancy and esotropia has been established in three studies. [156,169,171] Low SES increased the risk of exotropia by 2-fold (OR, 2.2; 95% CI, 1.1-4.4) which is again similar to the association found from the SPEDS data.

6.1.4 Chapter 5: Prevalence & parental awareness of ocular disorders.

Parental awareness of their child's ocular condition varied according to the type of ocular disorder their children had. Of the 1739 children examined, 238 (13.7%) had a significant ocular condition, the most common type being reduced visual acuity in one or both eyes (n = 132; 55.5%). Strabismus (n = 48, 20.2%) was the second. The next most common disorders were retinal conditions (n = 30, 12.6%), followed by colour blindness (n = 24, 10.1%). Abnormal external structures of the eye were less common (n = 16, 6.7%).

Parents were significantly more aware if their child had a strabismus (66.7%) when compared to other ocular conditions ($p < 0.05$). Parents were also significantly aware that their child had an abnormality or condition affecting an external ocular structure (37.5%), probably due to the physically obvious nature of the disease. The size of the angle of strabismus and the constancy did not significantly increase parental awareness of their child's condition and less than half (43.2%) of the parents with children who had reduced visual acuity were aware of this. Parents were not more aware if their child had bilateral reduced vision when compared with those who had reduced vision in one eye. The World Health Organization (WHO) classification for mild visual impairment, is 6/18 or better, however, in our study 100% parental awareness was not achieved until a much lower level of vision (6/30). Parents were even less aware if their child had ocular conditions that were not physically obvious such as colour blindness (37.5%) and retinal abnormalities (26.7%). These results suggest that parental report is not a substitute for universal vision screening.

6.2 DIRECTION FOR RESEARCH.

Our analysis has shown that when gold standards for epidemiology and ascertainment are adhered to, consistent data on populations of European Caucasian origin have been obtained. These have consistently put the prevalence of strabismus at around 3 percent or slightly higher, and have generally reported that esotropia is the predominant form of strabismus. There is insufficient data on other ethnic groups to provide a coherent picture of the prevalence of strabismus, but there is good evidence that in those of East Asian origin, exotropia, rather than esotropia is the predominant form of strabismus. Thus, there are major gaps in the literature which need to be filled with well-designed, gold standard studies.

In our analysis it has become apparent that when assessing the risk factors associated with strabismus it is important that the subtypes are assessed separately, since they appear to be differentially affected by risk factors. A significant increase in strabismus for children with family

history was shown from our data. A carefully designed study of twins could help further identify the roles of genes and environmental factors in the development of strabismus.

The mechanism, by which maternal smoking during pregnancy could influence the development of strabismus, is not clear. We had previously reported that maternal smoking was associated with hyperopia in both age samples [17]. However, Stone and colleagues [168] found that while maternal smoking was associated with both hyperopia and strabismus, they suggested the associations might be due to different mechanisms. The pattern of association between maternal smoking and strabismus, ocular biometry and refraction, is unclear and requires further investigation, particularly for any possible association with accommodative esotropia.

More precise definitions of the factors covered by the SES are needed to clearly determine the nature of its association with strabismus. To date there are no studies looking specifically at the impact of maternal nutrition on birth weight and strabismus. Poor maternal nutrition could be reflected in the significantly lower mean birth weight of children with exotropia, as compared with those without strabismus or with esotropia in our study.

It is also important to note that when evaluating the relative contributions of various risk factors such as of prematurity and low birth-weight, data ought to be stratified by the presence or absence of other confounding variables such as retinopathy of prematurity (ROP), which is a well-known risk factor for strabismus [9,175,191].

While there are limitations to parental awareness, public awareness campaigns should aim to educate parents to be aware of the signs and symptoms and ought to also emphasize the availability of treatment for these conditions. But the small percentage of parents who were aware of problems reinforces the need for vision screening. Reliance on parental assessment clearly results in too many false negatives. Mild levels of visual impairment, particularly unilateral visual impairment maybe

functionally difficult to observe and is another factor that justifies the need for expert screening. These campaigns may also target to increase awareness in teachers and other students, in hope to minimise the risk of bullying and social awkwardness for those children who have to wear glasses and patches.

For any meaningful statistical analysis to be done a fairly large number of cases are needed for each type or subtype of strabismus. Analysis needs to be controlled for any significant confounding factors to confirm that the association is independently affecting the development of strabismus. This may not be possible in a population-based study alone, given the low prevalence of strabismus. Case-control studies may provide the best way of gaining more statistically significant associations. Cases would have to be recruited and carefully selected and examined in a standard protocol. Age, ethnicity and other relevant factors would need to be matched in the case and control study participants, which is very difficult.

6.3 CONCLUSIONS

Using the gold standard of a population-based sample for epidemiology and the gold standard of a cover-uncover test for the ascertainment of strabismus, and the ascertainment of previously treated cases by trained professional observers, showed that there was a quite consistent picture for the prevalence of strabismus in children of European Caucasian origin, where there was generally a predominance of esotropia. However, there is insufficient data on other populations to draw definitive conclusions, except that in populations of East Asian origin, the prevalence may be significantly lower, and exotropia may be the predominant form. Deviations from these gold standards often led to markedly different estimates of prevalence, both higher when clinical samples were examined, and lower when untrained examiners were used. Further gold standard work on the prevalence of strabismus in other ethnic groups is clearly required.

In relation to the risk factors for strabismus, our results showed that the risk factors were quite distinct for esotropia and exotropia. Esotropia is associated with risk factors that appear to be directly

related to antenatal events. The strong association of strabismus with active maternal smoking during pregnancy has been consistently reported, and was confirmed in our study. Conveying information about the increased likelihood of strabismus due to maternal smoking is an important public health message for future mothers and could lead to an overall reduction in strabismus and its associated morbidities.

Exotropia on the other hand was associated with indicators of low SES such as no parental home ownership, low parental education and/or no parental employment. The arguments for screening are clear, but it is also clear that parental ability to detect some conditions needs to be supplemented by better understanding of treatment options.

Finally, even with an ocular condition as readily apparent, as in many cases of strabismus, many parents were unaware that their child had a problem. For ocular conditions which are less readily apparent, such as retinal problems and low visual acuity, including amblyopia, the majority of parents were not aware of a vision problem. This highlights the importance of early detection and diagnosis of vision problems being carried out by trained professionals, rather than relying on parents to report problems or initiate vision testing. Without systematic vision screening at an early age, many children would go untreated and suffer the permanent yet often avoidable consequences of their condition.

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APPENDIX

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APPENDIX 1 SMS QUESTIONAIRE

THE SYDNEY MYOPIA STUDY

QUESTIONNAIRE

Common questions and answers

What is myopia?

People with myopia, or short-sightedness, are usually not able to see objects in the distance clearly, so that they may find it hard to read signs, play ball games or to read off the classroom board.

What occurs in the eye?

The eye normally focuses light on the back of the eye (retina) so that you can see objects clearly. However, in a myopic eye, which is too long, the light is focused in front of the retina, so that objects are blurred.

When and why myopia occurs?

Myopia usually develops during a child's school years. The exact cause is not known. However, it can occur in some families (genetic) or in association with some diseases. Recent evidence also suggests that some environmental factors may play a part.

Why myopia is a problem?

While vision problems can usually be corrected with glasses, myopia can cause other eye diseases as a person gets older. In addition, there is evidence that the number of people with myopia is increasing worldwide.

The purpose of this study

The National Health and Medical Research Council has funded the Sydney Myopia Study to look at factors contributing to the development of myopia. You and your child are invited to participate in this large study that will involve children from all over Sydney.

This questionnaire will give us important information relating to you, your child and your family. Please take as much time as necessary to complete it. All of the answers you provide will be regarded as strictly confidential.

In a few weeks we will provide your child with a complete eye test, and a report will be sent to you. We recently tested children at a school in Sydney and found they really enjoyed the experience.

Guidelines

- Where possible we would like one parent or chief child carer to take responsibility for completing the questionnaire in consultation with other family members/caregivers.

- We use the word "parent" or "chief child carer" to cover those the child lives with, who are primarily responsible for the care of the child on a day to day basis. Some children will not

be living with both, or even one of their biological parents. In relation to pregnancy and parental health, we require information about the biological parents. We recognise that this will be difficult to provide in some situations, and we ask you to note if this is a problem in completing parts of the questionnaire.

- Please attempt to answer every question. In some circumstances you will be directed to skip questions because they don't apply to you.

- If you have difficulty with a question, please give the best response you can and make a comment in the margin.

- Please feel free to ask our staff for assistance. They can be contacted on the telephone numbers below.

Please note: While it would greatly assist the examiners if the questionnaire was completed prior to your child's examination, it will be possible to collect it from you later.

Statement of confidentiality

Information that would permit the identification of any person completing this questionnaire will be regarded as strictly confidential. All information provided will be used only for the Sydney Myopia Study and will not be disclosed or released for any other purpose without your consent.

You may correct any personal information provided at any time by contacting:

Sarah McDonald
Administration
Centre for Vision Research
Westmead Hospital
Telephone: 9845 9077
Fax: 9845 8345
Email: sarah_mcdonald@wmi.usyd.edu.au

Dr Kathryn Rose
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Faculty of Health Sciences,
University of Sydney.
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Professor Paul Mitchell
Project principal investigator,
Department of Ophthalmology,
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paul_mitchell@wmi.usyd.edu.au

ABOUT YOUR CHILD

Personal information

1. Your child's name: _____ _____
   (First name) ***(Family name)***

2. Your child's address: _____

3. Suburb _____ Postcode ☐☐☐☐

4. How long has your child lived in the above suburb? ☐☐ / ☐☐
   (years) *(months)*

5. Since your child was born, where else has he/she lived?

	Location	Length of time at location	Age of child
1			
2			
3			
4			
5			
6			

6. Gender (please tick): ☐Female ☐Male

7. Date of birth: ☐☐☐☐☐☐☐☐
   (day) *(month)* *(year)*

8. In which country was your child born: _____

9. Your child's school is: _____

10. Your child's grade is: _____

Parental contact details:

Telephone (day) _____

Telephone (night) _____

Mobile_____

Email_____

I wish to be present at my child's examination ☐

11. Could you please provide us with the name and address of three people we could contact to obtain a forwarding address for you if you were to move?

☐ No (go to question 15)

☐ Yes (please fill in details below)

12. **Contact 1**

Name _____ Telephone _____

Address _____

Relationship _____

13. **Contact 2**

Name _____ Telephone _____

Address _____

Relationship _____

14. **Contact 3**

Name _____ Telephone _____

Address _____

Relationship _____

6.1.1.1 General Practitioner (GP)

Please state the details of your child's usual G.P.

15. Who is your child's GP? _____

16. What is the address of his/her surgery? _____

_____

When did your child last visit his/her GP? _____ weeks/months ago *(please circle)*

17. On average, how many times per year does your child visit the GP? _____ per year

18. Please tick the box if you do not want a report outlining the results of the examination to also be sent to your nominated GP.

☐ I don't want a report to be sent to my child's GP.

Vision and Hearing Questions

This section has questions relating to your child's hearing and vision. The questions are important because certain hearing and eye conditions can affect your child's schooling.

Basic hearing tests can be performed by a doctor or nurse. A detailed hearing test is performed by an audiologist (hearing practitioner) and a report is given to you.

19. Has your child ever had his/her hearing tested?
    - ☐ No (go to question 27)
    - ☐ Unsure (go to question 27)
    - ☐ Yes

20. If yes, what age? _____ Who performed the test? _____

21. Did you receive a report?
    - ☐ No
    - ☐ Unsure
    - ☐ Yes

22. Were there any abnormalities found with your child's hearing?
    - ☐ No
    - ☐ Unsure
    - ☐ Yes

23. Did your child visit a local doctor or a hearing specialist for further testing?
    - ☐ No
    - ☐ Unsure
    - ☐ Yes

24. Were you told what was wrong with your child's hearing?
    - ☐ No (go to question 27)
    - ☐ Unsure (go to question 27)
    - ☐ Yes

    If yes, the problem was? _____

25. How many months/years ago was the problem reported? ☐☐ / ☐☐
    (years) *(months)*

26. Which ear was involved?
    - ☐ Right ear
    - ☐ Left ear
    - ☐ Both ears
    - ☐ Unsure

In the past, your child may have had an eye test. This could have been part of a screening program at school, performed by a nurse or orthoptist, or a detailed eye examination by a medical eye specialist (ophthalmologist) or optometrist.

27. Has your child ever had his/her vision tested?
    - ☐ No (go to question 37)
    - ☐ Unsure (go to question 37)
    - ☐ Yes

28. If yes, what age? _____Who performed the test? _____

29. Did you receive a report?

☐No ☐Unsure

☐Yes

30. Were there any reported abnormalities with your child's eyes?

☐No ☐Unsure

☐Yes

31. Did your child visit a local doctor or eye practitioner for further testing of the problem?

☐No ☐Unsure

☐Yes

32. Were you told what was wrong with your child's eyes?

☐No (go to question 35) ☐Unsure (go to question 35)

☐Yes

If yes, the problem was? _____

33. How many months/years ago was the problem reported? ☐☐ / ☐☐

(*years)* *(months)*

34. Which eye was involved?

☐Right eye ☐Left eye

☐Both eyes ☐Unsure

35. Does your child have any other sight problems?

☐No (go to question 37) ☐Unsure (go to question 37)

☐Yes

36. What other sight problems does your child have?

☐Totally blind in both eyes ☐Partially blind in both eyes

☐Totally blind in 1 eye only ☐Partially blind in 1 eye only

☐Glaucoma ☐Trachoma

☐Cataract ☐Don't know

☐Other (please describe) _____

37. Is your child colour blind?

☐No ☐ Unsure

☐Yes

The following section asks you about any visits your child may have had to an eye practitioner. An eye practitioner includes:

- ***Ophthalmologist (eye specialist)***
- ***Optometrist***
- ***Orthoptist (eye therapist)***

38. How long has it been since your child last consulted an eye specialist or optometrist?

☐ Never (go to question 42) ☐ 2 to less than 5 years

☐ Less than 1 year ☐ 5 years or more

☐ 1 to less than 2 years ☐ Don't Know (go to question 42)

39. Does your child attend regular eye examinations?

☐ No ☐ Unsure

☐ Yes

40. If yes, please fill in the details of the eye practitioner below. If you are unsure about the type of practitioner he/she is, tick the box marked "other" and state the name and suburb.

☐ **Ophthalmologist (Medical Eye Specialist)** ____/____/____ *(date last seen)*

Name: _____ Suburb: _____

☐ **Optometrist** ____/____/____ *(date last seen)*

Name: _____ Suburb: _____

☐ **Orthoptist** ____/____/____ *(date last seen)*

Name: _____ Suburb: _____

☐ **Other** ____/____/____ *(date last seen)*

Name: _____ Suburb: _____

41. Please tick how often the eye practitioner is seen (refer to the eye practitioner that the child sees most often)

☐ More than once in 6 months ☐ Once a year

☐ Every 6 months ☐ Less frequently than once a year

42. Does your child **currently** wear glasses or contact lenses to correct, or partially correct, his/her eyesight?

☐ No (go to question 45)

☐ Glasses

☐ Contact lenses

43. How often are the glasses or contact lenses used?

☐ All the time

☐ Only when eyes feel tired

☐ Sometimes

☐ Hardly ever

44. What sight problems do your child's glasses or contact lenses correct or partially correct? *(You may tick more than one box)*

☐ Astigmatism

☐ Short-sightedness / Myopia

☐ Long-sightedness / Hyperopia

☐ Don't know

☐ Other (please describe) _____

45. Has your child worn glasses or other optical correction such as contact lenses **in the past**?

☐ No (go to question 49) ☐ Unsure (go to question 49)

☐ Yes

If yes, please state the date and age when prescribed _____

Date stopped: ☐☐ / ☐☐☐☐
(month) *(year)*

Reason stopped _____

_____

46. How often did your child use their glasses / contact lenses?

☐ Most of the time

☐ Sometimes

☐ Only when eyes felt tired

☐ Hardly ever

We would like to know what glasses were previously prescribed. There are two ways we can find out this information. Firstly, by looking at your child's old glasses during his/her examination at school, OR, by viewing the prescription that the eye specialist / optometrist wrote out.

47. Do you have your child's old glasses?

☐ No (go to question 48) ☐ Unsure (go to question 48)

☐ Yes (could the child please bring the glasses with them to the examination)

48. Do you have a copy of your child's last prescription?

☐ No ☐ Unsure

☐ Yes

If yes, please attach the prescription or a copy of it to this page in the space provided below. Alternatively, you may write it down with the date it was prescribed:

_____

_____

_____

☐ Please tick if you want the original prescription to be returned to you

(Attach prescription here)

49. Has your child ever had any one or more of the following treatments for myopia (short-sightedness)?

☐ Bifocals

☐ Progressive lenses

☐ Atropine eye drops

☐ None of the above

☐ Don't know

50. Has your child ever worn an eye patch?

☐ No ☐ Unsure

☐ Yes

If yes, for how long? _____

51. Have you ever been told by a doctor or optometrist that your child has a strabismus (turned or lazy eye)?

☐ No (go to question 53) ☐ Unsure (go to question 53)

☐ Yes

52. Has your child received treatment for this condition?

☐ No ☐ Unsure

☐ Yes (please describe) _____

53. Has your child ever sustained any serious injury to the eyes or area around the eyes?

☐ No (go to question 55) ☐ Unsure (go to question 55)

☐ Yes

If yes, explain the injury (please describe) _____

_____

_____

54. Do you feel your child's vision was affected by the injury?

☐ No ☐ Unsure

☐ Yes

55. Has your child ever had eye surgery?

☐ No

☐ Yes (If yes, what was it for? Please tick)

☐ *Strabismus (turned eye or lazy eye)*

☐ *Other (please describe)* _____

56. Is your child currently using any eye drops/ointments?

☐ No ☐ Unsure

☐ Yes

If yes, please write down the name of all eye drops/ointments **currently** used.

	Name of eye drop/ointment	Times per day	Date started (month/year)	Reason for using
1.				
2.				
3.				

57. Has your child ever used eye drops/ointment in the past?

☐ No ☐ Unsure

☐ Yes

If yes, please write down the name of all eye drops/ointments **previously** used.

	Name of eye drop/ointment	Times per day	Duration of usage	Age at time of usage	Reason for taking
1.					
2.					
3.					

Your child may have never been diagnosed with an eye condition, however we would like to know about any concerns you or others might have with his/her eyes or vision.

58. Has your child ever complained of any eye or vision problems in the past?

☐ No (go to question 60) ☐ Unsure (go to question 60)

☐ Yes

59. Please tick below all symptoms experienced by your child:

☐ Blurred vision when looking in the distance ☐ Double vision

☐ Sore eyes (how often?) _____

☐ Other (please describe) _____

60. Does your child experience a headache when reading or doing close work?

☐ No (go to question 63) ☐ Unsure (go to question 63)

☐ Yes

61. If yes, how often?_____ and at what time of the day? (e.g. 2:30 pm) _____

62. How long do the headache symptoms last? (e.g. 30 min) ☐ / ☐☐

(hours) *(minutes)*

63. Has anyone ever thought there might be a problem with your child's eyesight?

☐ No (go to question 65) ☐ Unsure (go to question 65)

☐ Yes

64. What was thought to be wrong with his/her eyes?

☐ Squint (eyes not looking in same direction) ☐ Don't know

☐ Colour blind

☐ Something else (please describe) _____

65. Do you think your child might need to wear glasses?

☐ No ☐ Unsure

☐ Yes (please give the reason) _____

66. Have you noticed your child to have a turned or lazy eye?

☐ No (go to question 70) ☐ Unsure (go to question 70)

☐ Yes

67. What age was your child when you first noticed this? ☐☐ years ☐☐ months

68. Which eye was affected?

☐ Right eye ☐ Left eye

69. Has a doctor checked this?

☐ No

☐ Yes

If yes, how many year(s)/month(s) were there between the first time you noticed this and the time your child was seen by the doctor? ☐☐ years ☐☐ months

General Medical Details

This section will ask you questions relating to your child's general medical health. We are interested in both past and current medical conditions, and medicines that your child may have taken. A chronic illness or disability is a condition that has been detected in the past and is currently still ongoing, requiring treatment.

70. Has your child ever been diagnosed with a chronic illness or disability?

☐ No (go to question 75) ☐ Unsure (go to question 75)

☐ Yes

71. What was the nature of the illness or disability? (Please name or describe) _____

_____

72. Does your child still have this condition?

☐ No ☐ Unsure ☐ Yes

73. Does your child receive treatment for this condition?

☐ No (go to question 75) ☐ Unsure (go to question 75)

☐ Yes

74. Please tick the treatment(s) given:

☐ Medicine prescribed ☐ Surgery ☐ Given injections

☐ Physiotherapy ☐ Speech therapy ☐ Dental treatment

☐ Naturopathy ☐ Chiropractic treatment

☐ Homeopathic treatment ☐ Counselling / guidance

☐ Other (please describe)_____

Questions 75 to 81 refer to a condition that has been detected for the first time in the last 2 weeks. For example, the flu.

75. Has your child visited a doctor in the last 2 weeks?

☐ No (go to question 82) ☐ Unsure (go to question 82)

☐ Yes

If yes, what was the reason that you took your child to the doctor? (Please describe)_____

_____

76. Was any treatment given?

☐ No (go to question 82) ☐ Unsure (go to question 82)

☐ Yes

77. Please tick the treatment(s) given:

☐ Medicine prescribed ☐ Surgery performed or recommended

☐ Referred to another practitioner (specify)_____

☐ Other (specify)_____

78. Has your child had a second reason to visit a doctor during the last 2 weeks?

☐ No (go to question 82) ☐ Unsure (go to question 82)

☐ Yes

79. What was the illness or injury that caused your child's second visit to the doctor? _____

_____

80. Was any treatment given?

☐ No (go to question 82) ☐ Unsure (go to question 82)

☐ Yes

81. Please tick the treatment(s) given:

☐ Medicine prescribed ☐ Surgery performed or recommended

☐ Referred to another practitioner/ doctor

☐ Other (please describe)_____

Questions 82 – 89 refer to an illness that was severe enough to require your child's admission into hospital or day surgery. For example, appendicitis.

