Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay

Thesis submitted to

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(Deemed -to -be -University)

[Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Govt. of India Notification No.F.9-19/2000-U.3 (A)]

Accredited 'A' Grade by NAAC (2nd Cycle)

Placed in Category 'A' by MHRD (GoI)

For the award of the degree of

Doctor of Philosophy

In the Faculty of Medicine

(OPHTHALMOLOGY)

By

Dr. Smitha K.S. MBBS, MS.

(Registration No: KLE/Ph.D/12-13/DOUN12005)

Research Guide

Prof. (Dr.) V.D.Patil

Professor of Pediatrics

DEPARTMENT OF PEDIATRICS

KAHER J N MEDICAL COLLEGE,

BELAGAVI-590010

2019

UNDERTAKING

I, **Dr. Smitha K.S.** hereby declare that the information and the data mentioned in my thesis entitled **"Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay"** belongs to me and is original.

I am aware of definition of plagiarism as detailed below:

- An act or instance of using or closely imitating the language and thoughts of another author without authorization and the representation of that author's work as one's own, as by not crediting the original author.
- A piece of writing or other work reflecting such unauthorized use or imitation.
- The deliberate or reckless representation of another's words, thoughts or ideas as one's own without attribution in connection with submission of academic work, whether graded or otherwise.

I hereby declare that the thesis prepared by me is original-one and does not involve plagiarism anywhere. In case at a later stage it is found that I have indulged in plagiarism, then I am solely responsible for the same and the Institution is at liberty to take any disciplinary action against me including cancellation of dissertation or any other penalties imposed by the University.

Date:
Place: Belagavi

Dr. Smitha K.S
Ph.D Research Scholar
KAHER –Belagavi-10

PLAGIARISM REPORT

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Formerly known as KLE University)
(Deemed-to-be-University established u/s 3 of the UGC Act, 1956)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
JNMC Campus, Nehru Nagar, Belagavi-590 010, Karnataka State, India
☎: 0831-2444444 FAX: 0831-2493777 Web: http://www.kledeemeduniversity.edu.in E-mail: info@kledeemeduniversity.edu.in

Ref. No. KAHER/AA/19-20/D- 0606 19001 . 6th June 2019

Acceptance Letter

Madam,

The soft copy of Ph.D. research thesis of **Dr. Smitha K. S, Faculty of Medicine** of KAHER, Belagavi has been submitted for anti-plagiarism check at the office of the undersigned through "Turn-it-in" package. The scan has been carried out and the scanned output reveals a match percentage of **4%** which is within the acceptable limit of **10%.**

To obtain the comprehensive report of the plagiarism test, research scholar can send a mail to **diracademic@kledeemeduniversity.edu.in** along with the Registration Number, Name of the Scholar, Name of Guide/Co-guide and title of the thesis.

DIRECTOR ACADEMIC AFFAIRS Deemed-to-be University

(Dr.) Daksha Dixit)
Director, Academic Affairs

To,

Dr. Smitha K S
Part-Time Ph.D. Scholar, 2012-13 Batch
Faculty of Medicine, KAHER,
J.N. Medical College,
Belagavi.

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(Deemed-to-be-University)

[Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Govt. of India Notification No.F.9-19/2000-U.3 (A)]

Accredited 'A' Grade by NAAC (2nd Cycle)

Placed in Category 'A' by MHRD (GoI)

Copyright Declaration

We hereby declare that **KLE Academy of Higher Education and Research, Belagavi, Karnataka,** shall have the rights to preserve, use and disseminate this thesis in print or electronic format for academic/research purpose.

Signature

Dr. Smitha K.S.
Ph.D Research scholar
KAHER
Belagavi-590010

Signature

Prof. (Dr.) V.D.Patil
Professor of Pediatrics
Department of Pediatrics,
KAHER-Belagavi-590010

Place: Belagavi
Date:

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(Deemed-to-be-University)

[Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Govt. of India Notification No.F.9-19/2000-U.3 (A)]

Accredited 'A' Grade by NAAC (2nd Cycle)

Placed in Category 'A' by MHRD (GoI)

Declaration

I hereby declare that the thesis entitled **"Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay"** is a bona-fide and original research carried out by me under the guidance of **Prof. (Dr).V.D.Patil,** Professor of Pediatrics, Department of Pediatrics, J.N.Medical College, KAHER Belagavi-590010. The thesis or any part thereof has not formed the basis for the award of any degree/fellowship or similar title to any candidate of any University.

Place: Belagavi
Date:

Signature
Dr. Smitha K.S.
Ph.D Research Scholar
KLE University Belagavi

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(Deemed-to-be-University)

[Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Govt. of India Notification No.F.9-19/2000-U.3 (A)]

Accredited 'A' Grade by NAAC (2nd Cycle)

Placed in Category 'A' by MHRD (GoI)

Certificate

This is to certify that the thesis entitled **"Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay"** is a bona-fide and genuine research carried out by **Dr.Smitha K.S.** under the guidance of **Prof.(Dr).V.D.Patil,** Professor of Pediatrics, Department of Pediatrics, J.N.Medical College, KAHER, Belgaum-590010

Place: Belagavi
Date:

Signature
Dr.V.A.Kothiwale
Dean, Faculty of Medicine
KAHER, BELAGAVI-10

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

(Deemed-to-be-University)

[Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Govt. of India Notification No.F.9-19/2000-U.3 (A)]

Accredited 'A' Grade by NAAC (2nd Cycle)

Placed in Category 'A' by MHRD (GoI)

Certificate

This is to certify that the thesis entitled **"Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay"** is a bonafide record of original research carried out by **Dr.Smitha K.S.** for the award of degree of **DOCTOR OF PHILOSOPHY** in faculty of Medicine under my supervision and guidance

Place: Belagavi
Date:

Signature

Prof. (Dr.) V.D.Patil
Professor of Pediatrics
Department of Pediatrics,
J.N.Medical College
KAHER-Belagavi-590010

ACKNOWLEDGMENT

I wish to express my deep sense of gratitude to my guide

Prof. (Dr.)V.D.Patil, **MD., DCH** Professor of Pediatrics, Department of Pediatrics. J N Medical College and respected Registrar, Belagavi, for giving multifaceted guidance, encouragement and valuable suggestions towards completion of this study.

I thank honorable Vice Chancellor **Dr.Vivek A. Saoji**, **MS** **KAHER** for his encouragement and support throughout my study period.

I am grateful to **Dr.(Mrs.) N. S. Mahantashetti** **MD** Principal J N Medical College, Belagavi for her help and encouragement.

I express my deep sense of gratitude to **Dr.Mahesh Kamate,** MD., DM Paediatric Neurologist for his support and encouragement.

I am thankful to **Dr.Aravind L Tenagi**, Professor and Head, Dept of Ophthalmology, **Dr.S.B.Patil, Dr.Umesh Harakuni, Dr.Shivanand Bubanale, Dr.Bhagyajyothi B.K**. and all my departmental colleagues for their utmost helpful attitude and valuable suggestions during my study period.

I thank **Mr.Mahesh, Ms.Jabeen, Mr.Mahantesh** and **Mr.Pundalik**, the support staff for all their help.

I express my sincere thanks to Prof (**Dr.)N.K.Tyagi** **Ph.D** Department of Biostatistics, for his valuable help and guidance throughout study.

I thank **Dr.S. G. Kardesai, Dr.Daksha Dixit and Dr.B. S. Kodkany** for giving valuable suggestions.

I thank my post-graduate students for their help and assistance. I express my gratitude to all the patients who were part of the study.

I thank **Mrs.Sangeeta Mali**, child psychologist for her help and assistance. I express my gratitude to all the staff of Child Development Centre.

I express my gratitude to my parents, in-laws, my daughter, **Ira**, my husband, **Dr.Madhav Prabhu** and my entire family for their support and co-operation. I would like to specially thank my mother in law, **Mrs.Lalan Prabhu** for her constant support and encouragement.

I express my gratitude to all others who have helped me directly or indirectly.