82. Has your child had a major illness in the past that has required admission to hospital or day surgery?

☐ No (go to question 90) ☐ Unsure (go to question 90)

☐ Yes

83. Please describe the reason for your child's admission? _____

_____

84. At what age did this occur? _____

85. Did your child have surgery?

☐ No (go to question 87) ☐ Unsure (go to question 87)

☐ Yes

86. Please name or describe the **surgical procedure** _____

87. What was the name of the hospital and in which suburb was it located?_____

_____

88. Has your child had more than one admission to hospital or day surgery?

☐ No (go to question 90) ☐ Unsure (go to question 90)

☐ Yes

89. Please list the name of the hospital, the suburb in which it was located, the reason for the admission and the date of the admission.

- Hospital:

_____

Suburb: _____ Date: _____ / _____ / _____ *(day/month/year)*

Reason:

_____

- Hospital:

_____

Suburb: _____ Date: _____ / _____ / _____ *(day/month/year)*

Reason: _____

We wish to ask about any medications that your child is <u>currently</u> using, these include both prescribed and non-prescribed medications. Please note that vitamins, inhaled medicines, skin lotions, eye-drops, laxatives, homeopathic and herbal remedies should also be included.

90. Has your child taken any medication(s) in the last 2 weeks?

☐ No (go to question 91) ☐ Unsure (go to question 91)

☐ Yes *(If yes, please list all the medications in the table below)*

	Medication name	Method of intake (ie. oral, injected)	Number of times per day	Date started	Reason for taking
1					
2					
3					
4					
5					

91. In the **<u>past</u>** has there been any prescribed or non-prescribed medication(s) that your child has taken every day or nearly every day for a period of at least 3 months?

- ☐ No (go to question 94) ☐ Unsure (go to question 94)

  ☐ **Yes**

- *If yes please list:*

  1) Prescribed medication in Table A;

  2) Non-prescribed medication in Table B.

92. TABLE A: Please list all medications which were prescribed by a local doctor.

	Medication name	Method of intake (ie oral, injected)	How many times a day	Duration in weeks	Reason for taking	Age at time
1						
2						
3						
4						
5						

93. TABLE B: Please list all medications which were purchased over the counter (that is, a doctors prescription wasn't needed to purchase these medications)

	Medication name	Method of intake (ie oral, injected)	How many times a day	Duration in weeks	Reason for taking	Age at time
1						
2						
3						
4						
5						

We would like to ask you about common medical conditions. Certain conditions have proven to be associated with myopia.

94. Has your child ever been told by a doctor or nurse that he/she has asthma?

☐ No (go to question 96) ☐ Unsure (go to question 96)

☐ Yes

95. Does your child still get asthma?

☐ No ☐ Unsure

☐ Yes

96. Do you (the mother) smoke?

☐ No

☐ Yes

97. Do other people living in your home smoke inside the house?

☐ No

☐ Yes

If you answered ***Yes*** to ***Questions 96 or 97***, please complete the table below.

Cigarettes/day	Mother	Father	Other
1-10/ day			
11-20/ day			
21-40/day			
41+/day			

98. Was there any delay in your child's early development?

☐ No ☐ Unsure

☐ Yes (Please tick below)

Delayed development in:

☐ Sitting

☐ Walking

☐ Talking

☐ Other (please describe) _____

99. Has your child experienced any difficulties with learning at school or pre-school?

☐ No ☐ Unsure

☐ Yes

If yes, please describe _____

100. Have you ever been told that your child has Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD)?

☐ No (go to question 103) ☐ Unsure (go to question 103)

☐ Yes

101. What age was your child when you were first told that he/she had Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD)

☐☐ Years ☐☐ Months ☐ Don't Know

102. Is your child receiving treatment for this disorder?

☐ No ☐ Unsure

☐ Yes

103. Has your child ever been diagnosed with any of the following? (Please tick)

☐ Epilepsy ☐ Meningitis

☐ Marfan Syndrome ☐ Down Syndrome

☐ Stickler Syndrome ☐ Diabetes

☐ Toxoplasmosis

☐ Other (please describe) _____

Gestation and neo-natal.

The following questions are about your child's birth and early years.
If you still have your health record book (the blue/yellow book) it may help to look at it. These books record birth details.

Birth Details: **Extract from Personal Child Health Record- TRANSCRIBE FROM:**

NSW	**Blue Book**	**Page 39**
WA	**Yellow Book**	**Page 45**
SA	**Blue Book**	**Page 38**
Tas	**Blue Book**	**Page 57**
Qld	**Blue Book**	**Page 20**

Vic Yellow Book "Birth, Vit K, Hep B, Newborn Examination" section

104. Do you have your child's State Child Health Record (the blue/yellow book) available?
☐ No ☐ Yes

105. Delivery Type
☐ Normal ☐ Breech ☐ Caesarean
☐ Vacuum extraction ☐ Forceps ☐ Other
☐ Don't know

106. What was your child's birth weight? _____ Grams or _____ Pounds _____ Ounces

107. Birth length _____ cms

108. Birth head circumference _____ cms

109. What was your child's gestation period? ☐☐ weeks (go to question 111)
☐ Unsure (go to question 110)

If your child's gestation period in weeks is unknown, please try to answer the following question.

110. Was your child born
☐ Late (42 weeks or more)
☐ On time (37-41 weeks gestation)
☐ Early (33-36 weeks gestation)
☐ Very early (32 weeks or less)

111. Was your child admitted to a Neonatal Intensive Care Unit (NICU) after birth?

☐ No ☐ Don't know

☐ Yes

112. Was your child admitted to a Special Care Nursery (SCN) after birth?

☐ No (go to question 114) ☐ Don't know (go to question 114)

☐ Yes

(If your child was admitted to a NICU or SCN please answer the following question)

113. If known, please write down date of discharge. ☐☐ / ☐☐ / ☐☐
(day) (month) (year)

114. Was this a multiple pregnancy? (eg. twins or triplets)

☐ No, single birth ☐ Don't know

☐ Yes, twins

☐ Yes, triplets

☐ Yes, more than triplets

115. Was your child born:

☐ In a hospital or birthing centre? (Please name the hospital or birthing centre he/she was born in and the suburb)

Name of hospital _____

Suburb _____ State _____

☐ At home

☐ Other (please describe) _____

116. Did you use your child's health record book to answer the above questions?

☐ No

☐ Yes

117. Has your child ever been breastfed?

☐ No (go to question 119) ☐ Don't know (go to question 119)

☐ Yes

118. What is the total time your child was breastfed?

☐ Longer than 3 months

☐ Longer than 1 week but less than 3 months

☐ Less than one week

☐ Unsure

The mother's health during pregnancy can influence her child's development. We would like to know about specific conditions the mother may have experienced during the pregnancy.

119. Were there any problems with the pregnancy?

☐ No ☐ Unsure

☐ Yes (If yes, please describe)_____

_____

120. During the pregnancy, did the mother:

	Yes	No	Don't know
Have high blood pressure needing treatment? (admission to hospital or medication)	☐	☐	☐
Have diabetes needing insulin injections?	☐	☐	☐
Have diabetes but didn't have insulin injections?	☐	☐	☐
Have a high fever anytime during the pregnancy?	☐	☐	☐
Have Rubella (German measles)?	☐	☐	☐
Have Mumps?	☐	☐	☐
Have other health problems? (Please describe) _____	☐	☐	☐

_____

121. During the pregnancy, did the mother ever smoke cigarettes, cigars, pipes or other tobacco products?

☐ No (go to question 124) ☐ Don't Know (go to question 124)

☐ Yes

122. How often did the mother smoke cigarettes, cigars, pipes or other tobacco products, while she was pregnant with the child?

☐ Daily ☐ Not at all

☐ At least weekly, not daily ☐ Don't know

☐ Less often than weekly

123. During the pregnancy, did the mother:

☐ Reduce the amount of tobacco she smoked

☐ Try and give up smoking but were unsuccessful

☐ Successfully give up smoking

☐ None of the above

☐ Don't know

124. During the pregnancy, did the mother share a home with people who smoked indoors?

☐No ☐Unsure

☐Yes

If yes please specify approximately how many cigarettes were smoked indoors in a day during the pregnancy_____

125. During the pregnancy, did the mother take any prescribed medications?

☐No ☐Unsure

☐Yes (please write down the names of the medications and for how long they were taken in the table below)

Please list all medications which were prescribed by a local doctor

	Medication name	Method of intake (ie oral, injected)	How many times a day	Duration in weeks	Reason for taking
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

126. During the pregnancy, did the mother take any over-the-counter medications?

☐No ☐Unsure

☐Yes (please write down the names of the medications and for how long they were taken in the table below)

Please list all medications which were purchased over the counter (ie a doctors prescription wasn't needed to purchase these medications)

	Medication name	Method of intake (ie oral, injected)	How many times a day	Duration in weeks	Reason for taking
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

In recent years, researchers have studied the impact a child's environment may have on vision. We are interested in all the activities your child engages in on a regular basis.

127. Please tick the average number of ***hours per day*** that your child spends doing the following activities.

	ON A SCHOOL WEEKDAY				**ON A SCHOOL WEEKEND**			
	Not at all	**Less than 1 hour**	**1-2 hours**	**3 or more hours**	**Not at all**	**Less than 1 hour**	**1-2 hours**	**3 or more hours**
a) Playing out of doors (in a backyard, at the park, riding a bike)	☐	☐	☐	☐	☐	☐	☐	☐
b) Outdoor leisure activities (BBQs, picnic, beach, walk)	☐	☐	☐	☐	☐	☐	☐	☐
c) Watching T.V/ videos / DVDs	☐	☐	☐	☐	☐	☐	☐	☐
d) Playing video games eg. Playstation	☐	☐	☐	☐	☐	☐	☐	☐
e) Drawing or writing	☐	☐	☐	☐	☐	☐	☐	☐
f) Playing with toys, hobby or craft	☐	☐	☐	☐	☐	☐	☐	☐
g) Cooking, making or constructing things	☐	☐	☐	☐	☐	☐	☐	☐
h) School homework	☐	☐	☐	☐	☐	☐	☐	☐
i) Reading books for pleasure	☐	☐	☐	☐	☐	☐	☐	☐
j) Playing musical instruments	☐	☐	☐	☐	☐	☐	☐	☐
k) Using a computer or playing computer games	☐	☐	☐	☐	☐	☐	☐	☐
l) Playing ***hand-held*** computer games	☐	☐	☐	☐	☐	☐	☐	☐
m) Playing with and caring for pets	☐	☐	☐	☐	☐	☐	☐	☐
n) Going shopping	☐	☐	☐	☐	☐	☐	☐	☐

128. Please tick the activities your child does and the number of ***hours per week during the school term*** that he/she spends doing the activity. Please also indicate whether this activity is usually done outdoors, in a hall or gym sized room, or in a classroom sized room or smaller.

DURING THE 7 DAYS OF THE WEEK

	YES	Number of hours per week spent in this activity	Outdoors	In a hall or gym	In a classroom or smaller
a) Dancing, gymnastics or callisthenics	☐	_____**hrs per week**	☐	☐	☐
b) Little athletics	☐	_____**hrs per week**	☐	☐	☐
c) Swimming	☐	_____**hrs per week**	☐	☐	☐
d) Football, soccer, rugby, league, AFL	☐	_____**hrs per week**	☐	☐	☐
e) Netball, basketball	☐	_____**hrs per week**	☐	☐	☐
f) Tennis	☐	_____**hrs per week**	☐	☐	☐
g) Kanga cricket	☐	_____**hrs per week**	☐	☐	☐
h) Skating, riding a scooter, rollerblading	☐	_____**hrs per week**	☐	☐	☐
i) Baseball/ softball	☐	_____**hrs per week**	☐	☐	☐
j) Attending a youth group/club e.g. cubs, brownies etc	☐	_____**hrs per week**	☐	☐	☐
k) Attending a religious centre	☐	_____**hrs per week**	☐	☐	☐
l) Other, please describe below	☐	_____**hrs per week**	☐	☐	☐

129. Please list other activities: _____

_____

_____

_____

Questions about Holidays

In the last year your child would have had on average about 12 weeks of school holidays. During those weeks, he/she may have spent some considerable time doing different activities at home or in a different location. Please indicate below where and for how long your child spent his/her holidays. More than one box may be ticked.

130. For the 6 weeks of summer, Christmas holidays

Duration (if greater than 2 days)

- ☐ At home, or at a relative's or friend's home for the day _____
- ☐ In vacation care or at a camp _____
- ☐ Away from home, travelling or in one location _____
- ☐ Other (please describe) _____

131. During these holidays, please estimate the amount of time that your child spent indoors and outdoors during the day.

- ☐ Most of the time indoors
- ☐ Mainly indoors and occasionally going outdoors for a day, or up to 2 hours outdoors per day
- ☐ About equal amounts of time indoors and outdoors
- ☐ Mostly outdoors and occasionally spending a day indoors, or up to 2 hours indoors per day
- ☐ Most of the time outdoors

132. Describe the activities that your child liked to do most often during these holidays.

_____

_____

_____

_____

_____

133. The 2 weeks of holidays at the end of term one, the Easter break

Duration (if greater than 2 days)

- ☐ At home, or at a relative's or friend's home for the day _____
- ☐ In vacation care or at a camp _____
- ☐ Away from home, travelling or to stay in one location _____
- ☐ Other (please describe) _____

134. During these holidays, please estimate the amount of time that your child spent indoors and outdoors during the day.

- ☐ Most of the time indoors
- ☐ Mainly indoors and occasionally going outdoors for a day, or up to 2 hours outdoors per day
- ☐ About equal amounts of time indoors and outdoors
- ☐ Mostly outdoors and occasionally spending a day indoors, or up to 2 hours indoors per day
- ☐ Most of the time outdoors

135. Describe the activities that your child liked to do most often during these holidays.

_____

_____

_____

_____

_____

136. The 2 weeks of holidays at the end of term two, the winter holidays

Duration (if greater than 2 days)

- ☐ At home, or at a relative's or friend's home for the day _____
- ☐ In vacation care or at a camp _____
- ☐ Away from home, travelling or to stay in one location _____
- ☐ Other (please specify) _____

137. During these holidays, please estimate the amount of time that your child spent indoors and outdoors during the day.

- ☐ Most of the time indoors
- ☐ Mainly indoors and occasionally going outdoors for a day, or up to 2 hours outdoors per day
- ☐ About equal amounts of time indoors and outdoors
- ☐ Mostly outdoors and occasionally spending a day indoors, or up to 2 hours indoors per day
- ☐ Most of the time outdoors

138. Describe the activities that your child liked to do most often during these holidays.

_____

_____

_____

_____

_____

139. The 2 weeks of holidays at the end of term three, these include the October long weekend.

Duration (if greater than 2 days)

- ☐ At home, or at a relative's or friend's home for the day _____
- ☐ In vacation care or at a camp _____
- ☐ Away from home, travelling or to stay in one location _____
- ☐ Other, please specify _____ _____

140. During these holidays, please estimate the amount of time that your child spent indoors and outdoors during the day.

- ☐ Most of the time indoors
- ☐ Mainly indoors and occasionally going outdoors for a day, or up to 2 hours outdoors per day
- ☐ About equal amounts of time indoors and outdoors
- ☐ Mostly outdoors and occasionally spending a day indoors, or up to 2 hours indoors per day
- ☐ Most of the time outdoors

141. Describe the activities that your child liked to do most often during these holidays.

_____

_____

_____

_____

_____

Near/distance work questions.

142. Can your child read independently?

- ☐ No
- ☐ Unsure
- ☐ Yes

143. Please tick one of the following

- ☐ Someone reads to my child on a regular basis (almost every night)
- ☐ Someone reads to my child often
- ☐ Someone reads to my child occasionally
- ☐ Someone reads to my child infrequently

144. How many books or magazines does your child finish reading in a week?

☐ books or magazines per week

145. How often does he/she borrow books from a library?

- ☐ Never
- ☐ Less than once a week
- ☐ Around once a week
- ☐ More than once a week

146. Does your child place his/her face abnormally close to the book while reading/writing?

- ☐ No (go to question 148)
- ☐ Unsure (go to question 148)
- ☐ Yes

147. If your child's reading/writing distance is abnormally close, please estimate how close by ticking one box.

- ☐ 0 – less than10 centimetres (0 – less than 4 inches)
- ☐ 10 – less than 20 centimetres (4 – less than 8 inches)
- ☐ 20 – less than 30 centimetres (8 – less than 12 inches)
- ☐ Unsure

148. Does your child use a mobile phone either to make calls or play games on?

- ☐ No
- ☐ Unsure
- ☐ Yes

149. When your child is watching TV, how close to the T.V does your child sit?

- ☐ Less than one metre (less than 3 feet)
- ☐ 1 – 2 metres (3 – 6 feet)
- ☐ 2 – 3 metres (6 – 9 feet)
- ☐ Greater than 3 metres (greater than 9 feet)

150. When your child plays video games, like Playstation, how close to the screen does he/she sit?

- ☐ Less than one metre (less than 3 feet)
- ☐ 1 – 2 metres (3 – 6 feet)
- ☐ 2 – 3 metres (6 – 9 feet)
- ☐ Greater than 3 metres (greater than 9 feet)

151. What is your child's main method of transport to school?

- ☐ Car
- ☐ Train/bus
- ☐ Walking
- ☐ Other (please describe) _____

152. How many minutes does it take **one way** for your child to get to school?

☐ minutes

153. If your child is driven to and from school, what activity is he/she most likely to do during the journey?

☐ Read a book ☐ Talk to other people in the vehicle

☐ Play hand held games ☐ Sleep

☐ Look outside the window

☐ Other (please describe) _____

_____

154. Did your child attend preschool?

☐ No (go to question 156) ☐ Unsure (go to question 156)

☐ Yes

At what age did your child first attend preschool? ☐☐ / ☐☐

(years) *(months)*

155. How many days per week did your child attend preschool? ☐

(days)

156. Has your child had any periods of prolonged absence from school **due to ill health, travel or any other reason**?

☐ No (go to question 159) ☐ Unsure (go to question 159)

☐ Yes (please give details below)

157. If yes, how many days or weeks? _____ Reason for absence: _____

158. Please tick when the absence occurred:

☐ Preschool

☐ Kindergarten

☐ Grade 1

159. How many days was your child absent from school in the last year?

☐ Up to 5 days

☐ 6 – 20 days

☐ More than 20 days

160. Does your child receive any tutorials, coaching or community classes outside school hours?

☐ No ☐ Unsure

☐ Yes

If yes, please state how many hours per week. ☐☐

(hours)

This section will ask about your <u>child's biological (natural) parents and family members</u> to identify genetic associations. Children with parents who are myopic are more likely to develop myopia. In addition, people with particular ethnic backgrounds seem to develop myopia more than others. We realise that some parent(s) may not be the biological parent(s) and in some cases not have the knowledge to complete some sections. If this is the case, please tick unsure. Where possible it is preferable that the biological parent completes this section.

Biological Parents

161. **Please tick the box that applies to your child:**

- ☐ Both parents are the biological parents
- ☐ Current father is the biological father and current mother is not the biological mother
- ☐ Current mother is the biological mother and current father is not the biological father
- ☐ Current father is the biological father and no mother present (single father)
- ☐ Current mother is the biological mother and no father present (single mother)
- ☐ Both parents are **not the** biological parents
- ☐ Other (please describe) _____

162. Country of birth of both biological parents?

Mother _____ ☐ Tick if unsure

Father _____ ☐ Tick if unsure

163. What is the ethnic origin of the child's biological parents? (Provide more than one ethnic group if applicable; e.g. If the father's mother is Caucasian and father's father is East Asian, then you would tick both boxes in the father's column.)

	Mother	Father
Caucasian (European)	☐	☐
East Asian	☐	☐
Indian/ Pakistani/ Sri Lankan	☐	☐
African	☐	☐
Melanesian/ Polynesian	☐	☐
Middle Eastern	☐	☐
Indigenous Australian	☐	☐
South American	☐	☐
Unsure	☐	☐

Other (please describe)_____

164. Date of Birth of the biological mother:

Date of birth: _____ / _____ / _____ (*dd/mm/yy)* ☐Tick if unsure

165. Please tick all medical conditions the child's biologicalmother may have had or currently have?

☐High Blood Pressure ☐Cancer ☐Asthma
☐Diabetes ☐Heart disease ☐Stroke
☐Unsure ☐Other (please describe)_____

166. Date of birth of the biological father:

Date of birth: _____ / _____ / _____ *(dd/mm/yy)* ☐Tick if unsure

167. Please tick all medical conditions the child's biological father may have had or currently have?

☐ High Blood Pressure ☐Cancer ☐Asthma
☐Diabetes ☐Heart disease ☐Stroke
☐Unsure ☐Other (please describe)_____

Biological Family Members

168. Have any of the child's biological family members ever been diagnosed with the following? (Including mother, father, grandparents or any other family member)

(Please specify which biological family members on the lines below)

☐Marfan's syndrome ☐Stickler syndrome

_____ _____

☐Noonan syndrome ☐Down syndrome

_____ _____

☐Turner's syndrome ☐Unsure

_____ _____

169. Please state whether anyone in your child's biological mother's family has had a cataract operation?

(Age when surgery first performed)

- ☐ Mother _____
- ☐ Mother's father _____
- ☐ Mother's mother _____
- ☐ Mother's brothers _____
- ☐ Mother's sisters _____
- ☐ Unsure

170. Is there anyone in your child's biological mother's family with any other eye condition?

(Condition)

- ☐ Mother _____
- ☐ Mother's father _____
- ☐ Mother's mother _____
- ☐ Mother's brothers _____
- ☐ Mother's sisters _____
- ☐ Unsure

171. Please state whether anyone in your child's biological father's family has had a cataract operation?

(Age when surgery first performed)

- ☐ Father _____
- ☐ Father's father _____
- ☐ Father's mother _____
- ☐ Father's brothers _____
- ☐ Father's sisters _____
- ☐ Unsure

172. Is there anyone in your child's biological father's family with any other eye condition?

(Condition)

- ☐ Father _____
- ☐ Father's father _____
- ☐ Father's mother _____
- ☐ Father's brothers _____
- ☐ Father's sisters _____
- ☐ Unsure _____

173. Please indicate the total number of children in the household

☐ Males ☐ Females

174. Please list the full name, sex, year and place of birth for **all** brothers and sisters including biological and non-biological.