Date:

Place: **Dr.Smitha K.S.**

ABBREVIATIONS

GDD:	Global Developmental Delay
ID:	Intellectual Disability
AAIDD:	American Association on Intellectual and Developmental Disabilities
IQ:	Intelligence Quotient
WHO:	World Health Organization
ICD:	International Statistical Classification of Diseases and Related Health Problems
MRI:	Magnetic Resonance Imaging
CNS:	central nervous system
NDD:	Neuro Developmental Disabilities
SD:	Standard Deviation
AAP:	American Academy of Pediatrics
AAN:	American Academy of Neurology
TIDE:	Treatable Intellectual Disability Endeavor
aCGH:	array-based Comparative Genomic Hybridization
DQ:	Developmental Quotient
DA:	Developmental Age
CA:	Chronological Age
BSID:	Bayley Scales of Infant Development
BDSTI:	Baroda Developmental Screening Test for Infants
DASII:	Developmental Assessment Scale for Indian Infants
PCDTP:	Pandey's Cognitive Development Test for Pre-schoolers

CVI:	Cortical Visual Impairment
DVM:	Delayed Visual Maturation
FC-PL:	Forced choice preferential looking
TAC:	Teller Acuity Cards
VECR:	Visually Evoked Cortical Response
VEP:	Visual Evoked Potential
OKN:	Opto Kinetic Nystagmus.
OPD:	Out Patient Department
IRB:	Institutional Review Board
EC:	Ethics Committee
D:	Diopter
ABS:	Adaptive Behaviour Scales
SPSS:	Statistical Package for Social Sciences
PVL:	Peri Ventricular Leukomalacia
VPI:	Visuo-Perceptual Impairment
IEP:	Individualized Education Plan

Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay

ABSTRACT

Introduction: Primary cause of GDD is irreversible, but secondary factors like visual defects, auditory factors etc., are amenable to treatment, and benefit from intervention (Bader 1980). According to a study by Salt (2014), of the various ocular manifestations, refractive error was the most common (20-60%). There is a dearth of studies on the quantification of DQ improvement, on behavioral improvement, due to visual improvement. Hence, the study was attempted.

Objectives: To study the impact of early Refractive Errors correction, on Vision, Developmental Quotient (DQ) and their determinants in GDD children of age 1 to 5 years.

Methodology: Subjects of age one to five years, having GDD with refractive error were considered for the study. DQ and vision were estimated, after complete ocular examination including anterior segment examination, muscle balance and dilated fundoscopy was done. Spectacles were prescribed after refraction testing. Reassessment at follow up was done after six months for Visual acuity and Developmental Quotient estimation. Post-test behaviour of the children was assessed using Questionnaire.

Chi square test was used to test significance of change by explanatory variables. Statistical Package for Social Sciences (SPSS), Version 22.0 was used for data analysis.

Results: Refractive error in both younger and older age groups was significantly different. Refractive errors were higher in the severe ID group (43%) as compared to

mild group (18%) in age group less than 2.5 years. Visual improvement was 50% in term, as compared to 23% in preterm born children, the differences were statistically significant. Hyperopes and myopes were observed in 71% and 21%, respectively. However, visual improvement in myopes was seen in 15 (71%) children, as compared to 29 (41%) in hyperopes ($p< 0.041$). Overall, 47 % of children improved in vision significantly. Mild ID group exhibited maximum improvement (69%), as compared to moderate ID (49%). Improvement in social behaviour was more in mild ID group, as compared to moderate. Overall DQ improved significantly in 14% of children after six months.

Conclusion: The neurological cases are on increase in India, stressing need for awareness among the treating Paediatricians and Ophthalmologists, regarding early ophthalmic care.

Study concludes that the Global Developmental Delay children must be subjected to Refractive Error correction through spectacles at an early age for a better functional life.

Keywords: Global Developmental Delay (GDD), Refractive Error (RE), Developmental Quotient (DQ)

CONTENTS

LIST OF TABLES

LIST OF GRAPHS

FLOW CHARTS OF THE STUDY

1. INTRODUCTION

1.1.Global Developmental Delay (GDD):

Neurodevelopmental disabilities and associated comorbidities are challenging problems for clinical practitioners. Children having disturbance in developmental growth are grouped together under the heading NeuroDevelopmental Delay (NDD). [1]The term developmental delay is used for a child, who is continually slower in attaining the milestones, as expected in children of that age group. Prevalence of developmental disabilities was 5-10% of the paediatric population (Montreal 2004). [2] Today, with the advent of highly specialized NICU care and higher rate of survival of premature babies, NDD is considered a new pediatric morbidity, and is on the rise. [1]

"GDD is a significant delay of at least 2 SD below mean, on objective norm referenced, age appropriate testing in two or more of the following major Developmental Domains

1. Gross and Fine motor
2. Speech and Language
3. Cognition
4. Social and Personal Development
5. Activities of Daily Living.

Typically, a delay in two domains, often implies delay across all domains". [1,3]

Global Developmental Delay (GDD) and Intellectual Disability (ID) are complementary terms. American Association on Intellectual and Developmental Disabilities (AAIDD) defined ID as *"a disability characterized by a significant limitation both in intellectual functioning and in adaptive behaviour as expressed in*

conceptual, social, practical and adaptive skills." [1] The term Global Developmental Delay (GDD) is used in children younger than five years and Intellectual Disability for older children. [1] The prevalence of GDD was observed to be around 1-3% of the population of children under 5 years of age. [5] GDD was defined as a chronic condition, with early onset developmental disabilities, with disturbance in the attainment of motor, cognitive or language and social skills. [3]

According to the AAMR committee, GDD can be diagnosed entirely on clinical judgement, due to inaccessibility or delay in standardized assessment procedures, and/or socio-cultural barriers, necessitating reliability on clinical judgment. [4] Extensive experience in handling such individuals, reliable information from third party, and involvement of a skilled interdisciplinary team validates this judgment. The AAN practice parameter for GDD provides a framework, with screening tools and specific testing guidelines for diseases. [5] Newer developments for diagnosis are- genomic micro arrays, proteomic analysis for mitochondrial disease and MRI diffusion tractography. However, in 50-80% of cases, there was no determined aetiology. [6]

The causes are classified as:

- Prenatal- Genetic syndromes (25-50%) most common being Down syndrome, CNS malformations, environmental causes (infectious and toxic).
- Perinatal causes – birth asphyxia, stroke, infection.
- Postnatal- infections, toxins, injury.

Complete intellectual development of the child depends on environmental factors such as familial discord, poverty, malnutrition, sensory and emotional deprivation.

Mild or borderline ID is usually seen in the socio-culturally deprived group. Severe ID is commonly caused by biological impairment. (Bader, 1980) [7]

1.2. GDD and VISION:

GDD has a primary initiating factor, i.e., cerebral insult and secondary compounding factors, like associated visual and/or auditory defects. Primary cause is irreversible, but secondary factors are amenable to treatment and benefit from intervention. [7]

Vision plays a central role in early interaction and motor development. The synaptic plasticity of the visual cortex continues after birth. The visual environment provides information that helps in refining the processing capacities of cortical neurons. Johnson et al (1999) found that eighty percent of learning by children was via visual information.[9] AAN report (2003) showed an increasing frequency of ocular and visual anomalies among children with developmental delay.[5] Visual impairment varied from 10.5 - 50% in GDD children, compared to approximately 0.16% in normal children, [8] and audiologic impairment was 18% and above in GDD. [5]

Of the various ocular manifestations, refractive error was the most common finding (20-60%), followed by optic atrophy (21%), strabismus (18%) and cortical visual impairment (11%).[9] Emmetropization (reduction of ametropia present at birth) was guided by visual feedback mechanism.[10] Thus, visual deprivation in infancy lead to retention or increase in refractive errors.[11] Visual impairments affected intellectual development and motor achievement by hampering neurological development i.e., defects of the ocular refractive system reduced the visual input, which further inhibited sensory, perceptual and cognitive development in children with GDD.[7]

1.3. Intervention and time of intervention:

Shevell in 2005, studied outcomes or natural history of children diagnosed with developmental delay, without any intervention. He found that 75 to 100 % of children remained below the mean scores, compared to age matched normative data. They showed persistent poor performance at school age in both developmental and functional outcomes. [3] This highlighted the need for intervention in these children. Intervention was aimed at improving the disturbed visual sensory input. Uncorrected refractive errors lead to amblyopia and poor stereo acuity or binocular function. The degree of refractive error that produced sensory deprivation and its extent was uncertain. Undetected visual impairment lead to an underestimation of Intellectual Development. Visual deficit when missed, lead to an inappropriate attribution of the poor performance to low Developmental Quotient (DQ). [12] Thus, visual correction is the key to appropriate development.