First name	Family name	Gender	Year of birth	Place of birth	Same mother	Same father
		☐ Male ☐ Female			☐ Yes ☐ No	☐ Yes ☐ No
		☐ Male ☐ Female			☐ Yes ☐ No	☐ Yes ☐ No
		☐ Male ☐ Female			☐ Yes ☐ No	☐ Yes ☐ No
		☐ Male ☐ Female			☐ Yes ☐ No	☐ Yes ☐ No
		☐ Male ☐ Female			☐ Yes ☐ No	☐ Yes ☐ No
		☐ Male ☐ Female			☐ Yes ☐ No	☐ Yes ☐ No
		☐ Male ☐ Female			☐ Yes ☐ No	☐ Yes ☐ No

175. Do any of your children living in the household have any known eye problems?
Please list:

Name	Eye Problem

176. This table refers to all children except your child involved in the study.

Children	Does the child wear glasses or contact lenses?	At what age did the child start wearing glasses?	What does the child wear glasses and/or contact lens primarily for?	Does the child have astigmatism?
1. First name: _____	☐ Yes ☐ No ☐ Don't know *If no, please move on to the next child*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
2. First name: _____	☐ Yes ☐ No ☐ Don't know *If no, please move on to the next child*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
3. First name:	☐ Yes ☐ No ☐ Don't know *If no, please move onto the next child*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
4. First name: _____	☐ Yes ☐ No ☐ Don't know *If no, please move on to the next child*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
5. First name: _____	☐ Yes ☐ No ☐ Don't know *If no, please move on to the next child*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
6. First name: _____	☐ Yes ☐ No ☐ Don't know *If no, please move on to the next child*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know

We would like to know whether other family members including the parents have eye conditions requiring correction with glasses, contact lenses.

177. Please fill out the tables with reference to your child's biological family members.
As a guide: indicate in the second column whether any family member has ever worn glasses or contact lenses. If your answer is No, then go to the next relative on the row below. If your answer is yes, please fill out the rest of the information in the row.

Family members	**Do they wear glasses or contact lenses?**	**At what age did they start wearing glasses?**	**What do they wear glasses or contact lens primarily for?**	**Do they have astigmatism?**
1. Father	☐ Yes ☐ No ☐ Don't know *If no, please move on to next family member*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
2. Mother	☐ Yes ☐ No ☐ Don't know *If no, please move on to next family member*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
3. Father's father	☐ Yes ☐ No ☐ Don't know *If no, please move on to next family member*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
4. Father's mother	☐ Yes ☐ No ☐ Don't know *If no, please move on to next family member*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
5. Mother's father	☐ Yes ☐ No ☐ Don't know *If no, please move on to next family member*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
6. Mother's mother	☐ Yes ☐ No ☐ Don't know *If no, please move on to next family member*		☐ Seeing clearly in distance (e.g. television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know

178. Has anyone in your family had refractive surgery?

☐ No (go to question 181)

☐ Yes

179. If yes, what is his or her relation to the child (e.g., father, sister) _____

180. Refractive surgery (laser surgery/ LASIK) was done at the age of _____ years old and for correction of:

☐ Myopia ☐ Presbyopia

☐ Hyperopia ☐ Don't know

☐ Astigmatism

The questions in this section refer to the current parents caring for the child, which in some cases may not be the biological parents.

Current parents

181. Parents' occupation(s):

Mother's Occupation: _____

Current Occupation:_____

Father's Occupation:_____

Current Occupation _____

182. How would you describe the mother's employment status?

☐ Employed full time (includes self employment)

☐ Employed part time (includes self employment)

☐ Unemployed

☐ Home duties

☐ Student and working

☐ Student and not working

☐ Retired

☐ Unable to work due to health problems

☐ Pension

☐ Other _____

183. How would you describe the father's employment status?

- ☐ Employed full time (includes self employment)
- ☐ Employed part time (includes self employment)
- ☐ Unemployed
- ☐ Home duties
- ☐ Student and working
- ☐ Student and not working
- ☐ Retired
- ☐ Unable to work due to health problems
- ☐ Pension
- ☐ Other _____

184. What is the highest level of education completed by the mother?

- ☐ Never attended school
- ☐ Some primary school completed
- ☐ Some high school completed
- ☐ Completed School Certificate – Intermediate -Year 10 - 4th Form
- ☐ Completed HSC - Year 12 – Leaving - 6th Form
- ☐ TAFE Certificate or Diploma, including trade certificate
- ☐ University, CAE or some other tertiary institute degree
- ☐ Higher degree including a Masters or PhD
- ☐ Other _____

185. What is the highest level of education completed by the father?

- ☐ Never attended school
- ☐ Some primary school completed
- ☐ Some high school completed
- ☐ Completed School Certificate – Intermediate -Year 10 - 4th Form
- ☐ Completed HSC - Year 12 – Leaving - 6th Form
- ☐ TAFE Certificate or Diploma, including trade certificate
- ☐ University, CAE or some other tertiary institute degree
- ☐ Higher degree including a Masters or PhD
- ☐ Other _____

186. What sort of a place does the family live in?

☐ Own house ☐ With relatives
☐ Own flat/unit ☐ Don't know
☐ Rented house ☐ Rented flat
☐ Other (please describe) _____

Please answer these questions about your child's home. This information will be used to study whether a child's dwelling affects development.

187. Please tick the box that best describes the dwelling structure your child lives in:

☐ Separate house
☐ Semi-detached, row or terrace housewith:
  ☐ *One story*
  ☐ *Two or more stories*
☐ Flat attached to a house
☐ Other flat/unit/apartment:
  ☐ *In a 1 or 2 storey block*
  ☐ *In a 3 storey block*
  ☐ *In a 4 or more storey block*
☐ Caravan/tent/cabin in a caravan park, houseboat in a marina, etc.
☐ Caravan not in a caravan park/houseboat not in a marina, etc.
☐ Improvised home/campers out
☐ House or flat attached to a shop, office, etc.

188. Does your child live regularly in another dwelling structure for 2 days or more per week on average?

☐ No (go to question 190)
☐ Yes

189. If yes, please tick the box that best describes the dwelling structure your child lives in regularly for greater than two days per week:

- ☐ Separate house
- ☐ Semi-detached, row or terrace housewith:
  - ☐ *One story*
  - ☐ *Two or more stories*
- ☐ Flat attached to a house
- ☐ Other flat/unit/apartment:
  - ☐ *In a 1 or 2 storey block*
  - ☐ *In a 3 storey block*
  - ☐ *In a 4 or more storey block*
- ☐ Caravan/tent/cabin in a caravan park, houseboat in a marina, etc.
- ☐ Caravan not in a caravan park/houseboat not in a marina, etc.
- ☐ Improvised home/campers out
- ☐ House or flat attached to a shop, office, etc.

Greenspace Questions

190. From the front door of your dwelling, how many other residential dwellings can you see?

- ☐ Less than 5
- ☐ 5-10
- ☐ Greater than 10
- ☐ Unsure

191. From the front door of your dwelling, how many commercial buildings can you see?

- ☐ None (go to question 193)
- ☐ Less than 5
- ☐ Greater than 5
- ☐ Unsure (go to question 193)

192. Of these, how many high rise buildings, including apartments, flats and offices are included?

- ☐ None
- ☐ Less than 5
- ☐ Greater than 5
- ☐ Unsure

193. Is it possible to get a view of the horizon from the ground floor of your dwelling?

- ☐ No
- ☐ Yes
- ☐ Unsure

The date when the questionnaire was completed: ☐☐ / ☐☐ / ☐☐
(Day) *(Month)* *(Year)*

Name of person filling out the questionnaire:

Name_____ Relationship to child_____

Names of other people consulted in filling out this questionnaire:

Name_____ Relationship to child_____

Name_____ Relationship to child_____

Name_____ Relationship to child_____

Name_____ Relationship to child_____

Thank you for completing this questionnaire. We look forward to seeing your child at the examinations.

APPENDIX 2

SYDNEY MYOPIA STUDY [SMS]

EXAMINATION BOOKLET

School: _____

Study ID No. _____

Name _____

Class _____

DOB: ☐☐☐☐☐☐☐☐ **Female:** ☐ **Male:** ☐

Date of examination: ☐☐☐☐☐☐☐☐

STATION 1 Examiner Initials: ☐☐

The Sydney Myopia Study
Examination Booklet

1.1 VERTOMETRY

1.11 Current glasses

Wears the following spectacle type:

unifocal	☐	does not wear glasses	☐
bifocal	☐	missing	☐
multifocal	☐		
glasses not brought	☐		

1.12 Attach printout for glasses here

1.13 Current contact lenses

(*record prescription*)

SPH _____D CYL _____D AXIS _____°

OBSERVATIONS

For Reporting:

Normal (comment #14) ☐

Other:

EXAMINATION CHECK LIST

TEST	Normal	Abnormal	Not completed
Vision Has Glasses ☐	☐ (1)	☐ (2)	☐ (3)
Colour Vision	☐ (1)	☐ (2)	☐ (3)
Cover Test/ Eye Motility	☐ (1)	☐ (2)	☐ (3)
Slit-lamp	☐ (1)	☐ (2)	☐ (3)
Fundus Photography	☐ (1)	☐ (2)	☐ (3)
Autorefraction (Spherical Equivalent)	**Right eye**	**Left eye**	
>+2.00 (Hyperopia)	☐	☐	☐ Anisometropia
+0.50 — +2.00 (Mild hyperopia)	☐	☐	☐ Astigmatism ≥1D
>-0.50 — <+0.50 (Emmetropic)	☐	☐	
<-0.50 — <-3.00 (Mild myopia)	☐	☐	
-3.00 — <-6.00 (Moderate myopia)	☐	☐	
≤-6.00 (High myopia)	☐	☐	

	Completed	Not Completed
Blood Pressure	☐	☐
Aberrometry (post-dilation)	☐ (1)	☐ (2)
IOLMaster (non-	☐ (1)	☐ (2)
(cycloplegic)	☐ (1)	☐ (2)
Anthropometry	☐ (1)	☐ (2)
OCT	☐ (1)	☐ (2)
Dietary Questionnaire	☐	☐
Best-corrected refraction	Required ☐	Not required ☐

Main cause of reduced vision	Right eye	Left eye
Refractive error	☐	☐
Amblyopia	☐	☐
Retinal abnormalities	☐	☐
Corneal opacity	☐	☐
Lens opacity	☐	☐
Vitreous opacity	☐	☐

STATION 1

1.2 VISUAL ACUITY

R I G H T E Y E

1.21 LogMAR Distance VA **(perform at 2.44m)**

WITHOUT glasses ☐

Snel. Eq	LogMAR letters	No. correct (…/5)	Log MAR score
6/60	H V Z D S	5	1.0
6/48	N C V K D	10	0.9
6/36	C Z S H N	15	0.8
6/30	O N V S R	20	0.7
6/24	K D N R O	25	0.6
6/19	Z K C S V	30	0.5
6/15	D V O H C	35	0.4
6/12	O H V C K	40	0.3
6/9.5	H Z C K O	45	0.2
6/7.5	N C K H D	50	0.1
6/6	Z H C S R	55	0.0
6/4.8	S Z R D N	60	-0.1
6/3.8	H C D R O	65	-0.2
6/3.0	R D O S N	70	-0.3
1.21a Total letters read			

WITH glasses ☐

Snel. Eq	LogMAR letters	No. correct (…/5)	Log MAR score
6/60	H V Z D S	5	1.0
6/48	N C V K D	10	0.9
6/36	C Z S H N	15	0.8
6/30	O N V S R	20	0.7
6/24	K D N R O	25	0.6
6/19	Z K C S V	30	0.5
6/15	D V O H C	35	0.4
6/12	O H V C K	40	0.3
6/9.5	H Z C K O	45	0.2
6/7.5	N C K H D	50	0.1
6/6	Z H C S R	55	0.0
6/4.8	S Z R D N	60	-0.1
6/3.8	H C D R O	65	-0.2
6/30	R D O S N	70	-0.3
1.21b Total letters read			

1.22 If VA ≤ 6/7.5 OR one line difference (5 letters) between eyes, check with pinhole at 2.44 m

1.22a Total no. of letters with PINHOLE (without **glasses): _____**

1.23 If VA <6/60, measure VA at 1.22m

WITHOUT glasses ☐			
Snel. Eq	LogMAR letters	No. correct (…/5)	Log MAR score
6/120	H V Z D S (6/60 line)		1.3
6/96	N C V K D (6/48 line)		1.2
6/72	C Z S H N (6/36 line)		1.1
1.23a Total letters read			

WITH glasses ☐			
Snel. Eq	LogMAR letters	No. correct (…/5)	Log MAR score
6/120	H V Z D S (6/60 line)		1.3
6/96	N C V K D (6/48 line)		1.2
6/72	C Z S H N (6/36 line)		1.1
1.23b Total letters read			

1.24 If VA <3/60, measure VA at 38 cm

1.24a CF ☐ **1.24b HM** ☐ **1.24c PL+P** ☐ **1.24d PL** ☐ **1.24e NPL** ☐

CF – to perform, hold up different numbers of fingers 4-5 times asking the person to count how many fingers they see. At 38cms CF is approximately equivalent to 6/60

HM – to perform, move the hand in different directions, up, down and horizontally at a distance of 38cms, ask the subject in which direction is the hand moving.

LP – switch a small bright fixation torch on and off, held in different locations at 38cms from the subject. Light perception with projection (LP + P) indicates that they can locate the source of the light.

L E F T E Y E

1.25 LogMAR Distance VA **(perform at 2.44m)**

WITHOUT glasses ☐			
Snel. Eq	LogMAR letters	No. correct	LogMAR score
6/60	H V Z D S	5	1.0
6/48	N C V K D	10	0.9
6/36	C Z S H N	15	0.8
6/30	O N V S R	20	0.7
6/24	K D N R O	25	0.6
6/19	Z K C S V	30	0.5

WITH glasses ☐			
Snel. Eq	LogMAR letters	No. correct	Log MAR score
6/60	H V Z D S	5	1.0
6/48	N C V K D	10	0.9
6/36	C Z S H N	15	0.8
6/30	O N V S R	20	0.7
6/24	K D N R O	25	0.6
6/19	Z K C S V	30	0.5

WITHOUT glasses ☐			
Snel. Eq	LogMAR letters	No. correct	LogMAR score
6/15	D V O H C	35	0.4
6/12	O H V C K	40	0.3
6/9.5	H Z C K O	45	0.2
6/7.5	N C K H D	50	0.1
6/6	Z H C S R	55	0.0
6/4.8	S Z R D N	60	-0.1
6/3.8	H C D R O	65	-0.2
6/3.0	R D O S N	70	-0.3
1.25a Total letters read			

WITH glasses ☐			
Snel. Eq	LogMAR letters	No. correct	Log MAR score
6/15	D V O H C	35	0.4
6/12	O H V C K	40	0.3
6/9.5	H Z C K O	45	0.2
6/7.5	N C K H D	50	0.1
6/6	Z H C S R	55	0.0
6/4.8	S Z R D N	60	-0.1
6/3.8	H C D R O	65	-0.2
6/30	R D O S N	70	-0.3
1.25b Total letters read			

1.26 If VA ≤ 6/7.5 OR one line difference (5 letters) between eyes, check with pinhole at 2.44 m

1.26a Total no. of letters with PINHOLE (without **glasses): _____**

1.27 If Vision <6/60, measure VA at 1.22 m

WITHOUT glasses ☐			
Snel. Eq	LogMAR letters	No. correct (…/5)	Log MAR score
6/120	H V Z D S (6/60 line)		1.3
6/48	N C V K D (6/96 line)		1.2
6/36	C Z S H N (6/72 line)		1.1
1.27a Total letters read			

WITH glasses ☐ 			
Snel. Eq	LogMAR letters	No. correct (…/5)	Log MAR score
6/120	H V Z D S (6/60 line)		1.3
6/48	N C V K D (6/96 line)		1.2
6/36	C Z S H N (6/72 line)		1.1
1.27b Total letters read			

1.28 If Vision <3/60, measure VA at 38 cm

1.28a CF ☐ **1.28b HM** ☐ **1.28c PL+P** ☐ **1.28d PL** ☐ **1.28e NPL** ☐

If VA in any eye is ≤ 6/7.5 you MUST do dry autorefraction and subjective refraction.

1.3 BEST CORRECTED VISUAL ACUITY

1.31 RIGHT Eye LogMAR Distance VA **(at 2.44m)**

WITH best correction ☐			
Snel. Eq	LogMAR letters	No. correct	LogMAR score
6/60	H V Z D S	5	1.0
6/48	N C V K D	10	0.9
6/36	C Z S H N	15	0.8
6/30	O N V S R	20	0.7
6/24	K D N R O	25	0.6
6/19	Z K C S V	30	0.5
6/15	D V O H C	35	0.4
6/12	O H V C K	40	0.3
6/9.5	H Z C K O	45	0.2
6/7.5	N C K H D	50	0.1
6/6	Z H C S R	55	0.0
6/4.8	S Z R D N	60	-0.1
6/3.8	H C D R O	65	-0.2
6/3.0	R D O S N	70	-0.3
1.31a Total letters read			
1.31b Sphere			
1.31c Cylinder			
1.31d Axis			

Attach
non-cycloplegic
autorefraction
printout here

**(DO NOT
PUT STICKY TAPE
OVER THE PRINT)**

1.32 LEFT Eye LogMAR Distance VA **(at 2.44m)**

WITH best correction ☐			
Snel. Eq	LogMAR letters	No. correct	LogMAR score
6/60	H V Z D S	5	1.0
6/48	N C V K D	10	0.9
6/36	C Z S H N	15	0.8
6/30	O N V S R	20	0.7
6/24	K D N R O	25	0.6
6/19	Z K C S V	30	0.5
6/15	D V O H C	35	0.4
6/12	O H V C K	40	0.3
6/9.5	H Z C K O	45	0.2
6/7.5	N C K H D	50	0.1
6/6	Z H C S R	55	0.0
6/4.8	S Z R D N	60	-0.1
6/3.8	H C D R O	65	-0.2
6/3.0	R D O S N	70	-0.3
1.32a Total letters read			
1.32b Sphere			
1.32c Cylinder			
1.32d Axis			

1.4 NEAR VA (tick whether glasses worn)

RIGHT EYE		
with glasses ☐	w/out glasses ☐	
Snellen Equiv.	LogMAR letters	No. correct (.../5)
6/60	O H V T	
6/30	V O T H	
6/21	O T V H	
6/15	H V O T	
6/12	T V H O	
6/9	H O V T	
6/6	V T H O	
1.41 Total letters read		
Near VA		

LEFT EYE		
with glasses ☐	w/out glasses ☐	
Snellen Equiv.	LogMAR letters	No. correct (…/5)
6/60	O H V T	
6/30	V O T H	
6/21	O T V H	
6/15	H V O T	
6/12	T V H O	
6/9	H O V T	
6/6	V T H O	
1.42 Total letters read		
Near VA		

1.5 STEREOACUITY

1.51 Langs II **(tick all objects seen)**

1.51a Star (only) ☐
1.51b Elephant (600") ☐
1.51c Car (400") ☐
1.51d Moon (200") ☐
1.51e Full BSV (all objects above seen) ☐
1.51f No objects seen ☐

Perform TNO if not all objects seen in Langs II (i.e. partial or negative)

1.52 TNO **(tick all objects seen)**

1.52a Plate I	☐	**1.52b No BSV demonstrated**		☐
1.52c Plate II	☐			
1.52d Plate III	☐			
1.52e Plate IV	☐			
1.52f Plate V	480" ☐		240"	☐
1.52g Plate VI	120" ☐		60"	☐
1.52h Plate VII	30" ☐		15"	☐

Perform four-dioptre test if both Langs II and TNO negative

1.53 Four prism-dioptre test

RIGHT EYE		LEFT EYE	
Positive	☐	**Positive**	☐
Negative	☐	**Negative**	☐

1.6 COLOUR VISION

1.61 Ishihara **(perform at 40 cm)**

Plate No.	CHILD'S RESPONSES (tick or write down abnormal responses)		
	Normal Response	**R-G deficient responses**	**Other** (write number)
1	12	12 ☐ (control)	
2	8	3 ☐	
3	29	70 ☐	
4	5	2 ☐	
5	3	5 ☐	
6	15	17 ☐	
7	74	21 ☐	
8	6	X ☐	
9	45	X ☐	
10	5	X ☐	
11	7	X ☐	
12	16	X ☐	
13	73	X ☐	
14	X	5 ☐	
15	X	45 ☐	
		Protan **Deutan**	
16	26 ☐	6 ☐ 2 ☐	other ☐
17	42 ☐	2 ☐ 4 ☐	other ☐

X means they don't see any number

RESULT

Normal ☐(1)
Red-green defect ☐(2)
Protan ☐(3)
Deutan ☐(4)
Other colour defect ☐(5)
Total colour blindness ☐(6)

1.62 City University **(perform at 33 cm)**

(Tick the box with the child's response)

Page No.	*Normal*	*Protan*	*Deutan*	*Tritan*
5	R ☐	B ☐	L ☐	T ☐
6	L ☐	R ☐	T ☐	B ☐
7	R ☐	L ☐	B ☐	T ☐
8	L ☐	T ☐	R ☐	B ☐
9	R ☐	L ☐	B ☐	T ☐
10	R ☐	L ☐	B ☐	T ☐

RESULT

Normal ☐(1)
Protan ☐(2)
Deutan ☐(3)
Tritan ☐(4)
Other ☐(5)

1.7 COVER TEST

1.71 Near **(perform at 33 cm)**

WITHOUT Glasses

Esophoria	☐	Esotropia	☐	Right eye	☐	Intermittent	☐	mf	☐
Exophoria	☐	Exotropia	☐	Left eye	☐	Constant	☐	nmf	☐
Orthophoria	☐	Vertical component	☐	Alternating	☐				

WITH Glasses

Esophoria	☐	Esotropia	☐	Right eye	☐	Intermittent	☐	mf	☐
Exophoria	☐	Exotropia	☐	Left eye	☐	Constant	☐	nmf	☐
Orthophoria	☐	Vertical component	☐	Alternating	☐				

1.72 Distance **(perform at 6 m)**

WITHOUT Glasses

Esophoria	☐	Esotropia	☐	Right eye	☐	Intermittent	☐	mf	☐
Exophoria	☐	Exotropia	☐	Left eye	☐	Constant	☐	nmf	☐
Orthophoria	☐	Vertical component	☐	Alternating	☐				

WITH Glasses

Esophoria	☐	Esotropia	☐	Right eye	☐	Intermittent	☐	mf	☐
Exophoria	☐	Exotropia	☐	Left eye	☐	Constant	☐	nmf	☐
Orthophoria	☐	Vertical component	☐	Alternating	☐				

1.8 PRISM BAR COVER TEST

1.81 Near **(perform at 33 cm)**

WITHOUT Glasses

Horizontal _____ D BI ☐ BO ☐ Vertical _____ D BU ☐ BD ☐

WITH Glasses

Horizontal _____ D BI ☐ BO ☐ Vertical _____ D BU ☐ BD ☐

1.82 Distance **(perform at 6 m)**

WITHOUT Glasses

Horizontal _____ D BI ☐ BO ☐ Vertical _____ D BU ☐ BD ☐

WITH Glasses

Horizontal _____ D BI ☐ BO ☐ Vertical _____ D BU ☐ BD ☐

1.9 CONVERGENCE NEAR POINT 1.10 ACCOMMODATION NEAR POINT

☐≤ 6 cm (*tick*)

Other _____ cm Near point _____ D

1.11 OCULAR DOMINANCE

1st Attempt:	RE dominant	☐(1)	LE dominant	☐(2)	Uncertain	☐(3)
2nd Attempt	RE dominant	☐(1)	LE dominant	☐(2)	Uncertain	☐(3)
3rd Attempt	RE dominant	☐(1)	LE dominant	☐(2)	Uncertain	☐(3)

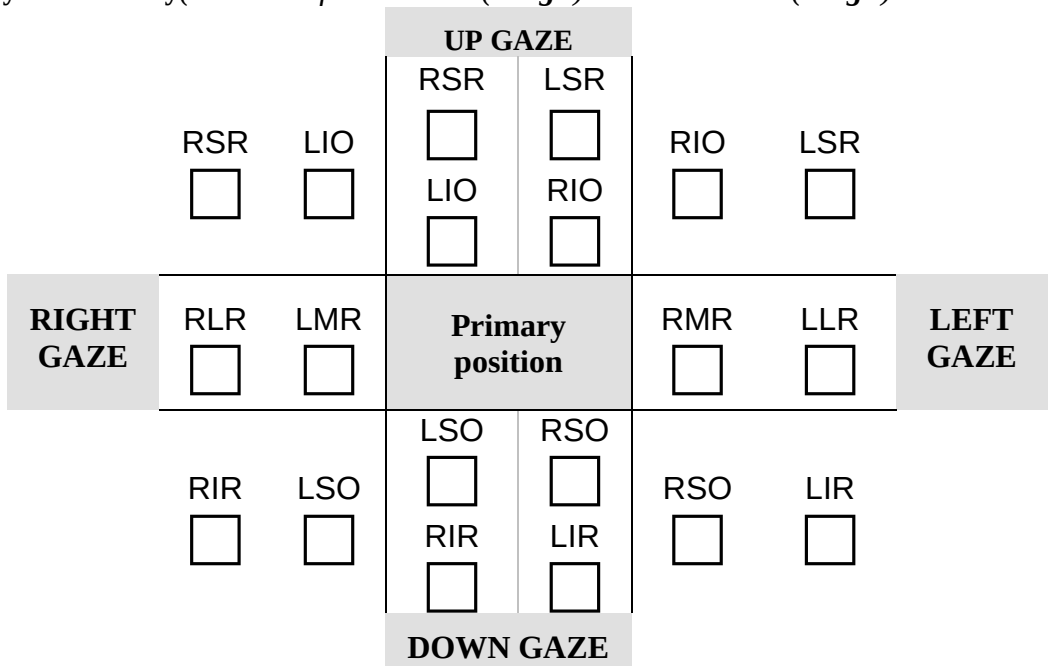
1.12 DEXTERITY

☐Right handed ☐Left handed ☐Ambidextrous

1.13 OCULAR MOVEMENTS

NAD ☐(1) Abnormality detected *(see below)* ☐(2)

Identify abnormality*(Indicate if overaction (+ **sign**) or underaction (– **sign**) in the boxes)*



V pattern A pattern Significant V or A pattern (> 15Δ or tropia in position of gaze)

☐☐☐

1.14 BLOOD PRESSURE

Blood Pressure: _____ /_____ Performed manually ☐(1)
Pulse:_____BPM Unable to perform ☐

Blood Pressure: _____ /_____ Performed manually ☐(2)
Pulse:_____BPM Unable to perform ☐

Blood Pressure: _____ /_____ Performed manually ☐(3)
Pulse:_____BPM Unable to perform ☐

STATION 2

IRIS COLOUR

(Use iris photograph reference standards)

Right eye
< std #1 (blue)……..…1
< std #2 (hazel/green)… 2
< std #3 (tan/brown)….. 3
> std #3 (dark brown)… 4
cannot judge/not done... 5

Left eye
< std #1 (blue)……..…1
< std #2 (hazel/green)… 2
< std #3 (tan/brown)….. 3
> std #3 (dark brown)… 4
cannot judge/not done... 5

IOLMaster

Pre-cycloplegic **Right Eye** ☐ Performed ☐ Not performed

Left Eye ☐ Performed ☐ Not performed

Reason:_____

Post-cycloplegia ☐ Performed ☐ Not performed

SLIT LAMP EXAMINATION

	Eye condition NAD ☐	RE	LE	Code (ICD-10-AM)
Eyelids, lacrimal system	Hordeolum or deep inflammation of the eye lid (abscess, furuncle, stye)	☐	☐	H00.0
	Chalazion	☐	☐	H00.1
	Blepharitis (excl: blepharoconjunctivitis)	☐	☐	H01.0
	Ptosis	☐	☐	H02.4
	Epiphora	☐	☐	H04.2
	Entropion and Trichiasis	☐	☐	H02.0
Conjunctiva and external eye	Mucopurulent conjunctivitis	☐	☐	H10.0
	Pterygium	☐	☐	H11.0
	Pingueculum	☐	☐	
	Conjunctival degenerations and deposits (concretions, pigmentation, xerosis NOS)	☐	☐	H11.1
	Conjunctival scars	☐	☐	H11.2
Corneal disease	Corneal ulcer	☐	☐	H16.0
	Superficial keratitis	☐	☐	H16.1
	Corneal scars or opacities	☐	☐	H17.8
	Heredity corneal dystrophies	☐	☐	H18.5
	Keratoconus	☐	☐	H18.6
Iris and ciliary body	Anterior uveitis	☐	☐	H20.2
	Pupillary membrane	☐	☐	H21.4
Lens	Opacity	☐	☐	

Comments:

STATION 3

First Instillation of: AUTOREFRACTION

20-25 minutes after 2nd Cyclogyl drop

Amethocaine **Time** ☐☐ : ☐☐ *Estimated time for* ☐☐ : ☐☐

2 MINUTES LATER

Tropicamide **Time** ☐☐ : ☐☐

Cyclogyl 1% **Time** ☐☐ : ☐☐

Phenylephrine *Time* ☐☐ : ☐☐

Attach cycloplegic Autorefraction Printout here

(DO NOT PUT TAPE OVER PRINT)

5 MINUTES LATER

Second Instillation of :

Tropicamide **Time** ☐☐ : ☐☐

Cyclogyl 1% **Time** ☐☐ : ☐☐

Phenylephrine *Time* ☐☐ : ☐☐

HEIGHT _____(cm)

WAIST CIRCUMFERENCE _____ (cm)

Body Fat Index **No reading** ☐
(attach output at right)

Attach TANITA printout here

WEIGHT _____(kg)

(if unable to obtain Body Fat Index)

3.1 **ABERROMETRY** (post dilation)

Right Eye

☐ (1) Performed ☐ (2) Not performed Reason:_____

Left Eye

☐ (1) Performed ☐ (2) Not performed Reason:_____

STATION

STATION

STATION 4

OCT

Right Eye

☐ (1) Performed: ☐ (2) Not performed Reason:_____

Left Eye

☐ (1) Performed: ☐ (2) Not performed Reason:_____

STATION 5

RETINAL PHOTOGRAPHY

Fundus abnormalities	**RE**	**LE**
Retina	☐	☐
Macula	☐	☐
Cup	☐	☐
Cup/disc ratio	☐	☐
Blood vessels	☐	☐
NAD	☐	☐

Description _____

_____

_____

Unable to take photographs:

Reason	**RE**	**LE**
(1) Unable to keep still	☐	☐
(2) Refusal	☐	☐
(3) Failure to dilate	☐	☐

Optional Tests

6.1 OBJECTIVE RETINOSCOPY

	RIGHT EYE		LEFT EYE	
	Type	**Refraction**	**Type**	**Refraction**
Emmetrope	☐(1)	SPH:_____D	☐(1)	SPH:_____D
Myope	☐(2)	CYL:_____D	☐(2)	CYL:_____D
Hypermetrope	☐(3)	AXIS:_____°	☐(3)	AXIS:_____°
Astigmatism	☐(1)		☐(1)	

6.2 INDIRECT OPHTHALMOSCOPY

Right eye only ☐(1) Unable to view ☐(4)

Left eye only ☐(2)

Both eyes ☐(3)

Describe any abnormality

☐Right eye

☐Left eye

6.3 DIRECT OPTHALMOSCOPY

Right eye only ☐(1) Unable to view ☐(4)

Left eye only ☐(2)

Both eyes ☐(3)

Describe any abnormality

☐Right eye

☐Left eye

APPENDIX 3

SYDNEY PAEDIATRIC EYE DISEASE STUDY [SPEDS] QUESTIONNAIRE

ID NUMBER: .....

THE SYDNEY PAEDIATRIC EYE DISEASE STUDY

University of Sydney, Department of Ophthalmology, Westmead Hospital and Westmead Millennium Institute, Westmead 2145 and University of Sydney, School of Applied Vision Sciences, Lidcombe 1825

Website: Centre for Vision Research; www.cvr.org.au

Telephone: +61 2 9845 9077

Parent Questionnaire

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THE SYDNEY CHILDHOOD EYE SURVEY QUESTIONNAIRE

Dear Parent,

We are very grateful for your participation with your child in this project. It will provide you with not only a comprehensive report regarding your child's eye health but will also ensure researchers obtain important information about general eye health for children in the Sydney area.

The purpose of this study

The National Health and Medical Research Council has funded the University of Sydney to undertake a survey of eye health in children aged up to 6 years within Sydney. The survey is called the Sydney Paediatric Eye Disease Study (Sydney Childhood Eye Survey).

We will look at the frequency of eye problems affecting children's eyes such as strabismus (turned eye), amblyopia (lazy eye or poor vision in one eye), and a need for glasses. You and your child are invited to participate in this large project that will involve children from a number of suburbs in Sydney the first being Quakers Hill and Acacia Gardens.

This questionnaire will give us important information relating to you, your child and your family. Please take as much time as necessary to complete it. All of the answers you provide will be regarded as strictly confidential.

Please bring this questionnaire with you on the day of your scheduled appointment or send back to us in the stamped self address envelope provided.

Common questions and answers

What happens in the eye examination?
Each child will have their vision tested, as well as tests to see how well the two eyes work together. Colour vision will also be tested. We will measure your child's refraction to see if they need glasses and we will have a look at the back of your child's eye. To do these tests all children will need eye drops. All the tests and eye drops we use are the same as your child would have if they had their eyes examined by an eye doctor or optometrist. You will be told the results of the eye examination, and if we find any problems you will be referred to an eye practitioner.

Will this eye examination cost me anything?
No! These eye examinations are provided without any cost to you or to Medicare. The cost is covered by the funds we receive from the National Health and Medical Research Council.

Guidelines

- Where possible we would like one parent or guardian to take responsibility for completing the questionnaire in consultation with other family members/caregivers.
- Please attempt to answer every question. In some circumstances you will be directed to skip questions because they do not apply to you.
- If you have difficulty with a question, please give the best response you can and make a comment in the margin.
- We understand that some children will not be living with both, or even one of their biological parents, and we ask you to please note this in completing the relevant parts of the questionnaire.
- The majority of questions in this questionnaire are standard questions derived from the Australian Bureau of Statistics (ABS) National Census, the NSW Child Health Survey and other international eye studies.
- Please feel free to ask our staff for assistance. They can be contacted on the telephone numbers below.

Please note: While it would greatly assist the examiners if the questionnaire was completed prior to your child's examination, it will be possible to collect it from you later.

Statement of confidentiality

Information that would permit the identification of any person completing this questionnaire will be regarded as strictly confidential. All information provided will be used only for the Sydney Childhood Eye Survey and will not be disclosed or released for any other purpose without your consent.

You may correct any personal information provided at any time by contacting:

Administration
Centre for Vision Research
Westmead Hospital
Telephone: 9845 9077
Fax: 9845 8345

Dr Kathryn Rose
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SECTION 1

General information about you and your children (section 2 will ask more detailed information about each child).

General Family and Contact Information					
The following section is to be answered for you and your entire family					
1a.	What is your full name? (name of person completing questionnaire)	_____			
1b.	What is your relationship to the child/children being tested?	☐ Biological mother ☐ Step-mother ☐ Adoptive mother ☐ Legal guardian ☐ Foster mother ☐ Grandmother ☐ Aunt ☐ Other female relative ☐ Other female non-relative (specify): _____ _____ ☐ Don't know		☐ Biological father ☐ Step-father ☐ Adoptive father ☐ Legal guardian ☐ Foster father ☐ Grandfather ☐ Uncle ☐ Other male relative ☐ Other male non-relative(specify): _____ _____ ☐ Don't know	
1c.	Is this the same for all children begin tested?	☐ Yes ☐ No (specify): _____ _____			
2a.	What is your partner's full name?	_____			
2b.	What is their relationship to the child/children being tested?	☐ Biological mother ☐ Step-mother ☐ Adoptive mother ☐ Legal guardian ☐ Foster mother ☐ Grandmother ☐ Aunt ☐ Other female relative ☐ Other female non-relative (specify): _____ _____ ☐ Don't know		☐ Biological father ☐ Step-father ☐ Adoptive father ☐ Legal guardian ☐ Foster father ☐ Grandfather ☐ Uncle ☐ Other male relative ☐ Other male non-relative(specify): _____ _____ ☐ Don't know	
2c.	Is this the same for all children begin tested?	☐ Yes ☐ No (specify): _____ _____			

3a.	What is your full address?	Address: _____ _____ Suburb: _____ Postcode: _____
3b.	Are there any other addresses where you/your child live for some of their time? (eg. Father/Mother/Grandparent)	Address: _____ _____ Suburb: _____ Postcode: _____
4.	How long have you lived at this address?	☐☐ years ☐☐ months
5.	If you move from your current address can you please provide us with the details of people we can contact to obtain a forwarding address?	
	Contact 1 Name: _____ Telephone: _____ Address: _____ _____ Relationship: _____ **Contact 2** Name: _____ Telephone: _____ Address: _____ _____ Relationship: _____	**Contact 3** Name: _____ Telephone: _____ Address: _____ _____ Relationship: _____ **Contact 4** Name: _____ Telephone: _____ Address: _____ _____ Relationship: _____
6.	Please provide us with your children's full names. Please place the details of your oldest child first. Please tick those children who are eligible to participate in this study.	
☐	**Child 1**: First name: _____ Family name: _____ Gender: _____ Date of birth: _____ Country of birth: _____	☐ **Child 2**: First name: _____ Family name: _____ Gender: _____ Date of birth: _____ Country of birth: _____
☐	**Child 3**: First name: _____ Family name: _____ Gender: _____ Date of birth: _____ Country of birth: _____	☐ **Child 4**: First name: _____ Family name: _____ Gender: _____ Date of birth: _____ Country of birth: _____

☐	**Child 5**: First name: _____ Family name: _____ Gender: _____ Date of birth: _____ Country of birth: _____	☐	**Child 6**: First name: _____ Family name: _____ Gender: _____ Date of birth: _____ Country of birth: _____
7.	Do you live in the same household with the child/children?	☐ ☐	Yes No

	For all of the following questions please tick the relevant box. Child 1 refers to your 1st ELIGBLE CHILD, Child 2 refers to your 2nd ELIGBLE CHILD, Child 3 refers to your 3rd ELIGBLE CHILD.		
8.	About how long has it been since your child/ children had a routine physical examination? (ie. not for a particular illness, but a general check-up)		**Child 1/ Child's name: _____**
		☐	Less than 1 year ago
		☐	More than 1 year but less than 2 years ago
		☐	More than 2 years but less than 5 years ago
		☐	Never
		☐	Don't know
			Child 2 / Child's name: _____
		☐	Less than 1 year ago
		☐	More than 1 year but less than 2 years ago
		☐	More than 2 years but less than 5 years ago
		☐	Never
		☐	Don't know
			Child 3 / Child's name: _____
		☐	Less than 1 year ago
		☐	More than 1 year but less than 2 years ago
		☐	More than 2 years but less than 5 years ago
		☐	Never
		☐	Don't know
9.	Where do you go for your child/children's routine care?	☐	Doctor's office
		☐	Baby Health Clinic
		☐	Medical Centre
		☐	Some other place (please specify): _____
		☐	Don't know

10.	Has your child stayed in hospital overnight or longer since he/she was born? (Please do not include the hospitalisation when he/she was born.)	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**Child 1:** _____ Yes, ☐☐ times No (go to question 12) Don't know **Child 2**: _____ Yes, ☐☐ times No (go to question 12) Don't know **Child 3**: _____ Yes, ☐☐ times No (go to question 12) Don't know
11.	What was the reason(s) your child stayed in the hospital overnight or longer?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**Child 1**: _____ Asthma Respiratory disease/pneumonia Diarrhoea and/or dehydration Vomiting and/or dehydration Seizure Other - please specify: _____ Don't know **Child 2**: _____ Asthma Respiratory disease/pneumonia Diarrhoea and/or dehydration Vomiting and/or dehydration Seizure Other - please specify: _____ Don't know **Child 3**: _____ Asthma Respiratory disease/pneumonia Diarrhoea and/or dehydration Vomiting and/or dehydration Seizure Other - please specify: _____ Don't know

12.	Has your child had any surgery since birth?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**Child 1**: _____ Yes No (go to question 14) Don't know **Child 2**: _____ Yes No (go to question 14) Don't know **Child 3**: _____ Yes No (go to question 14) Don't know
13.	What surgery did he/she have?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**Child 1**: _____ Tonsils & adenoids Hernia Ear tubes Other surgery: _____ Don't know **Child 2**: _____ Tonsils & adenoids Hernia Ear tubes Other surgery: _____ Don't know **Child 3**: _____ Tonsils & adenoids Hernia Ear tubes Other surgery: _____ Don't know
14.	In the past 12 months, has your child been seen in the emergency room? If so, how many times?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	**Child 1: _____** Yes, ☐☐ times No (go to question 16) Don't know **Child 2**: _____ Yes, ☐☐ times No (go to question 16) Don't know **Child 3**: _____ Yes, ☐☐ times No (go to question 16) Don't know

15.	What were the reasons your child was seen in the emergency room?		Reason(s): _____ _____ _____

Parent Information			
16.	Parent's occupation(s):	Mother's occupation: _____ Current occupation: _____ Father's occupation: _____ Current occupation: _____	
17.	How would you describe the mother's employment status?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Employed full time (includes self employment) Employed part time (includes self employment) Unemployed Home duties Student and working Student and not working Retired Unable to work due to health problems Pensioner Other (please describe): _____ Don't know
18.	How would you describe the father's employment status?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Employed full time (includes self employment) Employed part time (includes self employment) Unemployed Home duties Student and working Student and not working Retired Unable to work due to health problems Pensioner Other (please describe): _____ Don't know
19.	What is the highest level of education completed by the mother?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Never attended school Some primary school completed Some high school completed Completed school certificate (Year 10 / 4th form) Completed HSC (Year 12 / 6th form) TAFE certificate or diploma, including trade certificate University, CAE or other tertiary institute degree Higher degree including a Masters or PHD Other (please describe): _____ Don't know

20.	What is the highest level of education completed by the father?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Never attended school Some primary school completed Some high school completed Completed school certificate (Year 10 / 4th form) Completed HSC (Year 12 / 6th form) TAFE certificate or diploma, including trade certificate University, CAE or other tertiary institute degree Higher degree including a Masters or PHD Other (please describe): _____ Don't know
21.	What sort of place does your family live in?	☐ ☐ ☐ ☐ ☐ ☐ ☐	Own house Own flat/unit Rented house Rented flat/unit With relatives Other (please describe): _____ Don't know

Parent History (to be answered by biological parents)			
BIOLOGICAL MOTHER SECTION			
22.	In what country were you born?	☐ ☐	Australia Other (specify) : _____
23.	What is your ethnic origin? (provide more than one ethnic group if applicable, eg. if your mother is Caucasian and your father is East Asian, then tick both boxes).	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Caucasian (European) East Asian Indian/ Pakistani/ Sri Lankan African Melanesian/ Polynesian Middle Eastern Indigenous Australian South American Other (specify): _____ Don't know
24.	In general, would you say your health is…?	☐ ☐ ☐ ☐ ☐	Excellent Good Fair Poor Very Poor
Has a doctor advised you that you have any of the following conditions:			
25.	High Blood Pressure?	☐ ☐ ☐	Yes No (go to question 26) Don't know
	a) When was it first diagnosed?		☐☐years ago

	b) For how many years has it been treated with medication?		☐☐ years
26.	Diabetes?	☐ ☐ ☐	Yes No (go to question 27) Don't know
	a) When was it first diagnosed?		☐☐ years ago
	b) In what year did you begin and finish each type of treatment? (if currently on treatment put 7777 as year finished)		
	Diet alone: started _____ finished _____		☐ Yes ☐ No ☐ Don't know
	Tablets: started _____ finished _____		☐ Yes ☐ No ☐ Don't know
	Insulin: started _____ finished _____		☐ Yes ☐ No ☐ Don't know
	No treatment		☐ Yes ☐ No ☐ Don't know
27.	High Cholesterol?	☐ ☐ ☐	Yes No (go to question 28) Don't know
	a) When was it first diagnosed?		☐☐ years ago
	b) Are you taking tablets?	☐ ☐ ☐ ☐ ☐ ☐	Gemfibrozil (lopid, ausgem) Fluvastatin (lescol, vastin) Simvastatin (lipex, zocor) Other (please specify): _____ No Don't know
28.	Asthma?	☐ ☐ ☐	Yes No (go to question 29) Don't Know
	a) When was it first diagnosed?		☐☐ years ago
29.	Angina?	☐ ☐ ☐	Yes No (go to question 30) Don't know
	a) When was it first diagnosed?		☐☐ years ago
	b) Was the diagnosis confirmed with an ECG?		☐ Yes ☐ No ☐ Don't know
	c) Name and address of Dr. who made diagnosis?		Name: _____ Address: _____ _____ Suburb: _____ Post Code: _____
	d) How often do you take anginine tablets or sprays?	OR	☐☐ times per day ☐☐ times per month