GDD has an immense social, emotional and economic impact on an individual, family and the society at large. Visual support enhances child's educational gains, decreases dependence on family and social institutions leading to economic and social benefit. [7]

Time of intervention: American Association of Neurologists (2003) found that intervention in a child with global delay improved outcome, in its early years. [5]A young child's brain is in a state of maximum readiness. Neglect in this period leads to a risk of missing an opportunity to learn. The brain is highly receptive in the first three to five years, as 75-80% of the brain growth occurs in this age. Stimulation at this age enriches children at-risk, enabling their maximum potential development. Evidence shows that correction of ocular problems highly benefits these children.

However, they receive less than average ophthalmic care. [13] As greater emphasis is laid on other modalities of treatment in a child with multiple disabilities, vision is often neglected.

Refractive error correction is of clinical significance for the overall development of the child. A younger child is more receptive and compliant than an older child or adult. [14] Thus, proper evaluation of visual acuity and correction of refractive error, at an early age is quintessential. Studies have shown that, besides visual acuity, functional vision is also significant in the child's day to day activities. This necessitates the study of behavioral change and adaptive function, before and after refractive correction. [7] Though there were studies on prevalence of refractive errors and qualitative behavioral studies after refractive correction; there was a dearth of studies on the quantification of DQ improvement and behavioural improvement, after visual improvement in GDD. Hence, this study served as an attempt to bridge the gap.

1.4. Aims and Objectives:

Aim of the study was to improve the vision in children with GDD, by refractive error correction, which lead to mental development and improvement in functional behaviour of the child.

The objective was to study the impact of early Refractive Errors correction, on Vision, Developmental Quotient (DQ) and their determinants in GDD children of age 1 to 5 years.

2. REVIEW OF LITERATURE

2.1. Global Developmental Delay (GDD)

Children with disturbance in the developmental progress were grouped together under Neuro Developmental Disabilities (NDD); as they faced similar challenges and had a common approach to diagnostic evaluation and interventions. (London 2013) [15] The term "delay" suggests that there could be a maturational catch up, but studies reveal otherwise. [16] Cognitive Development follows a rapid path of new skill acquisition. This is followed by a consolidation path which appears like a plateau phase.[7]

Children initially diagnosed as GDD in preschool years, continued to meet the diagnostic criteria for GDD, on reassessment at school age. (Shevell 2005) [3] This adaptive behaviour deficiency was defined as problems in learning conceptual, social and practical skills or social adjustment difficulties to ordinary demands. Overall, this was a defect in the ability to comprehend the surroundings. [17] Standard age appropriate measures validated on normal population were used to assess Adaptive behaviour skills.(US 2002) [18] A significant limitation for a test being,2 standard deviations below the mean. [4] Objectification of the limitations lead to planning of structured support and improved quality of life.

Review of guidelines for diagnostic workup of GDD:

Confirmation and classification of the condition was done through history, physical examination, ophthalmic, audiological examination and a etiological investigations via selective laboratory tests. Based on history and examination, a review found etiological diagnosis in 12.5% to 38.6% of cases, stressing the importance of history. [20] The history included a comprehensive family history of three generations, parental

consanguinity, maternal pregnancy issues, details of labour and delivery process, neonatal and perinatal problems, infantile deaths, major milestone timings, socio economic status, ethnic heritage and geographic origin. All these provided important clues towards the diagnosis and aetiology of GDD.