30.	Heart attack?	☐ ☐ ☐	Yes No (go to question 31) Don't know
	a) When was it first diagnosed?		☐☐years ago
	b) Was the diagnosis confirmed with an ECG?		☐ Yes ☐ No ☐ Don't know
	c) Was it confirmed with a blood test?		☐ Yes ☐ No ☐ Don't know
	d) Name and address of Dr. who made diagnosis?		Name: _____ Address: _____ _____ Suburb: _____ Post Code: _____
	e) Were you admitted to hospital?		☐ Yes ☐ No ☐ Don't know
	f) For how long?		☐☐days
	g) How was your heart attack treated	☐ ☐ ☐ ☐ ☐	Bypass Angioplasty Pacemaker Valve Replacement Other (specify) _____
	h) How many years ago?		☐☐years ago
31.	Stroke?	☐ ☐ ☐	Yes No (go to question 32) Don't Know
	a) When was it first diagnosed?		☐☐years ago
	b) Was the diagnosis confirmed with a CT scan?		☐ Yes ☐ No ☐ Don't know
	c) Name and address of Dr. who made diagnosis?		Name: _____ Address: _____ _____ Suburb: _____ Post Code: _____
	d) Were you admitted to hospital?		☐ Yes ☐ No ☐ Don't know Hospital _____ for ☐☐days
	e) How did the stroke affect you?		☐Mild ☐Moderate
	f) Part of body affected	☐ ☐ ☐ ☐ ☐	Arm☐ right ☐ left Leg ☐ right ☐ left Speech Other (specify) _____ Don't know

	g) How well have you recovered from the stroke?		_____ % recovery (100% is full recovery)
	h) How long did it take?		☐☐ months
	i) Which treatment did you receive?	☐ ☐ ☐ ☐	Aspirin, clopidogrel, persantin Anticoagulation (heparin, clexane and warfarin) None Don't know
32.	Have you had any multiple pregnancies? (eg. twins or triplets)	☐ ☐ ☐ ☐ ☐	No, single births only Yes, twins Yes, triplets Yes, more than triplets Don't know
33.	How old were you when your first child was born?	☐	☐☐ years old Don't know
34.	How old was your child's biological father when your first child was born?	☐	☐☐ years old Don't know
35.	Have you ever smoked cigarettes, cigars or a pipe regularly?	☐ ☐ ☐	Yes No (go to question 40) Don't know
36.	If yes, which of the following have you ever regularly smoked:		
	a) Cigarettes (ready made)		Age ☐☐ to age ☐☐
	b) Cigarettes (roll your own)		Age ☐☐ to age ☐☐
	c) Tobacco		Age ☐☐ to age ☐☐
	d) Pipe		Age ☐☐ to age ☐☐
	e) Cigars		Age ☐☐ to age ☐☐
37.	Have you given up smoking?	☐ ☐ ☐	Yes No (go to question 39) Don't Know
38.	How much did you usually smoke a week before you stopped?		☐☐ Packs of manufactured cigarettes (20 per pack) ☐☐ Packets of hand-rolled cigarettes ☐☐ Cigars ☐☐ Packets of pipe tobacco Go to question 40.
39.	How much do you smoke per week currently?		☐☐ Packs of manufactured cigarettes (20 per pack) ☐☐ Packets of hand-rolled cigarettes ☐☐ Cigars ☐☐ Packets of pipe tobacco

40.	How often do you have an alcoholic drink?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Never (go to question 44) Less than once per week Once per week 1-2 days per week 3-4 days per week 5-6 days per week Every day Don't know
41.	What do you mostly drink?	☐ ☐ ☐ ☐ ☐ ☐ ☐	Light beer Beer Wine Spirits Fortified wine Other Don't know
42.	On days when you have a drink, how many drinks do you usually have?	☐ ☐ ☐ ☐ ☐ ☐	1-2 3-4 5-8 9-12 13 or more Don't know
43.	Has there ever been a time in your life when you regularly drank four or more alcoholic drinks a day?	☐ ☐ ☐	Yes No Don't know

BIOLOGICAL FATHER			
44.	In what country were you born?	☐ ☐	Australia Other (specify) : _____
45.	What is your ethnic origin? (provide more than one ethnic group if applicable, eg. if your mother is Caucasian and your father is East Asian, then tick both boxes).	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Caucasian (European) East Asian Indian/ Pakistani/ Sri Lankan African Melanesian/ Polynesian Middle Eastern Indigenous Australian South American Other (specify): _____ Don't know
46.	In general, would you say your health is…?	☐ ☐ ☐ ☐ ☐	Excellent Good Fair Poor Very Poor
Has a doctor advised you that you have any of the following conditions:			
47.	High Blood Pressure?	☐ ☐ ☐	Yes No (go to question 48) Don't know

	a) When was it first diagnosed?		☐☐ years ago
	b) For how many years has it been treated with medication?		☐☐ years
48.	Diabetes?	☐ ☐ ☐	Yes No (go to question 49) Don't know
	a) When was it first diagnosed?		☐☐ years ago
	b) In what year did you begin and finish each type of treatment? (if currently on treatment put 7777 as year finished)		
	Diet alone: started _____ finished _____		☐ Yes ☐ No ☐ Don't know
	Tablets: started _____ finished _____		☐ Yes ☐ No ☐ Don't know
	Insulin: started _____ finished _____		☐ Yes ☐ No ☐ Don't know
	No treatment		☐ Yes ☐ No ☐ Don't know
49.	High Cholesterol?	☐ ☐ ☐	Yes No (go to question 50) Don't know
	a) When was it first diagnosed?		☐☐ years ago
	b) Are you taking tablets?	☐ ☐ ☐ ☐ ☐ ☐	Gemfibrozil (lopid, ausgem) Fluvastatin (lescol, vastin) Simvastatin (lipex, zocor) Other (please specify): _____ No Don't know
50.	Asthma?	☐ ☐ ☐	Yes No (go to question 51) Don't know
	a) When was it first diagnosed?		☐☐ years ago
51.	Angina?	☐ ☐ ☐	Yes No (go to question 52) Don't know
	a) When was it first diagnosed?		☐☐ years ago
	b) Was the diagnosis confirmed with an ECG?		☐ Yes ☐ No ☐ Don't know
	c) Name and address of Dr. who made diagnosis?		Name: _____ Address: _____ _____ Suburb: _____ Post Code: _____

	d) How often do you take anginine tablets or sprays?	OR	☐☐ times per day ☐☐ times per month
52.	Heart attack?	☐ ☐ ☐	Yes No (go to question 53) Don't know
	a) When was it first diagnosed?		☐☐ years ago
	b) Was the diagnosis confirmed with an ECG?		☐ Yes ☐ No ☐ Don't know
	c) Was it confirmed with a blood test?		☐ Yes ☐ No ☐ Don't know
	d) Name and address of Dr. who made diagnosis?		Name: _____ Address: _____ _____ Suburb: _____ Post Code: _____
	e) Were you admitted to hospital?		☐ Yes ☐ No ☐ Don't know
	f) For how long?		☐☐ days
	g) How was your heart attack treated	☐ ☐ ☐ ☐ ☐	Bypass Angioplasty Pacemaker Valve Replacement Other (specify) _____
	h) How many years ago?		☐☐ years ago
53.	Stroke?	☐ ☐ ☐	Yes No (go to question 54) Don't Know
	a) When was it first diagnosed?		☐☐ years ago
	b) Was the diagnosis confirmed with a CT scan?		☐ Yes ☐ No ☐ Don't know
	c) Name and address of Dr. who made diagnosis?		Name: _____ Address: _____ _____ Suburb: _____ Post Code: _____
	d) Were you admitted to hospital?		☐ Yes ☐ No ☐ Don't know Hospital _____ for ☐☐ days
	e) How did the stroke affect you?		☐ Mild ☐ Moderate

	f) Part of body affected	☐ ☐ ☐ ☐ ☐	Arm☐ right ☐ left Leg ☐ right ☐ left Speech Other (specify) _____ Don't know
	g) How well have you recovered from the stroke?		_____ % recovery (100% is full recovery)
	h) How long did it take?		☐☐ months
	i) Which treatment did you receive?	☐ ☐ ☐ ☐	Aspirin, clopidogrel, persantin Anticoagulation (heparin, clexane and warfarin) None Don't know
54.	Have you ever smoked cigarettes, cigars or a pipe regularly?	☐ ☐ ☐	Yes No (go to question 59) Don't know
55.	If yes, which of the following have you ever regularly smoked:		
	a) Cigarettes (ready made)	Age ☐☐ to age ☐☐	
	b) Cigarettes (roll your own)	Age ☐☐ to age ☐☐	
	c) Tobacco	Age ☐☐ to age ☐☐	
	d) Pipe	Age ☐☐ to age ☐☐	
	e) Cigars	Age ☐☐ to age ☐☐	
56.	Have you given up smoking?	☐ ☐ ☐	Yes No (go to question 58) Don't Know
57.	How much did you usually smoke a week before you stopped?		☐☐ Packs of manufactured cigarettes (20 per pack) ☐☐ Packets of hand-rolled cigarettes ☐☐ Cigars ☐☐ Packets of pipe tobacco Go to question 59.
58.	How much do you smoke per week currently?		☐☐ Packs of manufactured cigarettes (20 per pack) ☐☐ Packets of hand-rolled cigarettes ☐☐ Cigars ☐☐ Packets of pipe tobacco

59.	How often do you have an alcoholic drink?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Never (go to question 63) Less than once per week Once per week 1-2 days per week 3-4 days per week 5-6 days per week Every day Don't know
60.	What do you mostly drink?	☐ ☐ ☐ ☐ ☐ ☐ ☐	Light beer Beer Wine Spirits Fortified wine Other Don't know
61.	On days when you have a drink, how many drinks do you usually have?	☐ ☐ ☐ ☐ ☐ ☐	1-2 3-4 5-8 9-12 13 or more Don't know
62.	Has there ever been a time in your life when you regularly drank four or more alcoholic drinks a day?	☐ ☐ ☐	Yes No Don't know

63.	We would like to know whether other family members including the parents have eye conditions requiring correction with glasses, or contact lenses. Please fill out the table with reference to your child's <u>biological family members</u>. As a guide: indicate in the second column whether any family member has ever worn glasses or contact lenses. If your answer is no, then go to the next relative in the row below. If your answer is yes, please fill out the rest of the information in the row.

Family member	**Does he/she wear glasses or contact lenses?**	**At what age did he/she start wearing glasses?**	**What does he/she wear glasses or contact lens primarily for?**	**Do they have astigmatism?**
Father	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
Mother	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know

Father's father	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
Father's mother	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
Mother's father	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
Mother's mother	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
Child's Sibling – Brother (d.o.b. _____)	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
Child's Sibling – Sister (d.o.b. _____)	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
Child's Sibling – Brother (d.o.b. _____)	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know
Child's Sibling – Sister (d.o.b. _____)	☐ Yes: Glasses or contact lenses (please circle) ☐ No (go to next person) ☐ Don't know		☐ Seeing clearly in distance (e.g., television, movies) ☐ Reading, working at a computer, or other close work ☐ Equally important for distance and close work.	☐ Yes ☐ No ☐ Don't know

SECTION 2

This is repeated for each child being examined.

CHILD No: 1 2 3 (please circle)/ CHILD'S NAME: _____			
General Information			
Questions 1- 3 may not need to be answered if BLUE BOOK has been provided.			
1.	Was your child born…?	☐ ☐ ☐ ☐	Late (42 weeks or more) On time (37-41 weeks gestation) Early (33-36 weeks gestation) Very early (32 weeks or less)
2.	Was your child born…?	☐ ☐ ☐	In a hospital or birthing centre? Name of Hospital: _____ Suburb: _____ State: _____ At home Other (please describe) _____ _____
3.	How much did your child weigh at birth?	 ☐	☐☐☐☐grams Don't know
4.	Was your child admitted to a Neonatal Intensive Care Unit (NICU) after birth?	☐ ☐ ☐	Yes No Don't know
5.	Was your child admitted to a Special Care Nursery (SCN) after birth?	☐ ☐ ☐	Yes No Don't know
6.	During which week/month of pregnancy did you first visit a doctor?	 OR ☐	☐☐ weeks ☐months Don't know
7.	During pregnancy did a doctor ever tell you that you had any of the following?		
	a) Toxaemia or pre-eclampsia	☐ ☐ ☐	Yes, which month? _____ No Don't know
	b) Anaemia or low blood count	☐ ☐ ☐	Yes, which month? _____ No Don't know

	c) High blood pressure that developed during pregnancy, but went away after the pregnancy was over	☐ ☐ ☐	Yes, which month? _____ No Don't know
	d) Gestational diabetes	☐ ☐ ☐	Yes, which month? _____ No Don't know
	e) Any other problem during the pregnancy (specify)_____	☐ ☐ ☐	Yes, which month? _____ Which child/children? _____ No Don't know
8.	At any time during the pregnancy with your child did you smoke?	☐ ☐ ☐	Yes No (go to question 11) Don't know
9.	During which months of the pregnancy with your child did you smoke? (Tick all months that apply.)	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Month 1 Month 2 Month 3 Month 4 Month 5 Month 6 Month 7 Month 8 Month 9 All Don't know
10.	On average, how many cigarettes per day did you smoke?	 ☐	☐☐ cigarettes per day Don't know
11.	At any time during the pregnancy with your child did you drink alcohol?	☐ ☐ ☐	Yes No (go to question 15) Don't know
12.	During which months of the pregnancy with your child did you drink alcohol?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Month 1 Month 2 Month 3 Month 4 Month 5 Month 6 Month 7 Month 8 Month 9 All Don't know
13.	During the months you drank, how many days a week did you drink or if you only drank occasionally how many times in the month?	 OR ☐	☐☐ days per week ☐☐ days per month Don't know
14.	On average, how many drinks per day did you have?	 ☐	☐☐ drinks per day Don't know

History of Health Conditions							
15.	Has a doctor ever diagnosed your child with a serious illness (such as any of the below)?						
	a) Asthma	☐	Yes	☐	No	☐	Don't know
	b) Chronic allergies or sinus trouble	☐	Yes	☐	No	☐	Don't know
	c) Mental retardation	☐	Yes	☐	No	☐	Don't know
	d) Cerebral palsy	☐	Yes	☐	No	☐	Don't know
	e) Down syndrome	☐	Yes	☐	No	☐	Don't know
	f) Very high fever that caused convulsions or seizures	☐	Yes	☐	No	☐	Don't know
	g) Other convulsions or seizures	☐	Yes	☐	No	☐	Don't know
	h) Coordination problem, motor delay, muscle weakness or paralysis	☐	Yes	☐	No	☐	Don't know
	i) Any heart condition	☐	Yes	☐	No	☐	Don't know
	j) Foetal alcohol syndrome	☐	Yes	☐	No	☐	Don't know
	k) Speech or hearing problems	☐	Yes	☐	No	☐	Don't know
	l) Attention or learning problems	☐	Yes	☐	No	☐	Don't know
	m) Developmental delay	☐	Yes	☐	No	☐	Don't know
	n) Diabetes	☐	Yes	☐	No	☐	Don't know
	o) Tumour or cancer	☐	Yes	☐	No	☐	Don't know
	p) Meningitis or encephalitis	☐	Yes	☐	No	☐	Don't know
	q) Headaches or migraine	☐	Yes	☐	No	☐	Don't know
	r) Other problems (specify) _____						

History of Ocular Conditions			
16.	During the past 12 months have you noticed your child frequently squinting/ screwing up their face to concentrate?	☐	Yes No Don't know
17.	During the past 12 months has your child had difficulty drawing or colouring, besides not staying in the lines?	☐	Yes No Too Young Don't know
18.	Does your child close one eye or screw up his/her eyes when he/she is in bright sun light?	☐	Yes No Don't know
19.	Does your child close or cover one eye when (he/she) is concentrating on a task?	☐	Yes No Don't know

20.	Have you ever noticed one or both eyelids drooping?	☐ ☐ ☐	Yes No Don't know
21.	Have you noticed any thing else your child may do related to his/her eyesight?	☐ ☐ ☐	Yes (specify) _____ _____ No Don't know
22.	When was your child's last complete eye examination, one that included dilating of pupils where the doctor used bright lights to look in the back of his/her eyes?	☐ ☐ ☐ ☐ ☐	Never Within the past 12 months 1-3 years ago More than 3 years ago Don't know
23.	Amblyopia is poor vision in an eye that cannot be corrected with glasses or contact lenses and the eye looks normal. Has a doctor ever told you that your child had amblyopia or a lazy eye?	☐ ☐ ☐	Yes No (go to question 27) Don't know
24.	Was that in his/her right eye, left eye, or both eyes?	☐ ☐ ☐ ☐	Right eye Left eye Both eyes Don't know
25.	Has your child ever been treated for amblyopia?	☐ ☐ ☐	Yes No (go to question 27) Don't know
26.	What treatment(s) did your child receive?		

	a) Glasses or contact lenses	☐	Yes	☐	No	☐	Don't know
	b) Patching	☐	Yes	☐	No	☐	Don't know
	c) Eye drops	☐	Yes	☐	No	☐	Don't know
	d) Vision therapy	☐	Yes	☐	No	☐	Don't know
	e) Orthoptic treatment	☐	Yes	☐	No	☐	Don't know
	f) Other(specify) _____						

27.	Did you or did any of your child's relatives have amblyopia?	☐ ☐ ☐	Yes No (go to question 29) Don't know
28.	Which relatives? We are only interested in blood relatives.		

	a) Child's biological mother	☐	Yes	☐	No	☐	Don't know
	b) Child's biological father	☐	Yes	☐	No	☐	Don't know
	c) Child's biological sister	☐	Yes	☐	No	☐	Don't know
	d) Child's biological brother	☐	Yes	☐	No	☐	Don't know

29.	Strabismus (squint) is a condition in which the eyes are not properly lined-up. This happens when one eye looks straight ahead and the other eye crosses in or wanders out. Has a doctor ever told you that your child had strabismus?	☐ ☐ ☐	Yes No (go to question 33) Don't know				
30.	Was that in his/her right eye, left eye, or both eyes?	☐ ☐ ☐ ☐	Right eye Left eye Both eyes Don't know				
31.	Has your child ever been treated for strabismus (squint)?	☐ ☐ ☐	Yes No (go to question 33) Don't know				
32.	What treatment or treatments did your child receive?						
	a) Glasses or contact lenses	☐	Yes	☐	No	☐	Don't know
	b) Eye muscle surgery	☐	Yes	☐	No	☐	Don't know
	c) Patching	☐	Yes	☐	No	☐	Don't know
	d) Eye drops	☐	Yes	☐	No	☐	Don't know
	e) Orthoptic treatment	☐	Yes	☐	No	☐	Don't know
	f) Vision therapy	☐	Yes	☐	No	☐	Don't know
	g) Botulinum injections	☐	Yes	☐	No	☐	Don't know
	h) Other (specify) _____						
33.	Did you or did any of your child's relatives have strabismus (squint)?						
	a) Child's biological mother	☐	Yes	☐	No	☐	Don't know
	b) Child's biological father	☐	Yes	☐	No	☐	Don't know
	c) Child's biological sister	☐	Yes	☐	No	☐	Don't know
	d) Child's biological brother	☐	Yes	☐	No	☐	Don't know
34.	Has a doctor ever told you that your child has myopia or nearsightedness or needs to wear glasses to see far away?	☐ ☐ ☐	Yes No (go to question 37) Don't know				
35.	Was that in his/her right eye, left eye, or both eyes?	☐ ☐ ☐ ☐	Right eye Left eye Both eyes Don't know				
36.	Has your child ever been treated for his/her myopia or nearsightedness?	☐ ☐ ☐	Yes No Don't know				
37.	Does your child wear glasses?	☐ ☐ ☐	Yes No (go to question 40) Don't know				
38.	How old was your child when he/she began wearing glasses?	☐☐ ☐	☐☐ years ☐☐ months Don't know				

39.	Does he/she need glasses primarily for:	☐ ☐ ☐ ☐	Viewing things clearly in the distance (e.g., television or the blackboard) Reading or other close work Equally important for distance and close work Don't know

Eye Care			
40.	Has your child ever seen an eye practitioner(s)?	☐ ☐ ☐	Yes (please provide details below) No (go to question 43) Don't know
	a) Ophthalmologist	Name: _____ Suburb: _____ Date Last Seen: _____	
	b) Optometrist	Name: _____ Suburb: _____ Date Last Seen: _____	
	c) Orthoptist (Eye Therapist)	Name: _____ Suburb: _____ Date Last Seen: _____	
	d) Other/Don't know	Name: _____ Suburb: _____ Date Last Seen: _____	
41.	Which eye practitioner does your child see most often?	☐ ☐ ☐ ☐	a) Ophthalmologist b) Optometrist c) Orthoptist (Eye Therapist) d) Other/Don't know
42.	How often is that eye practitioner seen? (Refer to the eye practitioner that the child sees most often.)	☐ ☐ ☐ ☐	More than once in 6 months Once a year Every 6 months Less than once a year

43.	Has a doctor ever told you that your child has: (if yes, specify date diagnosed and treatment received)			
	a) Cataracts	☐Yes	☐No	☐Don't know
		Date diagnosed: _____ Treatment received: _____ _____		
	b) Glaucoma	☐Yes	☐No	☐Don't know
		Date diagnosed: _____ Treatment received: _____ _____		
	c) Retinopathy of prematurity	☐Yes	☐No	☐Don't know
		Date diagnosed: _____ Treatment received: _____ _____		
	d) Eye tumour or retinoblastoma	☐Yes	☐No	☐Don't know
		Date diagnosed: _____ Treatment received: _____ _____		
	e) Optic nerve hypoplasia	☐Yes	☐No	☐Don't know
		Date diagnosed: _____ Treatment received: _____ _____		
	f) Nasolacrimal/tear duct blocked	☐Yes	☐No	☐Don't know
		Date diagnosed: _____ Treatment received: _____ _____		
	g) Cortical visual impairment	☐Yes	☐No	☐Don't know
		Date diagnosed: _____ Treatment received: _____ _____		
44.	What other eye or vision problems has he/she had?	(specify) _____ _____ _____		

45.	What treatment did your child receive?	(specify) _____ _____ _____
46.	When did your child receive this treatment?	(specify) _____ _____ _____

Outdoors			
47.	Does your child wear a hat that shades their face when going outside?	☐ ☐ ☐ ☐ ☐	All the time Most of the time Some of the time Never Don't know
48.	Does your child wear sunglasses when outside?	☐ ☐ ☐ ☐ ☐	All the time Most of the time Some of the time Never Don't know
49.	Do you ever take your child outside in a stroller or pram?	☐ ☐ ☐	Yes No (go to question 55) Don't know
50.	Does the pram/stroller have a top sun/weather canopy or hood?	☐ ☐ ☐	Yes No Don't know
51.	Do you use the weather canopy (ie. fully extend it) when going outside?	☐ ☐ ☐ ☐ ☐	All the time Most of the time Some of the time Never Don't know
52.	Does the pram/stroller have a totally covering sun/insect shade (often black mesh)?	☐ ☐ ☐	Yes No Don't know
53.	Do you use the sun/insect shade (ie. pull it over the front of the stroller/pram) when going outside?	☐ ☐ ☐ ☐ ☐	All the time Most of the time Some of the time Never Don't know
54.	Do you use an additional cover/shade such as a wrap/cloth to cover the front of the stroller/pram?	☐ ☐ ☐ ☐ ☐	All the time Most of the time Some of the time Never Don't know
55.	Do you have sunshades on the rear windows of your car?	☐ ☐ ☐	Yes No Don't know
56.	Do you have a car seat or car-capsule with a sun shade?	☐ ☐ ☐	Yes No Don't know
57.	Has your child ever had a case of sunburn?	☐ ☐ ☐ ☐ ☐	Once Twice Three times or more Never Don't know

58.	On average, how many **hours per day** does your child sleep?	☐	At night ☐☐ hours In the morning ☐☐ hours In the afternoon ☐☐ hours Don't know
59.	On average, how many **hours per day** would you say your child spends outdoors?	☐	During the week ☐☐ hours At the weekend ☐☐ hours Don't know

Activities questions – indoors

We would like to find out what kind of activities your child does. Some of these activities may not be appropriate for the age of your child, if so, tick the box marked "my child is too young".