First-line investigation was genetic investigation i.e., standard karyotyping, which was replaced by 'molecular karyotyping' or chromosome microarray (array-based comparative genomic hybridisation (aCGH)). There was a panel of second line of tests, to be selected based on the individual case, followed by metabolic and biochemical investigations. Neuro-imaging tests by MRI of the brain were to be used both, selectively and non-selectively. Targeted imaging was advocated. MRI had a higher diagnostic yield in children with epilepsy, abnormal head circumference and focal neurological signs. (UK 2017) [20]

Belanger et al, in 2018 detected the cause in 80% of severe ID cases and 24% of mild ID cases, based on the severity of GDD/ID. [21]Occurrence of GDD was influenced by genetic, eco genetic and environmental factors. Timing of the cerebral insult also aided the diagnostic process. [1]

Management and Prognosis of GDD:

Guidelines set by American Academy of Paediatrics (AAP), American Academy of Neurology (AAN) and the Treatable Intellectual Disability Endeavor (TIDE) helped in diagnostic workup. Diagnosis in a case of GDD was of critical importance, as it lead to timely initiation of treatment and supportive management. It avoided costly inappropriate tests, improved prognosis and helped provide accurate genetic counseling. [21]

The overall management included rehabilitative services, counselling the family regarding the risks of recurrence and treating the associated conditions, to realize the child's full developmental and cognitive potential. (AAN 2003) [5] The primary goal was early intervention. This multi-dimensional therapy was based on concerns of a particular child, which included hearing, vision, speech, occupational therapy, family education and counseling. The child may be unable to outgrow a developmental problem on its own, but, with medical assistance full potential could be achieved.

2.2. Developmental Quotient (DQ):

In children under 5 years, it is difficult to objectify the limitations in intellectual functioning. Various developmental domains have to be evaluated for the disturbance. [17] The non-verbal tests confounded the bias caused by socio cultural effects, rather than the neurobiological ones and proved to be better for evaluation. Adaptive skills determine the ability to succeed in life. Hence, there was a controversy as to the importance of IQ level or adaptive behavioural deficits in categorization of the severity of the delay. [18] Approximate 2.25% of the population had IQ below 70. Rate of severe ID was less affected by the population studied and instruments tested, unlike the rate of mild ID. Mild ID was affected by harmful environmental factors like poor education, nutrition, environmental toxins like lead. A meta-analysis found mild ID rate as 8.4 per 1000 and severe as 3.6 per 1000. There was a racial disparity showing higher occurrence among blacks and a gender imbalance of 1.4: 1.0 male female ratio. [22]

In children under 5 years, developmental quotient is of greater relevance than IQ, as development is an on-going process in these children. Hence, developmental mental quotient was the principle variable in this study. DQ, frequently used in preschool

children, is a numerical representation of the child's growth. It is evaluated across a range of psychosocial skills. Webster et al (2003) defined DQ as a ratio statistic showing a child's overall development based on criteria, and in contrast, the IQ as a statistical comparison with normative data for a given age group. It used deviation score in contrived tasks by an individual under highly controlled test conditions. These frameworks helped to study the impact of intervention and development over time. Also, avoiding the shortcomings of standardized intelligence testing for atypical groups. [23]

Bayley Scales of Infant Development, [24] Battelle Developmental Inventory [25] and Denver Developmental Screening Test [26] are few standardized tests available for assessment worldwide. Domain-specific developmental measures such as motor profile, language skills and activities of daily living are available.

Bayley Scales of Infant Development (BSID) in 1969 assessed 3 necessary scales

1. The Mental scale
2. The Motor scale
3. The Infant Behaviour Record

Dr.P. Phatakchose 54 items of Bayley Scale of Infant Development Research Form 1961 and formed Baroda Developmental Screening Test for Infants (BDSTI), for screening in 1970. This was an easier version which provided DQ in Indian population. She dedicated more than 30 years and standardized the Developmental Assessment Scale for Indian Infants (DASII). She used indigenous materials to modify the original Bayley scale in a culturally accepted way. DASII calculates both mental development index and psychomotor development index. [27] DQ helps in comparing the development and performance of the child with that of other children

of same age. Serial assessments by the same examiner done every three to six months, gave the rate of development. Few disadvantages of this test were that, the cause of delay was not shown, it needed age correction for pre-terms, special training and the child's complete cooperation. Few tests lacked age appropriate norms and few environmental factors hampered the interpretation. Repeated measures lead to increased accuracy and reliability. (US 1993) [28] The scores were bounded by a range of confidence, in view of standard error of measurement called "zone of uncertainty". [29]

Hema Pandey's Cognitive Development Test for Pre-schoolers (PCDTP)(1992) was used in children older than two and a half years. Standard scores were obtained from the age norm table using the summated raw scores. [30]

The tests for DQ were validated and modified over the years. The ones followed widely in Indian setup were, DASII for children younger than 2 years 6 months and PCDTP for children older than 2.5 years.