60.	On average, how many **hours per day** does your child:		
	a) Read, or is read to?	☐ ☐ ☐ ☐ ☐ ☐	1 hour or more ½ hour or more, but less than 1 hour Less than ½ hour Never My child is too young Don't know
	b) Draw or paint?	☐ ☐ ☐ ☐ ☐ ☐	1 hour or more ½ hour or more, but less than 1 hour Less than ½ hour Never My child is too young Don't know
	c) Play with computers?	☐ ☐ ☐ ☐ ☐ ☐	1 hour or more ½ hour or more, but less than 1 hour Less than ½ hour Never My child is too young Don't know
	d) Play with hand-held computers or mobile phone games?	☐ ☐ ☐ ☐ ☐ ☐	1 hour or more ½ hour or more, but less than 1 hour Less than ½ hour Never My child is too young Don't know
	e) Play with toys?	☐ ☐ ☐ ☐ ☐ ☐ ☐	2 hours or more 1 hour or more ½ hour or more, but less than 1 hour Less than ½ hour Never My child is too young Don't know

	f) Watch television, DVDs, videos, including playing games (playstation/Wii/XBox etc)?	☐ ☐ ☐ ☐ ☐ ☐ ☐	2 hours or more 1 hour or more ½ hour or more, but less than 1 hour Less than ½ hour Never My child is too young Don't know
There may be some other **indoor** activities that your child does. These could include attending kindergym, gymberoo or dancing, indoor swimming, playing a musical instrument or going to academic classes.			
61.	Are there any indoor activities like these that your child does on a **regular** basis? 'Regular' means once a week or more.	☐ ☐ ☐	Yes No (go to question 63) Don't know
62.	Name the activity, and indicate the **hours per week** that the child spends in that activity.	Activity: _____ for ☐☐ hours per week Activity: _____ for ☐☐ hours per week Activity: _____ for ☐☐ hours per week Activity: _____ for ☐☐ hours per week	
63.	Some **indoor** activities that your child does are on an **irregular or infrequent** basis. Are there any other indoor activities that your child does on an **irregular** basis? 'Irregular' means less often than once a week.	☐ ☐ ☐	Yes No (go to question 65) Don't know
64.	Name the activity, and indicate the **hours per week** that the child spends in that activity.	Activity: _____ for ☐☐ hours per week Activity: _____ for ☐☐ hours per week Activity: _____ for ☐☐ hours per week Activity: _____ for ☐☐ hours per week	

Child's Development			
65.	Do you have any concerns about your child's learning and development?	☐ ☐ ☐ ☐	Yes A little No (go to question 67) Don't know
66.	What are your concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Seems behind Can't do what other kids the same age can Immature Learns slowly Late in learning to do things Does not learn Other (specify) _____ _____ Don't know
67.	Do you have any concerns about how your child talks and makes speech sounds?	☐ ☐ ☐ ☐	Yes A little No (go to question 69) Don't know
68.	What are your concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Not talking like he/she should Uses short sentences Can't always say what he/she means Doesn't always make sense Can't talk clearly Nobody understands what he/she is saying except family members Other (specify) _____ _____ Don't know
69.	Do you have any concerns about how your child understands what you say?	☐ ☐ ☐ ☐	Yes A little No (go to question 71) Don't know
70.	What are your concerns?	☐ ☐ ☐ ☐	Doesn't understand what you say Doesn't listen well Other (specify):_____ _____ Don't know
71.	Some children may have difficulty hearing and/or distinguishing sounds and voices, even with hearing aids. Do you think that your child has/or has had difficulty with this?	☐ ☐ ☐	Yes No Don't know
72.	Do you have any concerns about how your child uses his or her hands and fingers to do things?	☐ ☐ ☐ ☐	Yes A little No (go to question 73) Don't know

73.	What are your concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐	Can't stay in lines when colours Can't write his/her name Can't draw shapes Can't hold a pencil right Can't get food to mouth/messy eater Other (specify) _____ _____ Don't know
74.	Do you have any concerns about how your child uses his or her arms and legs?	☐ ☐ ☐ ☐	Yes A little No (go to question 76) Don't know
75.	What are you concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Clumsy Walks funny Can't ride a bike yet Falls a lot Limps Poor balance Other (specify): _____ _____ Don't know
76.	Some children may have trouble learning to walk, move or work with small objects. Do you think that your child has/or has had difficulty with this?	☐ ☐ ☐	Yes No Don't know
77.	Do you have any concerns about how your child behaves?	☐ ☐ ☐ ☐	Yes A little No (go to question 79) Don't know
78.	What are your concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Stubborn Over-active Short attention span Spoiled Aggravating Throws temper tantrums Only does what he/she wants Other (specify): _____ _____ Don't know
79.	Do you have any concerns about how your child gets along with others?	☐ ☐ ☐ ☐	Yes A little No (go to question 81) Don't know

80.	What are your concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Wants to be left alone Mood swings, clingy Whiny Bothered by changes Disinterested in usual things Easily lead Acts mean Easily frustrated Bossy Shy Class clown Angry Hates me Other (specify): _____ _____ Don't know
81.	Do you have any concerns about how your child is learning to do things for (himself/herself)?	☐ ☐ ☐ ☐	Yes A little No (go to question 83) Don't know
82.	What are your concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐	Won't do things for him/herself Won't tell me when he/she is wet Not toilet trained yet Still wants a bottle Can't get dressed by him/herself Other (specify): _____ _____ Don't know
83.	Does your child attend preschool?	☐ ☐	Yes No (go to question 86)
84.	Do you have any concerns about how your child is learning preschool or school skills?	☐ ☐ ☐ ☐	Yes A little No (go to question 86) Don't know
85.	What are your concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐	Can't write his/her name Doesn't know colours or numbers Difficulty learning shapes Just not learning to read Can't remember letter sounds Other (specify): _____ _____ Don't know
86.	Do you have any other concerns about your child?	☐ ☐ ☐ ☐	Yes A little No (go to question 88) Don't know

87.	What are your concerns?	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Ear infections Asthma Small for age Sick a lot I don't think he/she hears well He/she gets up too close to the TV and I worry about his/her sight Other (specify): _____ _____ Don't know

Nutrition

88.	Has your child ever been breastfed?	☐ ☐ ☐	Yes No (go to question 95) Don't know				
89.	Was your child breastfed when he/she first came home from hospital?	☐ ☐ ☐ ☐	Yes No Not born in hospital Don't know				
90.	Has your child ever been given infant formula regularly (at least once a day)?	☐ ☐ ☐	Yes No (go to question 92) Don't know				
91.	At what age was your child first given infant formula regularly?	☐☐ weeks ☐☐ months OR ☐ Less than 1 week ☐ Don't know					
92.	Since this time yesterday, has your child received any of the following?						
	a) Vitamins, mineral supplements, medicine	☐	Yes	☐	No	☐	Don't know
	b) Plain water	☐	Yes	☐	No	☐	Don't know
	c) Sweetened or flavoured water	☐	Yes	☐	No	☐	Don't know
	d) Fruit juice	☐	Yes	☐	No	☐	Don't know
	e) Tea or infusion	☐	Yes	☐	No	☐	Don't know
	f) Infant formula	☐	Yes	☐	No	☐	Don't know
	g) Tinned, powdered or fresh milk	☐	Yes	☐	No	☐	Don't know
	h) Solid or semi-solid food	☐	Yes	☐	No	☐	Don't know
	i) Other (specify) _____						
93.	Is your child currently being breastfed?	☐ ☐ ☐	Yes No Don't know				

94.	Including times of weaning, what is the total time that your child was breastfed?	OR ☐ ☐	☐☐ weeks ☐☐ months Less than one week Don't know
95.	Has your child ever been given solid food?	☐ ☐ ☐	Yes No (end of survey) Don't know
96.	At what age was your child first given solid food regularly?	OR ☐ ☐ ☐	☐☐ weeks ☐☐ months Never given solid food/not yet started Started but not regular Don't know
97.	How many serves of vegetables does your child usually eat each day? (one serve=1/2 cup cooked vegetables or 1 cup of salad vegetables)	OR ☐ ☐	☐ serves per day ☐ serves per week Doesn't eat vegetables Don't know
98.	How many serves of fruit does your child usually eat each day? (One serve=1 medium piece or 2 small pieces of fruit or 1 cup of diced pieces)	OR ☐ ☐	☐ serves per day ☐ serves per week Doesn't eat fruit Don't know
99.	How often does your child eat red meat, such as beef or lamb? Include all steaks, chops, roasts, mince, stir fries and casseroles. Do not include pork or chicken.	OR OR ☐ ☐	☐ times per day ☐ times per week ☐ times per month Rarely/never Don't know
100.	How often does your child eat meat products such as sausages, frankfurters, devon, ham, hamburgers or chicken nuggets?	OR OR ☐ ☐	☐ times per day ☐ times per week ☐ times per month Rarely/never Don't know
101.	How often does your child eat hot chips, French fries, wedges or fried potatoes?	OR OR ☐ ☐	☐ times per day ☐ times per week ☐ times per month Rarely/never Don't know
102.	How often does your child eat potato crisps or other salty snacks (such as Twisties or corn chips)?	OR OR ☐ ☐	☐ times per day ☐ times per week ☐ times per month Rarely/never Don't know

103.	How often does your child have meals or snacks such as burgers, pizza, chicken, or chips from places like McDonalds, Hungry Jacks, Pizza Hut, KFC, Red Rooster or local takeaway food places?	OR OR ☐ ☐	☐ times per day ☐ times per week ☐ times per month Rarely/never Don't know
104.	How often does your child have snack foods such as sweet or savoury biscuits, cakes, donuts or muesli bars?	OR OR ☐ ☐	☐ times per day ☐ times per week ☐ times per month Rarely/never Don't know
105.	How often does your child eat confectionary, such as lollies and chocolate?	OR OR ☐ ☐	☐ times per day ☐ times per week ☐ times per month Rarely/never Don't know
106.	How often does your child usually have something for breakfast?	☐ OR OR ☐ ☐	Everyday ☐ times per week ☐ times per month Rarely/never Don't know
107.	How often does your child eat dinner in front of the television?	☐ OR OR ☐ ☐	Everyday ☐ times per week ☐ times per month Rarely/never Don't know
108.	How many cups of milk does your child usually drink in a day?(1 cup=250ml, a household tea cup) (Includes cow's milk, soy milk, milk on cereal, flavoured milks)	OR OR ☐ ☐	☐ cups per day ☐ cups per week ☐ cup per month Doesn't drink milk (go to question 110) Don't know
109.	What type of milk does your child usually consume?	☐ ☐ ☐ ☐ ☐ ☐ ☐	Whole milk (regular, full-cream) Low/reduced fat milk Skim milk Evaporated or sweetened condensed Soy milk, regular (specify) _____ Soy milk, reduced fat (specify) _____ Other (specify) _____

110.	How many cups of soft drink, cordials, or sports drink, such as lemonade or Gatorade does your child usually drink? (1 cup=250ml. One can of soft drink = 1 ½ cups. One 500ml bottle of Gatorade = 2 cups)	OR OR ☐ ☐	☐ cups per day ☐ cups per week ☐ cup per month Doesn't drink soft drink Don't know
111.	How many cups of diet soft drink or diet cordial such as diet coke or diet sprite or coke zero does your child usually drink? (1 cup=250ml. One can of soft drink = 1 ½ cups. One 500ml bottle of Gatorade = 2 cups)	OR OR ☐ ☐	☐ cups per day ☐ cups per week ☐ cup per month Doesn't drink diet soft drink Don't know
112.	How many cups of fruit juice does your child usually drink? (1 cup=250ml, a household tea cup or 1 large popper)	OR OR ☐ ☐	☐ cups per day ☐ cups per week ☐ cup per month Doesn't drink fruit juice Don't know
113.	How many cups of water does your child usually drink in a day? (1 cup=250ml, a household tea cup, 1 average bottle of water = 2 ½ cups)	OR OR ☐ ☐	☐ cups per day ☐ cups per week ☐ cup per month Doesn't drink water Don't know

APPENDIX 4

SYDNEY PAEDIATRIC EYE DISEASE STUDY [SPEDS]

EXAMINATION BOOKLET

Child's ID No. _____ _____ _____ _____

Child Details

First name **Gender:** ☐Male ☐Female

Last name

Date of birth: ☐☐/☐☐/☐☐☐☐ **Age in Months:** ☐☐

The Sydney Paediatric Eye Disease Study

Examination Booklet

Adult Details		
Child brought in by (Name):		
Relationship to child:		

Reception to follow up	
☐	Vision Recheck
☐	Vision Recheck after child gets glasses
☐	Vision Recheck after home pre-training with LEA symbols
☐	Parent glasses measurement to follow up (back page)
☐	Siblings glasses measurement to follow up (back page)
☐	Vision Quality of Life Survey to Administer
☐	Other:

Date of examination: ☐☐/☐☐/☐☐☐☐ **Examiners Initials:** ☐☐

START TIME: _____:_____AM/PM

1. Childs Vertometry

Auto-Vertometer Tape

Here

Attach print out here:

Child's Current glasses:

unifocal	☐	no glasses	☐
bifocal.	☐	glasses not brought	☐
multifocal	☐	missing	☐

2. History: Initial Eye Sight Question

Has your child ever had any eye problems?

(Such as amblyopia (poor vision), lazy eye, eye turn, strabismus, eye surgery or wears glasses.)

☐ No
☐ Yes → if yes, Parent to fill out EXTRA vision quality of life survey and attach in file.

Child's EH: i.e. Glasses, Patching, Squint, Eye Turn

Family EH:

Please Tick When Completed

Any section marked as ABNORMAL must be detailed in the comments section by Orthoptist and Dr.

(Please attach side tab to reference pages with abnormalities).

Test	Normal	Abnormal	Unable	N/A
Vision ☐Has Glasses	☐	☐	☐	
Cover Test/ Eye Motility	☐	☐	☐	
Colour Vision	☐	☐	☐	☐
Other		☐Amblyopia ☐Nystagmus		
Slit-lamp	☐	☐	☐	
Fundus Examination	☐	☐	☐	
Fundus Photography	☐	☐	☐	☐
≤ 12 Months Retinoscopy (SE)	☐	☐> +3.50 D (Hyperopic) ☐≥ -0.50 D (Myopic)	☐	☐
>12 Months Cycloplegic (SE) ☐Autorefraction ☐Retinoscopy	☐+2.25 - < +3.00D (Mild hyperope) ☐>+0.25D - < +2.25 (Normal) ☐> -0.50 - < +0.25D (Mild myope)	☐≥+3.00 D (Hyperopic) ☐≤-0.50D (Myopic) ☐Anisometropia ≥ 1D ☐Astigmatism **≥** 1D	☐	☐

	Completed	Unable	N/A
Blood Pressure	☐	☐	
Anthropometry (post-dilation)	☐	☐	
IOL Master	☐	☐	☐

Referral:	Referral Needed? ☐No ☐Yes →	**Referral needed:** ☐ Urgent ☐ Within 1-2 months ☐ Recommendation for parent to reassess vision in 1-2 years
Comments:		

3a. Hirschberg / Corneal Reflections without Glasses

PERFORM ON ALL CHILDREN

Are corneal reflections equal and symmetrical?
☐Yes / non strabismic
☐No / strabismic (fill out form below)
☐Unable

A1a. Frequency **Constant** ___ **1** **Intermittent** ___ **2** ☐ Tick if unable (96)	*A2a. Direction: Horizontal* **Eso** ___ **1** **Exo** ___ **2** **No horizontal** ___ **3** ☐ Tick if unable (96)
A1b. Laterality **Right** ___ **1** **Left** ___ **2** **Alternating** ___ **2** ☐ Tick if unable (96)	A3a. Direction: Vertical RHyperT ___ 1 **LHyperT** ___ **2** No vertical _ 3 ☐ Tick if unable (96)

3b. Hirschberg / Corneal Reflections with Glasses

PERFORM ON ALL CHILDREN WITH GLASSES

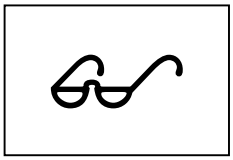
☐ Tick here if child does not wear glasses and skip section.

Are corneal reflections equal and symmetrical?

☐Yes / non strabismic

☐No / strabismic (fill out form below)

☐Unable



B1a. Frequency **Constant** ___ **1** **Intermittent** ___ **2** ☐ Tick if unable (96)	*B2a. Direction: Horizontal* **Eso** ___ **1** **Exo** ___ **2** **No horizontal** ___ **3** ☐ Tick if unable (96)
B1b. Laterality **Right** ___ **1** **Left** ___ **2** **Alternating** ___ **2** ☐ Tick if unable (96)	B3a. Direction: Vertical RHyperT ___ 1 **LHyperT** ___ **2** No vertical _ 3 ☐ Tick if unable (96)

4. Visual Acuity: Response to Occlusion

PERFORM ON ALL CHILDREN (with glasses if worn)

Is the child's response equal in both eyes? ☐Yes ☐No ☐Unable

If No record the response below (i.e. crying, pulling cover away, moving head to see etc.):

With Left Eye Covered (Testing **Right** eye): _____

With Right Eye Covered (Testing **Left** Eye): _____

5. Nystagmus

RECORD FOR ALL CHILDREN

Manifest Nystagmus present	**Latent Nystagmus present**
Yes ☐ 1	Yes ☐ 1
No ☐ 2	No ☐ 2

PLEASE NOTE:

If Nystagmus present continue testing of VA, CT and PBCT with OPAQUE OCCLUDER.

6a. Visual Acuity: OKN DRUM

TEST DISTANCE: 5OCM

☐ TICK HERE IF THIS SECTION IS NOT APPLICABLE

VISUAL ACUITY (OKN Drum) Detection acuity

If patient has glasses, they should be worn*:*

☐TICK HERE IF CHILD IS UNABLE TO COOPERATE WITH ALLACUITY TESTS

6a(i) Right eye: OKN elicited ☐ YES
☐ NO

6a(ii) Left eye: OKN elicited ☐ YES
☐ NO

6b. Visual Acuity: Teller Acuity Cards II

PERFORMED ON ALL CHILDREN LESS THAN 24 MONTHS OLD OR IF UNABLE TO PERFORM ALL RECOGNITION ACUITY TESTS.

TEST DISTANCE: 55CM

☐TICK HERE IF THIS TEST IS NOT APPLICABLE

VISUAL ACUITY (TELLER ACUITY CARDS II) Resolution acuity

If patient has glasses, they should be worn*:*

Conversion to cycles/deg:

6b(i). Both __ __ __ __ cycles/deg

☐ Tick if unable (96)

6b(ii). R __ __ __ __ cycles/deg

☐ Tick if unable (96)

6b(iii). L __ __ __ __ cycles/deg

☐ Tick if unable (96)

Comments:

_____

_____

Reliability of BE:
☐ Reliable
☐ Unreliable
☐ Unable

Reliability of R:
☐ Reliable
☐ Unreliable
☐ Unable

Reliability of L:
☐ Reliable
☐ Unreliable
☐ Unable

6c. (i) Visual Acuity: Electronic Visual Acuity (EVA) Distance without Glasses

PERFORMED ON ALL CHILDREN AT LEAST 30 MONTHS OLD.

☐ *TICK HERE IF THIS TEST IS NOT APPLICABLE*

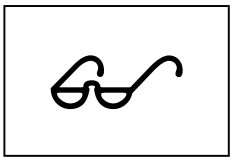
☐ *TICK HERE IF CHILD IS UNABLE TO COMPLETE TEST*

☐ *TICK HERE IF EVA IS NOT WORKING →USE ALTERNATE LOGMAR TEST INSTEAD*

Visual Acuity	***Visual Acuity***
R: 20/ __ __	**L**: 20/ __ __
☐ Tick if unable (96)	☐ Tick if unable (96)

** If child is older than 60 months (5 years), test with Adult LogMAR and EVA (only if child will cooperate with extended testing).*

6c. (ii) Visual Acuity: Electronic Visual Acuity (EVA) Distance with Glasses



PERFORMED ON ALL CHILDREN AT LEAST 30 MONTHS OLD.

☐ *TICK HERE IF THIS TEST IS NOT APPLICABLE*

☐ *TICK HERE IF CHILD IS UNABLE TO COMPLETE TEST*

☐ *TICK HERE IF EVA IS NOT WORKING →USE ALTERNATE LOGMAR TEST INSTEAD*

If patient has glasses 👓, they should be worn now*:*

Visual Acuity	***Visual Acuity***
R: 20/__ __	**L**: 20/__ __
☐ Tick if unable (96)	☐ Tick if unable (96)

Feet	Metres
20/400	6/120
20/320	6/96
20/250	6/75
20/200	6/60
20/160	6/48
20/125	6/38
20/100	6/30
20/80	6/24
20/63	6/19
20/50	6/15
20/40	6/12
20/32	6/10
20/25	6/7.5
20/20	6/6
20/16	6/5

6d. Visual Acuity: Response to Occlusion During Vision Testing

PERFORM ON ALL CHILDREN

Is the child's response equal in both eyes? ☐Yes ☐No ☐Unable

If No record the response below (i.e. crying, pulling cover away, moving head to see etc.):

With Left Eye Covered (Testing **Right** Eye):_____

With Right Eye Covered (Testing **Left** Eye):_____

6e. Visual Acuity: LogMAR Distance RIGHT EYE

☐TICK HERE IF THIS TEST IS NOT APPLICABLE

LogMAR test face used:

☐ EDTRS (>60 months) ☐Attempted Unable
☐ HOTV (>30 months) ☐Attempted Unable
☐ LEA symbols (>24 months) ☐Attempted Unable
☐ LEA crowded symbol book (>24 months) ☐Attempted

RIGHT EYE

6e(i) WITHOUT glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
6/60	5	1.0
6/48	10	0.9
6/36	15	0.8
6/30	20	0.7
6/24	25	0.6
6/19	30	0.5
6/15	35	0.4
6/12	40	0.3
6/9.5	45	0.2
6/7.5	50	0.1
6/6	55	0.0
6/4.8	60	-0.1
6/3.8	65	-0.2
6/3.0	70	-0.3
Total letters read		

6e(ii) With Glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
6/60	5	1.0
6/48	10	0.9
6/36	15	0.8
6/30	20	0.7
6/24	25	0.6
6/19	30	0.5
6/15	35	0.4
6/12	40	0.3
6/9.5	45	0.2
6/7.5	50	0.1
6/6	55	0.0
6/4.8	60	-0.1
6/3.8	65	-0.2
6/3.0	70	-0.3
Total letters read		

6e(iii) *If VA <6/60, measure VA at 1.22m using LogMAR chart*

WITH Glasses ☐or WITHOUT glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
3/60 (6/120)		1.3
3/48 (6/96)		1.2
3/36 (6/72)		1.1

6e(iv) *If Vision <3/60, measure VA at 38cm (Age limit: >30 months)*

CF ☐
HM ☐
LP+P ☐
LP ☐
NPL ☐

SPEDS EXAMINATION

Age limit: >30 months

CF – to perform, hold up different numbers of fingers 4-5 times asking the person to show you how many fingers they can see, either by counting or by mimicking how many fingers you are holding up. At 38cm CF is approximately equivalent to 6/60.

HM – to perform, move the hand in different directions, up, down and horizontally at a distance of 38cm, ask the subject in which direction is the hand moving.

LP – switch a small bright fixation torch on and off, held in 4 quadrants at 38cm from the subject. Light perception with projection (LP + P) indicates that they can locate the source of the light.

6f. Visual Acuity: LogMAR Distance LEFT EYE

☐TICK HERE IF THIS TEST IS NOT APPLICABLE

LogMAR test face used:

☐ EDTRS (>60 months) ☐Attempted Unable
☐ HOTV (>30 months) ☐Attempted Unable
☐ LEA symbols (>24 months) ☐Attempted Unable
☐ LEA crowded symbol book (>24 months) ☐Attempted Unable

LEFT EYE

6f(i) WITHOUT glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
6/60	5	1.0
6/48	10	0.9
6/36	15	0.8
6/30	20	0.7
6/24	25	0.6
6/19	30	0.5
6/15	35	0.4
6/12	40	0.3
6/9.5	45	0.2
6/7.5	50	0.1
6/6	55	0.0
6/4.8	60	-0.1
6/3.8	65	-0.2
6/3.0	70	-0.3
Total letters read		

6f(ii) With Glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
6/60	5	1.0
6/48	10	0.9
6/36	15	0.8
6/30	20	0.7
6/24	25	0.6
6/19	30	0.5
6/15	35	0.4
6/12	40	0.3
6/9.5	45	0.2
6/7.5	50	0.1
6/6	55	0.0
6/4.8	60	-0.1
6/3.8	65	-0.2
6/3.0	70	-0.3
Total letters read		

6f (iii) *If VA <6/60, measure VA at 1.22m*

WITH Glasses ☐ or WITHOUT glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
3/60 (6/120)		1.3
3/48 (6/96)		1.2
3/36 (6/72)		1.1

6f (iv) *If Vision <3/60, measure VA at 38cm (Age limit: >30 months)*

CF ☐
HM ☐
LP+P ☐
LP ☐
NPL ☐

7a&b. Cover Testing & PBCT at Near and Distance WITHOUT GLASSES

PERFORM ON ALL CHILDREN

A. NEAR Cover Testing:

Strabismic ☐1

Can't Determine ☐3
Non-Strabismic (Phoria) ☐2

A1.Frequency
Constant ☐1
Intermittent ☐2 ☐ Tick if unable (96)

A1a. Accommodative
☐ ET Increases with Accommodative Target

A2. Laterality
Right ☐1
Left ☐2
Alternating ☐3 ☐ Tick if unable (96)

A3a. Direction: Horiz
ET ☐1
XT ☐2
No Horiz ☐3

A3b. Horiz Mag by PCT
_____ _____ △
☐ Tick if unable (96)
BI ☐ BO☐ FR☐ FL ☐

A4a.Direction: Vertical
RHyperT ☐1
LHyperT ☐2
No Vert ☐3

A4b. Vert Mag by PCT
_____ _____ △
☐ Tick if unable (96)
BU☐ BD☐ FR ☐ FL ☐

A5. Fixation:
Wandering ☐1
Takes up fixation with non central point ☐2
Central fixation taken up but not maintained ☐3
Maintains Fixation ☐4
Alternates Fixation ☐5
Unable to determine fixation ☐6

A7a. Direction: Horizontal
☐1
Orthophoria
☐2
Esophoria
☐3
Exophoria
☐ Tick if unable (96)

A7b. Magnitude: Horizontal
_____ _____ △
☐ Tick if unable (96)
BI ☐ BO☐

A8a. Direction: Vertical
Right Hyperphoria ☐1
Left Hyperphoria ☐2
No vertical phoria ☐3
☐ Tick if unable (96)

A8b. Magnitude:Vertical
_____ _____ △
☐ Tick if unable (96)
BU ☐ BD ☐

A6. DVD
DVD (RE) ☐1
DVD (LE) ☐2
DVD (BE) ☐3
No DVD ☐4
Unable ☐5

Comments:

B.DISTANCE Cover Testing:

☐ *TICK IF DISTANCE CT PERFORMED AT 3 METRES*

Strabismic ☐1

Can't Determine ☐3

Non-Strabismic (Phoria) ☐2

B1.Frequency

Constant ☐1

Intermittent ☐2

☐ Tick if unable (96)

B1a. Accommodative

☐ ET Increases with Accommodative Target

B2. Laterality

Right ☐1

Left ☐2

Alternating ☐3

☐ Tick if unable (96)

B3a. Direction: Horiz

ET ☐1

XT ☐2

No Horiz ☐3

B3b. Horiz Mag by PCT

_____ _____ △

☐ Tick if unable (96)

BI ☐ BO☐ FR☐ FL ☐

B4a.Direction: Vertical

RHyperT ☐1

LHyperT ☐2

No Vert ☐3

B4b. Vert Mag by PCT

_____ _____ △

☐ Tick if unable (96)

BU☐ BD☐ FR ☐ FL ☐

B5. Fixation:

Wandering ☐1

Takes up fixation with non central point ☐2

Central fixation taken up but not maintained ☐3

Maintains Fixation ☐4

Alternates Fixation ☐5

Unable to determine fixation ☐6

B7a. Direction: Horizontal

☐1

Orthophoria

☐2

Esophoria

☐3

Exophoria

☐ Tick if unable (96)

B7b. Magnitude: Horizontal

_____ _____ △

☐ Tick if unable (96)

BI ☐ BO☐

B8a. Direction: Vertical

Right Hyperphoria ☐1

Left Hyperphoria ☐2

No vertical phoria ☐3

☐ Tick if unable (96)

B8b. Magnitude:Vertical

_____ _____ △

☐ Tick if unable (96)

BU ☐ BD ☐

B6. DVD

DVD (RE) ☐1

DVD (LE) ☐2

DVD (BE) ☐3

No DVD ☐4

Unable ☐5

Comments:

7c&d. Cover Testing & PBCT at Near and Distance WITH GLASSES

☐ *TICK HERE IF CHILD DOES NOT WEAR ANY GLASSES*

C.NEAR Cover Testing:

Strabismic ☐1 Can't Determine ☐3

Non-Strabismic (Phoria) ☐2

C1.Frequency

Constant ☐1

Intermittent ☐2 ☐ Tick if unable (96)

C1a. Accommodative

☐ ET Increases with Accommodative Target

C2. Laterality

Right ☐1

Left ☐2

Alternating ☐3 ☐ Tick if unable (96)

C3a. Direction: Horiz

ET ☐1

XT ☐2

No Horiz ☐3

C3b. Horiz Mag by PCT

_____ _____ △

☐ Tick if unable (96)

BI ☐ BO☐ FR☐ FL ☐

C4a.Direction: Vertical

RHyperT ☐1

LHyperT ☐2

No Vert ☐3

C4b. Vert Mag by PCT

_____ _____ △

☐ Tick if unable (96))

BU☐ BD☐ FR ☐ FL ☐

C5. Fixation:

Wandering ☐1

Takes up fixation with non central point ☐2

Central fixation taken up but not maintained ☐3

Maintains Fixation ☐4

Alternates Fixation ☐5

Unable to determine fixation ☐6

C7a. Direction: Horizontal

☐1

Orthophoria

☐2

Esophoria

☐3

Exophoria

☐ Tick if unable (96)

C7b. Magnitude: Horizontal

_____ _____ △

☐ Tick if unable (96)

BI ☐ BO☐

C8a. Direction: Vertical

Right Hyperphoria ☐1

Left Hyperphoria ☐2

No vertical phoria ☐3

☐ Tick if unable (96)

C8b. Magnitude:Vertical

_____ _____ △

☐ Tick if unable (96)

BU ☐ BD ☐

C6. DVD

DVD (RE) ☐1

DVD (LE) ☐2

DVD (BE) ☐3

No DVD ☐4

Unable ☐5

Comments:

D.DISTANCE Cover Testing:

☐ *TICK IF DISTANCE CT PERFORMED AT 3 METRES*

Strabismic ☐1

Can't Determine ☐3

Non-Strabismic (Phoria) ☐2

D1.Frequency

Constant ☐1

Intermittent ☐2

☐ Tick if unable (96)

D1a. Accommodative

☐ ET Increases with Accommodative Target

D2. Laterality

Right ☐1

Left ☐2

Alternating ☐3

☐ Tick if unable (96)

D3a. Direction: Horiz

ET ☐1

XT ☐2

No Horiz ☐3

D3b. Horiz Mag by PCT

_____ _____ △

☐ Tick if unable (96)

BI ☐ BO☐

D4a.Direction: Vertical

RHyperT ☐1

LHyperT ☐2

No Vert ☐3

D4b. Vert Mag by PCT

_____ _____ △

☐ Tick if unable (96)

BU☐ BD☐

FR☐ FL☐

D5. Fixation:

Wandering ☐1

Takes up fixation with non central point ☐2

Central fixation taken up but not maintained ☐3

Maintains Fixation ☐4

Alternates Fixation ☐5

Unable to determine fixation ☐6

D7a. Direction: Horizontal

☐1

Orthophoria

☐2

Esophoria

☐3

Exophoria

☐ Tick if unable (96)

D7b. Magnitude: Horizontal

_____ _____ △

☐ Tick if unable (96)

BI ☐ BO☐

D8a. Direction: Vertical

Right Hyperphoria ☐1

Left Hyperphoria ☐2

No vertical phoria ☐3

☐ Tick if unable (96)

D8b. Magnitude:Vertical

_____ _____ △

☐ Tick if unable (96)

BU ☐ BD ☐

D6. DVD

DVD (RE) ☐1

DVD (LE) ☐2

DVD (BE) ☐3

No DVD ☐4

Unable ☐5

Comments:

7e&f. Cover Testing & PBCT at FAR DISTANCE

PERFORM CT AT THIS DISTANCE WHEN EXOPHORIA OR EXOTROPIA INCREASES IN SIZE WITH DISTANCE FIXATION. USE BACK PORCH

☐ *TICK HERE IF SECTION E & F IS NOT APPLICABLE*

E. FAR DISTANCE Cover Testing *(WITHOUT GLASSES):*

Strabismic ☐1 Can't Determine ☐3
Non-Strabismic (Phoria) ☐2

E1.Frequency
Constant ☐1
Intermittent ☐2 ☐ Tick if unable (96)

E1a. Diplopia?
Yes ☐1
No ☐2
Unable ☐96

E2. Laterality
Right ☐1
Left ☐2
Alternating ☐3 ☐ Tick if unable (96)

E3a. Direction: Horiz
ET ☐1
XT ☐2
No Horiz ☐3

E3b. Horiz Mag by PCT
_____ _____ △
☐ Tick if unable (96)
BI ☐ BO☐ FR☐ FL ☐

E4a.Direction: Vertical
RHyperT ☐1
LHyperT ☐2
No Vert ☐3

E4b. Vert Mag by PCT
_____ _____ △
☐ Tick if unable (96)
BU☐ BD☐ FR ☐ FL ☐

E5. Fixation:
Wandering ☐1
Takes up fixation with non central point ☐2
Central fixation taken up but not maintained ☐3
Maintains Fixation ☐4
Alternates Fixation ☐5
Unable to determine fixation ☐6

E7a. Direction: Horizontal
☐1
Orthophoria
☐2
Esophoria
☐3
Exophoria
☐ Tick if unable (96)

E7b. Magnitude: Horizontal
_____ _____ △
☐ Tick if unable (96)
BI ☐ BO☐

E8a. Direction: Vertical
Right Hyperphoria ☐1
Left Hyperphoria ☐2
No vertical phoria ☐3
☐ Tick if unable (96)

E8b. Magnitude:Vertical
_____ _____ △
☐ Tick if unable (96)
BU ☐ BD ☐

E6. DVD
DVD (RE) ☐1
DVD (LE) ☐2
DVD (BE) ☐3
No DVD ☐4
Unable ☐5

Comments:

☐ *TICK HERE IF CHILD DOES NOT WEAR GLASSES*

F. FAR DISTANCE Cover Testing *(WITH GLASSES)*:

Strabismic ☐1 Can't Determine ☐3
Non-Strabismic (Phoria) ☐2

F1.Frequency
Constant ☐1
Intermittent ☐2
☐ Tick if unable (96)

F1a. Diplopia?
Yes ☐1
No ☐2
Unable ☐96

F2. Laterality
Right ☐1
Left ☐2
Alternating ☐3
☐ Tick if unable (96)

F3a. Direction: Horiz
ET ☐1
XT ☐2
No Horiz ☐3

F3b. Horiz Mag by PCT
_____ _____ △
☐ Tick if unable (96)
BI ☐ BO☐

F4a.Direction: Vertical
RHyperT ☐1
LHyperT ☐2
No Vert ☐3

F4b. Vert Mag by PCT
_____ _____ △
☐ Tick if unable (96)
BU☐ BD☐

FR☐ FL ☐
FR ☐ FL ☐

F5. Fixation:
Wandering ☐1
Takes up fixation with non central point ☐2
Central fixation taken up but not maintained ☐3
Maintains Fixation ☐4
Alternates Fixation ☐5
Unable to determine fixation ☐6

F7a. Direction: Horizontal
☐1
Orthophoria
☐2
Esophoria
☐3
Exophoria
☐ Tick if unable (96)

F7b. Magnitude: Horizontal
_____ _____ △
☐ Tick if unable (96)
BI ☐ BO☐

F8a. Direction: Vertical
Right Hyperphoria ☐1
Left Hyperphoria ☐2
No vertical phoria ☐3
☐ Tick if unable (96)

F8b. Magnitude:Vertical
_____ _____ △
☐ Tick if unable (96)
BU ☐ BD ☐

F6. DVD
DVD (RE) ☐1
DVD (LE) ☐2
DVD (BE) ☐3
No DVD ☐4
Unable ☐5

Comments:

6.1.1.28a. Krimsky WITHOUT Glasses

☐ TICK HERE IF THIS SECTION IS NOT APPLICABLE AND GO TO NEXT SECTION

PERFORM IF UNABLE TO OBTAIN RELIABLE PRISM BAR COVER TEST AT NEAR

A. KRIMSKY TESTING (without glasses):

Strabismic ☐ **1** **Unable** ☐ **96**

A1. Magnitude: Horizontal

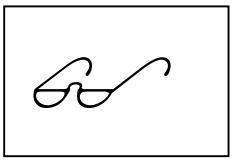
_____△**BI** ☐ **BO** ☐ **FR** ☐ **FL** ☐

6.1.1.38b. Krimsky Testing WITH glasses

☐TICK HERE IF THIS SECTION IS NOT APPLICABLE AND GO TO NEXT SECTION

PERFORM IF UNABLE TO OBTAIN RELIABLE PRISM BAR COVER TEST AT NEAR WITH GLASSES

B. KRIMSKY TESTING (with glasses):



Strabismic ☐ **1**

Unable ☐ **96**

B1. Magnitude: Horizontal

_____△**BI** ☐ **BO** ☐ **FR** ☐ **FL** ☐

☐ **Tick if unable (96)**

B2. Magnitude: Vertical

_____△ BU ☐ BD ☐ FR ☐ FL ☐

☐ Tick if unable (96)

Comments

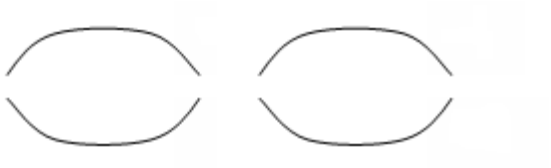
_____

_____

_____

6.1.1.49. Eye Alignment: Versions/Ductions Testing

PERFORM ON ALL CHILDREN
*(without glasses)**:***



Normal ☐**1**

Abnormal or Incomplete ☐**2**

Unable ☐**96**

a. Right Eye					b. Left Eye				
	u/a	o/a	u/a complete restriction *	Unable		u/a	o/a	u/a complete restriction *	Unable
RSO	☐ 1	☐ 2	☐ 3	☐ 96	*LSO*	☐ 1	☐ 2	☐ 3	☐ 96
RIO	☐ 1	☐ 2	☐ 3	☐ 96	LIO	☐ 1	☐ 2	☐ 3	☐ 96
RSR	☐ 1	☐ 2	☐ 3	☐ 96	LSR	☐ 1	☐ 2	☐ 3	☐ 96
RIR	☐ 1	☐ 2	☐ 3	☐ 96	LIR	☐ 1	☐ 2	☐ 3	☐ 96
RLR	☐ 1	☐ 2	☐ 3	☐ 96	LLR	☐ 1	☐ 2	☐ 3	☐ 96
RMR	☐ 1	☐ 2	☐ 3	☐ 96	LMR	☐ 1	☐ 2	☐ 3	☐ 96

**To Rate as a complete restriction it must be evident on ductions (monoc) if ductions are unable to be performed rate as u/a only, not a complete restriction.*

Additional Observations Please tick when present:	
☐	Lid retraction
☐	Latent Nystagmus
☐	End Point Nystagmus
☐	Widening Palp Fissures
☐	Narrowing Palp Fissures
☐	Muscle Surgery Scar Tissue Visible

Patterns:	
☐No pattern seen	
☐Pattern seen *(indicate pattern and significance below)*	
☐Unable to assess pattern	
Tick one box below for indicating pattern and significance:	
SIGNIFICANT A pattern **Significant** (>10△or a tropia in position of gaze) ☐→ V pattern **Significant** (>10△or a tropia in position of gaze) ☐→	**Is the Pattern esophoric or exophoric:**

NOT SIGNIFICANT A pattern not significant (<10△ difference in position of gaze)☐→ V pattern not significant (<10△difference in position of gaze)☐→	Eso ☐ or Exo ☐

Comments

_____

_____

10. Convergence Near Point

PERFORM ON ALL CHILDREN

CNP:☐ ≤ 6 cm *(tick)*

or Other _____cm

11. 15△ Fusional Response Test

PERFORM ON ALL CHILDREN

15△ Prism Test:

When prism placed in front of RE what is the response: **RE:** ☐ Positive (can overcome prism) ☐ Negative (cannot overcome prism) ☐ Unable to assess Comments for RE (ie, slower response): _____ _____ _____	When prism placed in front of LE what is the response: **LE:** ☐ Positive (can overcome prism) ☐Negative (cannot overcome prism) ☐Unable to assess Comments for LE (ie, slower response): _____ _____ _____

12. OPTIONAL 4△ prism test (test for suppression)

☐NOT APPLICABLE TO PATIENT

If there is a suspicion of Microtropia perform 4△ prism test

4△ Prism Test:

When prism placed in front of RE what is the response: **RE:** ☐Positive (can overcome prism) ☐Negative (no movement) ☐Unable to assess Comments for RE (i.e. conjugate movement indicates non-suppressing eye and no movement indicates suppressing eye): _____ _____ _____	When prism placed in front of LE what is the response: **LE:** ☐Positive (can overcome prism) ☐Negative (no movement) ☐Unable to assess Comments for LE (i.e. conjugate movement indicates non-suppressing eye and no movement indicates suppressing eye): _____ _____ _____

13a. Stereopsis: LANGS II

PERFORM ON ALL CHILDREN

Threshold Stereopsis: indicate smallest disparity level correct:

200 secs of arc	☐ 1
400 secs of arc	☐ 2
600 secs of arc	☐ 3
Star only	☐ 4
No Stereopsis	☐ 5
or Unable	☐ 96

Comments: _____

13b. Stereopsis: RANDOT PRESCHOOL TEST / STEREOPSIS

ATTEMPT RANDOT PRESCHOOL TEST ON ALL CHILDREN <u>ABOVE 30 MONTHS</u>, IF CHILD UNABLE TO DO THIS TEST TRY STEREOSMILE II INSTEAD

☐TICK HERE IF <30 MONTHS AND GO TO NEXT SECTION

Threshold Stereopsis: indicate smallest disparity level correct:

40 secs of arc	☐ 1
60 secs of arc	☐ 2
100 secs of arc	☐ 3
200 secs of arc	☐ 4
400 secs of arc	☐ 5
800 secs of arc	☐ 6
No Stereopsis	☐ 7
or Unable	☐ 96 → Do Stereosmile II instead.