2.3. Visual development:

Human brain has the unique quality of neuroplasticity i.e., in response to external stimuli, structure and function can change. This is more in childhood and decreases with age. Early in life, visual system is plastic and flexible to change, which eventually becomes hardwired. Neural activity strengthens cortical synaptic connections.[31]During "critical or sensitive period", change in environmental factors can influence the visual system. Visual deprivation leads to permanent visual loss in the form of amblyopia. Amblyopia or lazy eye is defined as functional reduction in vision, without any organic pathology in the eye. It interrupts the normal visual

experience in early life. Thus, the crucial age for visual correction is till the age of 7 to 9 years.[32]

Delayed Visual Maturation (DVM)[33]

Visual unresponsiveness in infants without any apparent cause, improving with time is termed as Delayed Visual Maturation (DVM). DVM is said to be a diagnosis of exclusion. M.Beauviex described 2 distinct categories of visual affection. [34]

First was an isolated anomaly, complete recovery of which was expected within 4- 6 months. The second was slower, which consisted of incomplete visual improvement, associated with mental retardation, high refractive error and strabismus. Although, final vision improved over time, it might not be normal (because of other ocular and systemic diseases). These need to be distinguished from poor vision due to visual pathway or visual cortex pathology. The notion of DVM being a cause of temporary delay in visual growth was proved incorrect. Uemera et al suggested three types of DVM. [35]

Type 1 DVM: visual maturation delay with no other anomaly.

Type 2 DVM: visual maturation delay with mental retardation or seizure disorder.

Type 3 DVM: primary visual abnormality and a superimposed visual maturation delay.

Recognition and grating resolution acuity

Evaluation of vision in children with developmental delay is important but equally difficult as the standard method of recognition of symbols cannot be performed in this age group. [36] Though subjective visual assessment using letter charts is satisfactory, there are cases of infants, children, malingerers and uncooperative patients in whom

objective evaluation and determination is the only suitable method. The visual stimuli in these tests is simpler than traditional methods such as letter chart. As response is mostly monitored from visual / cerebral system, it is lower than that required for letter recognition. The results are optimistic as compared to Snellen chart.

Resolution acuity is the capacity of the eye to distinguish two parallel lines as separate, where a series of parallel black and white lines with same width are presented called Foucalt or square-wave grating. The streaky nature appreciated before the resolution of actual element leads to a disadvantage. The limit of resolution is expressed in seconds of arc. The visual acuity and minimum angle of resolution are inversely related. The grating acuity compared with clinical acuity, is expressed in decimal notation. The finest feature detectable is grating acuity or resolution acuity. To overcome the differences in measuring acuity due to natural variation, non-standardized testing techniques, different viewing distances and illumination, Teller Acuity Cards system was devised. [37] Children considered 'visually inattentive' due to poor acuity could also be tested using preferential looking (PL) procedures. [38]

Objective vision determination:

In the early stage, development of acuity may be: normal, delayed or stationary, whereas, in later infancy onwards the abnormal patterns can be: asymptomatic, parallel, catch-up or regressing. This complex information helps to improve patient care and offers clues regarding the fundamental mechanisms involved in acuity development. [39]

Review of various methods for determining visual acuity

1. Forced choice preferential looking (PL) or differential fixation:

When given a choice between patterned and non-patterned stimulus, preference to view the patterned is known as preferential looking. On keeping the mean luminance same, when a child is shown a plain and patterned disc, the child prefers the patterned. Patterned discs are square wave gratings having a geometrical progression of sizes, that are equated to Snellen acuity. Teller et al, gave a simpler method of applying PL technique via acuity cards. The finest card showing no fixation or pointing response was the endpoint and gave the visual acuity. [37] Binocular activities were easier to measure as children dislike covering one eye. Reluctance to covering one particular eye was suggestive of amblyopia. Success rate was over 90%. [40]However, Friendly et al, stated that Teller Acuity Cards (TAC) did not identify loss of acuity in amblyopes as it was based on grating acuity. So, studies suggested that a difference greater than half an octave between both eyes in TAC should be considered abnormal. [41.42]