Comments:_____

13c. Stereopsis: STEREOSMILE TEST II

PERFORM ON ALL CHILDREN <u>BELOW 30 MONTHS</u>

☐TICK HERE IF >30 MONTHS AND GO TO NEXT SECTION

Threshold Stereopsis: indicate smallest disparity level correct:

60 secs of arc	☐ 1
120 secs of arc	☐ 2
240 secs of arc	☐ 3
480 secs of arc	☐ 4
No Stereopsis	☐ 5
or Unable	☐ 96

Comments:_____

14. Color Vision Testing Made Easy and Diagnostic Testing with City University and Ishihara

☐TICK HERE IF <30 MONTHS AND GO TO NEXT SECTION

A.WAGGONER®COLOR VISION TEST *(If patient has glasses 👓, they should be worn):*

Color Vision Testing Made Easy Screening Plates

Normal ___ 1

Failed ___ 2

Unable ____96

A1. Color Vision Testing Made Easy

1

Normal ☐

Deficient ☐ 2

A3. City University at 33 cm:

☐ Tick here if unable to perform City University

(Tick the box with the patients response)

If A1 deficient and A2 full, go to A3→ City University

Page No.	*Normal*	*Protan*	*Deutan*	*Tritan*
5	R ☐	B ☐	L ☐	T ☐
6	L ☐	R ☐	T ☐	B ☐
7	R ☐	L ☐	B ☐	T ☐
8	L ☐	T ☐	R ☐	B ☐
9	R ☐	L ☐	B ☐	T ☐
10	R ☐	L ☐	B ☐	T ☐

RESULT:

NAD ☐

Protan ☐

Deutan ☐

Tritan ☐

Other ☐

A4. Diagnostic Testing with Ishihara at 40cm

☐Tick here if unable to perform Ishihara

Plate	Normal Response	Person with Red-Green Deficiencies (tick box if no. displayed reported, any other answer write next to box)		
1	12	12 ☐		
2	8	3 ☐		
3	29	70 ☐		
4	5	2 ☐		
5	3	5 ☐		
6	15	17 ☐		
7	74	21 ☐		
8	6	X ☐		
9	45	X ☐		
10	5	X ☐		
11	7	X ☐		
12	16	X ☐		
13	73	X ☐		
14	X	5 ☐		
15	X	45 ☐		
		Protan	**Deutan**	
16	26	6 ☐	2 ☐	other☐
17	42	2 ☐	4 ☐	other☐

.

RESULT:

NAD ☐

R-G Defect ☐

Total Colour Blindness ☐

6.1.1.515. Pupils **(IF PUPILS ABNORMAL MEDICO NEEDS TO ASSESS BEFORE DILATION)**

PERFORM ON ALL CHILDREN (without glasses)

Right Eye: Normal ☐ 1
APD ☐ 2
Other ☐ 3 → Describe:_____
Unable ☐ 96

Left Eye: Normal ☐ 1
APD ☐ 2
Other ☐ 3 → Describe:_____
Unable ☐ 96

Are the Pupils Equal in Size?
Yes ☐
No ☐

If No, which Pupil is Larger?
Right ☐
Left ☐

☐ Heterochromia is present → Lighter Eye: ☐ Right ☐ Left

Comments:_____

16. Iris Colour

PERFORM ON ALL CHILDREN USING IRIS PHOTOGRAPH REFERENCE STANDARDS

Right Eye		**Left Eye**	
< std # 1 (blue)	☐ 1	< std # 1 (blue)	☐ 1
< std # 2 (hazel/green)	☐ 2	< std # 2 (hazel/green)	☐ 2
< std # 3 (tan/brown)	☐ 3	< std # 3 (tan/brown)	☐ 3
> std # 3 (dark brown)	☐ 4	> std # 3 (dark brown)	☐ 4
Cannot judge/not done	☐ 5	Cannot judge/not done	☐ 5

17. Brückner Test

PERFORM ON ALL CHILDREN

DOES THE CHILD HAVE GLASSES WHICH WILL BE WORN TODAY? ☐Yes ☐No

(If patient has glasses ∞, they should be worn):

Indicate which eye had the "Whiter and Brighter" reflex:

Right Eye ☐ 1
Left Eye ☐ 2
Equal Brightness ☐ 3

Unable ☐ 96

6.1.1.618. Blood Pressure

Blood Pressure 1: ___ /_____ **Pulse 1:_____**BPM Unable ☐

Blood Pressure 2: ___ /_____ **Pulse 2:_____**BPM Unable ☐

6.1.1.719. Eye Drops

First Instillation of :

Don't forget to set your timer to 20 minutes after last cycloplegic drop

Amethocaine 0.5% **Time** ☐☐ : ☐☐

2 minutes later

Cyclopentolate 0.5% **Time** ☐☐ : ☐☐
(for children under 12 months)

Cyclopentolate 1% **Time** ☐☐ : ☐☐

Tropicamide 1% **Time** ☐☐ : ☐☐

Phenylephrine 2.5% *Time* ☐☐ : ☐☐
(Instill if necessary)

5 minutes later

Second Instillation of:

Cyclopentolate 0.5% **Time** ☐☐ : ☐☐
(for children under 12 months)

Cyclopentolate 1% **Time** ☐☐ : ☐☐

Tropicamide 1% **Time** ☐☐ : ☐☐

Phenylephrine 2.5% *Time* ☐☐ : ☐☐
(Instill if necessary)

6.1.1.820. Anthropology

Height or Length:_____(cms)☐Tick if Recumbent Length Method used

Weight: _____ (kgs) → If possible attach printout here:

Waist Circumference:_____ (cms)

Head Circumference: _____ (cms)

21a. Refraction: Cycloplegic Autorefraction

☐TICK HERE IF UNABLE TO INSTILL DROPS

☐***CANON***	☐***Right***	☐***Left***
☐RETINOMAX	☐Right	☐Left

If unsuccessful, perform Cycloplegic Retinoscopy

R: Canon refraction successful
Retinomax refraction successful (confidence level>=8): ☐ Y ☐N

L: Canon refraction successful
Retinomax refraction successful (confidence level>=8) ☐ Y ☐N

AUTOREFRACTION PRINTOUT CANON OR RETINOMAX PRINT OUT

21b. Assessment of Cycloplegia

Dilated Pupil diameter: R_____mm ☐Unable

L_____mm ☐Unable

Reaction to light:

Right	Left
☐Yes	☐Yes
☐No	☐No
☐Unable	☐Unable

Constriction of pupil whilst viewing Autorefractor target:

Right	Left
☐Yes	☐Yes
☐No	☐No
☐Unable	☐Unable

Comments:

_____

_____

_____

22. IOL Master

☐ *TICK HERE IF <30 MONTHS OF AGE AND SKIP.*

Right ☐Tick if unable (96)

Left ☐Tick if unable (96)

Place printout in book

23. Refraction: Cycloplegic Retinoscopy

PERFORM IF EITHER EYE HAS HAD CYCLOPLEGIA AND "UNABLE" TO OBTAIN RETINOMAX READING OF CONFIDENCE LEVEL >=8. IF PERFORMING CYCLOPLEGIC RETINOSCOPY, PERFORM IN BOTH EYES (UNLESS ONE EYE DOES NOT HAVE CYCLOPLEGIA).

ADEQUATE CYCLOPLEGIA R? ☐YES

ADEQUATE CYCLOPLEGIA L? ☐YES

IF NO FOR EITHER EYE, PERFORM NON-CYCLOPLEGIC RETINOSCOPY FOR THAT

C. CYCLOPLEGIC RETINOSCOPY:

Cycloplegic Refraction Calculation:

R: _____ sph _____ cyl x _____ (axis)

L: _____ sph _____ cyl x _____ (axis)

Orunable (96):

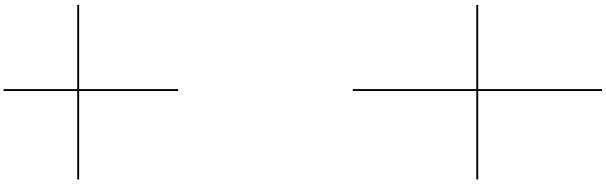
☐ R

☐L

24. Refraction: Non-Cycloplegic Retinoscopy

PERFORMED IN EITHER EYE IF THAT EYE DID NOT RECEIVE AT LEAST ONE DROP OF CYCLOPENTOLATE.

D. NON-CYCLOPLEGIC RETINOSCOPY:



Non-Cycloplegic Refraction Calculation:

R: _____ sph _____ cyl x _____ (axis)

L: _____ sph _____ cyl x _____ (axis)

Or unable (96):

☐*R*

☐*L*

Comments _____

6.1.1.925. Slit Lamp Examination

6.1.1.10 Right Eye	Eye condition NAD ☐		CRe (ICD-10-AM)
Eyelids, lacrimal system	Hordeolum or deep inflammation of the eye lid	☐	H00.0
	Chalazion	☐	H00.1
	6.1.1.11 Ptosis	☐	H02.4
	Epiphora	☐	H04.2
Conjunctiva and external eye	Conjunctivitis	☐	H10
	Conjunctival degenerations and deposits	☐	H11.1
	Conjunctival scars	☐	H11.2
Corneal disease	Corneal ulcers	☐	H16.0
	Superficial keratitis	☐	H16.1
	Corneal scars or opacities	☐	H17
	Heredity corneal dystrophies	☐	H18.5
	Keratoconus	☐	H18.6
Iris and ciliary body	Anterior uveitis	☐	H20.2
	Pupillary membrane	☐	H21.4
Lens	Cataract & Type	☐	
Left Eye	Eye condition NAD ☐		CRe (ICD-10-AM)
Eyelids, lacrimal system	Hordeolum or deep inflammation of the eye lid	☐	H00.0
	Chalazion	☐	H00.1
	Ptosis	☐	H02.4
	Epiphora	☐	H04.2
Conjunctiva and external eye	Conjunctivitis	☐	H10
	Conjunctival degenerations and deposits	☐	H11.1
	Conjunctival scars	☐	H11.2
Corneal disease	Corneal ulcers	☐	H16.0
	Superficial keratitis	☐	H16.1
	Corneal scars or opacities	☐	H17
	Heredity corneal dystrophies	☐	H18.5
	Keratoconus	☐	H18.6
Iris and ciliary body	Anterior uveitis	☐	H20.2
	Pupillary membrane	☐	H21.4
Lens	Cataract & Type		

6.1.1.12 26. Fundus Examination

Examiner: ___ ___ ___

A. OPHTHALMOSCOPIC EXAMINATION:

Technique:

(Circle) Indirect (1) Direct (2) Both (3)

A1. R Exam

	Normal	Abnormal	Unable
1) Macula	___1	___2	___96
2) Disc	___1	___2	___96
3) Media	___1	___2	___96
4) Periph. Retina	___1	___2	___96

If abnormal specify:

1)_____
____
2)_____
____

A2. L Exam

	Normal	Abnormal	Unable
1) Macula	___1	___2	___96
2) Disc	___1	___2	___96
3) Media	___1	___2	___96
4) Periph. Retina	___1	___2	___96

If abnormalspecify:

1)_____
____
2)_____
____
3)_____

Is visual acuity measured at 6/36 LOGMAR or worse or unable primarily because of organic disease?

***A3. Right Eye*:** No ☐ 0
Yes ☐ 1 Describe: _____

A4. Left Eye: No ☐ 0
Yes ☐ 1 Describe: _____

6.1.1.13 27. Retinal Photography

Attempt in all children aged 3 years or older

Both eyes ☐ Right eye only ☐ Left eye only ☐
Unable to take photographs ☐

Reason for inability to take photograph:

Unable to keep still ☐

Refusal ☐

Failure to dilate ☐ Extra Phenylephrine given ☐

Abnormality noted: RE ☐ LE ☐

Describe: _____

28a. Return Visit Visual Acuity: Retest Details

☐ *TICK HERE IF NOT INDICATED AND SKIP.*
Examiner:_____

Date of Visual Acuity Retest: _ _ / _ _ / _ _ _ _

Has the child acquired glasses since last visit? Y ☐N ☐
If so, on what date? _ _ / _ _ / _ _ _ _

Instructions: Use the sphere if that doesn't help the vision then use a pinhole over the sphere → only attempt cylinder as a last resort.

Record what script used in trial frame (see worksheet to determine):

R: _____ sph _____ cyl x _____ (axis)

L: _____ sph _____ cyl x _____ (axis)

☐ Check here if placed above prescription in trial frame

New Glasses:

Affix

Auto-Lensometer
Tape

Here

28b. Return Visit: Parent Training with LEA Symbols

Has the child had training with the LEA board at home:

☐Yes
☐No
☐N/A (not in age group 24-36 months)

If yes, is PARENT TRAINING RECORD attached to book? ___ (tick when attached)

28c. Return Visit Visual Acuity: OKN DRUM

TEST DISTANCE: 5OCM

☐ TICK HERE IF THIS SECTION IS NOT APPLICABLE

VISUAL ACUITY (OKN Drum) Detection acuity

If patient has glasses, they should be worn*:*

☐TICK HERE IF CHILD IS UNABLE TO COOPERATE WITH ALL ACUITY TESTS

28c(i) Right eye: OKN elicited ☐ YES ☐ NO

28c(ii) Left eye: OKN elicited ☐ YES ☐ NO

28d. Return VisitVisual Acuity: Teller Acuity Cards II

PERFORMED ON ALL CHILDREN LESS THAN 24 MONTHS OLD OR IF UNABLE TO PERFORM ALL RECOGNITION ACUITY TESTS.

TEST DISTANCE: 55CM

☐TICK HERE IF THIS TEST IS NOT APPLICABLE

VISUAL ACUITY (TELLER ACUITY CARDS II) Resolution acuity

If patient has glasses, they should be worn*:*

Conversion to cycles/deg:

28d(i). Both __ __ __ __ cycles/deg

☐ Tick if unable (96)

28d(ii). R __ __ __ __ cycles/deg

☐ Tick if unable (96)

28d(iii). L __ __ __ __ cycles/deg

☐ Tick if unable (96)

Comments:

_____

_____

Reliability of BE:	Reliability of R:	Reliability of L:
☐ Reliable	☐ Reliable	☐ Reliable
☐ Unreliable	☐ Unreliable	☐ Unreliable
☐ Unable	☐ Unable	☐ Unable

28e. (i) Return Visit Visual Acuity: Electronic Visual Acuity (EVA) Distance without Glasses

PERFORMED ON ALL CHILDREN AT LEAST 30 MONTHS OLD.

☐ *TICK HERE IF THIS TEST IS NOT APPLICABLE*

☐ *TICK HERE IF CHILD IS UNABLE TO COMPLETE TEST*

☐ *TICK HERE IF EVA IS NOT WORKING →USE ALTERNATE LOGMAR TEST INSTEAD*

Visual Acuity	***Visual Acuity***
R: 20/ __ __	**L**: 20/ __ __
☐ Tick if unable (96)	☐ Tick if unable (96)

** If child is older than 60 months (5 years), test with Adult LogMAR and EVA (only if child will cooperate with extended testing).*

28f. (ii) Return Visit Visual Acuity: Electronic Visual Acuity (EVA)Distance with Glasses

PERFORMED ON ALL CHILDREN AT LEAST 30 MONTHS OLD.

☐ *TICK HERE IF THIS TEST IS NOT APPLICABLE*

☐ *TICK HERE IF EVA IS NOT WORKING →USE ALTERNATE LOGMAR TEST INSTEAD*

If patient has glasses 👓, they should be worn now*:*

Visual Acuity	***Visual Acuity***
R: 20/__ __	**L**: 20/__ __
☐ Tick if unable (96)	☐ Tick if unable (96)

Feet	Metres
20/400	6/120
20/320	6/96
20/250	6/75
20/200	6/60
20/160	6/48
20/125	6/38
20/100	6/30
20/80	6/24
20/63	6/19
20/50	6/15
20/40	6/12
20/32	6/10
20/25	6/7.5
20/20	6/6
20/16	6/5

28g. Return Visit Visual Acuity: LogMAR Distance Right Eye

☐TICK HERE IF THIS TEST IS NOT APPLICABLE

LogMAR test face used:

☐ EDTRS (>60 months) ☐Attempted Unable
☐ HOTV (>30 months) ☐Attempted Unable
☐ LEA symbols (>24 months) ☐Attempted Unable
☐ LEA crowded symbol book (>24 months) ☐Attempted Unable

RIGHT EYE

28g(i) WITHOUT glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
6/60	5	1.0
6/48	10	0.9
6/36	15	0.8
6/30	20	0.7
6/24	25	0.6
6/19	30	0.5
6/15	35	0.4
6/12	40	0.3
6/9.5	45	0.2
6/7.5	50	0.1
6/6	55	0.0
6/4.8	60	-0.1
6/3.8	65	-0.2
6/3.0	70	-0.3
Total letters read		

28g(ii) With Glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
6/60	5	1.0
6/48	10	0.9
6/36	15	0.8
6/30	20	0.7
6/24	25	0.6
6/19	30	0.5
6/15	35	0.4
6/12	40	0.3
6/9.5	45	0.2
6/7.5	50	0.1
6/6	55	0.0
6/4.8	60	-0.1
6/3.8	65	-0.2
6/3.0	70	-0.3
Total letters read		

28g(iii) *If VA <6/60, measure VA at 1.22m using LogMAR chart*

WITH Glasses ☐ or WITHOUT glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
3/60 (6/120)		1.3
3/48 (6/96)		1.2
3/36 (6/72)		1.1

28g(iv) *If Vision <3/60, measure VA at 38cm (Age limit: >30 months)*

CF ☐
HM ☐
LP+P ☐
LP ☐
NPL ☐

SPEDS EXAMINATION

Age limit: >30 months

CF – to perform, hold up different numbers of fingers 4-5 times asking the person to show you how many fingers they can see, either by counting or by mimicking how many fingers you are holding up. At 38cm CF is approximately equivalent to 6/60.

HM – to perform, move the hand in different directions, up, down and horizontally at a distance of 38cm, ask the subject in which direction is the hand moving.

LP – switch a small bright fixation torch on and off, held in 4 quadrants at 38cm from the subject. Light perception with

28h. Return Visit Visual Acuity: LogMAR Distance Left Eye

☐TICK HERE IF THIS TEST IS NOT APPLICABLE

LogMAR test face used:

☐ EDTRS (>60 months) ☐Attempted Unable
☐ HOTV (>30 months) ☐Attempted Unable
☐ LEA symbols (>24 months) ☐Attempted Unable
☐ LEA crowded symbol book (>24 months) ☐Attempted Unable

LEFT EYE

28h(i) WITHOUT glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
6/60	5	1.0
6/48	10	0.9
6/36	15	0.8
6/30	20	0.7
6/24	25	0.6
6/19	30	0.5
6/15	35	0.4
6/12	40	0.3
6/9.5	45	0.2
6/7.5	50	0.1
6/6	55	0.0
6/4.8	60	-0.1
6/3.8	65	-0.2
6/3.0	70	-0.3
Total letters read		

28h (ii) With Glasses 👓☐		
Snellen Eq.	No. Correct	LogMAR score
6/60	5	1.0
6/48	10	0.9
6/36	15	0.8
6/30	20	0.7
6/24	25	0.6
6/19	30	0.5
6/15	35	0.4
6/12	40	0.3
6/9.5	45	0.2
6/7.5	50	0.1
6/6	55	0.0
6/4.8	60	-0.1
6/3.8	65	-0.2
6/3.0	70	-0.3
Total letters read		

28h (iii) *If VA <6/60, measure VA at 1.22m*

WITH Glasses ☐or WITHOUT glasses ☐		
Snellen Eq.	No. Correct	LogMAR score
3/60 (6/120)		1.3
3/48 (6/96)		1.2
3/36 (6/72)		1.1

28h (iv) *If Vision <3/60, measure VA at 38cm (Age limit: >30 months)*

CF ☐
HM ☐
LP+P ☐
LP ☐
NPL ☐

29. Parent Training Record for LEA Symbols

30. Family Vertometry

☐ Refraction in Older Siblings File (please tick)

If the mother has glasses:

Affix

Auto-Vertometer Tape

Here

If the father has glasses:

Affix

Auto-Vertometer Tape

Here

If a Sibling has glasses:

Affix

Auto-Vertometer Tape

Here

If another Sibling has glasses:

Affix

Auto-Vertometer Tape

Here

Comments:_____

_____

APPENDIX