2**. Methods based on visually evoked cortical response. (VECR, VEP)**

Neural activities result in electrical effects. Cortical response to checkerboard pattern stimuli of constant mean luminance with reversal at 12 Hz intervals is called VEP. Nawratzki showed a difference in latency in normal and amblyopic eyes. [43] Douthwaite and Jenkins found that amplitude of VECR and acuity bear a good correlation. [44]

3**. Methods based on evoking an oscillatory motion:**

Vertical grating oscillations leading to pendular motion of the eyes were calculated as objective acuity.

4. Methods based on evoking an Optokinetic nystagmus (OKN):

In this method, instead of oscillations, the test object was continuously moving in one direction, leading to a slow following phase and a rapid recovery phase, called nystagmus. This had good correlation with subjective acuity (Optokinetic drum and the Catford visual acuity apparatus). [45]

5**. Methods based on arresting OKN:**

This uses a stationary object of fine detail superimposed on the background of coarse grating. Dobson and Teller (1978) showed that OKN and PL findings were in fair agreement, whereas VEP gave appreciably higher acuities. They found the visual acuity was about 6/15 (20/50) at one year (VEP – 20/20 at 6 months). [45]

These studies did not imply a parallel development of shape perception, letter recognition or verbal response. There were cases of unilateral small optic disc with reduced nerve fibers, owing to minimal damage of the neural system causing decreased vision in one eye, leading to strabismus or/ and anisometropia. Thus, resulting in failure of the "emmetropization" process. [46]

Comparison of Preferential Looking and VEP showed that VEP gave higher values at lower acuity threshold. The two techniques were only comparable if VEP latency was used instead of amplitude. Hence, PLT was used in this study.

Crowding:

Difficulty in separation of letters on a line on the test chart is known as crowding phenomenon (in strabismic amblyopia). Letters in the center are jumbled and order confused, but letters at the end may be read. The same letters shown singly may lead to higher acuity. This is because of "contour interaction", which is due to cortical effect. [47] This arises when the eye does not fixate centrally at the fovea, but at an extra foveal region: more eccentric the fixation, lower the acuity. Regan challenged this and suggested that crowding was due to defective control of gaze; [48]Subjects having nystagmus fared better with repeat letter acuity than chart acuity, substantiating the same.[49]

Acuity Card Procedure / Forced Choice Preferential Looking Test:

Mc Donald M et al said that visual acuity determination should be done on objective measurements and quantitative estimate of grating acuity was to be done by preferential looking technique with TAC. [50] Vision was assessed with Preferential Looking test using Teller acuity cards (TAC). TAC provided high-quality grating stimuli and child's response to a series of cards with stripes was qualitativelyassessed.TAC also filled the gap between formal quantitative time-consuming techniques and informal qualitative assessment of acuity.

Inter-observer agreement:

Good inter observer agreement among 86% to 98% of children with normal vision demonstrated by a previous study. This agreement was poorer in children (17 to 53%) with ocular and neurological abnormalities. According to them, subjective judgement of variations in a child's response lead to poorer agreement. [42, 50, 52-55]

Inter-observer agreement rates were 85% and 95% for monocular and binocular testing in another study. According to a US based study, reliability of tests conducted by experienced testers had similar results in children with ocular and neurological abnormalities and normal children, but testing was difficult in the abnormal group. [42,50, 52-55]Robbins et al (2003) described the limitations of this test as follows:

- False negative test may result from low motor co-ordination of the eyes and neck.
- Nystagmus or visual field defects lead to limited test accuracy.
- Proper fixation by awake, alert infants was a requirement. [56]

In order to overcome the limitations and achieve higher reliability of acuity estimates by TAC repeated testing was advised.

2.4. Refractive Error and Intervention:

According to Salt (2014), of the various ocular manifestations, refractive error was most common (20 to 80%) in GDD. [8]

At birth, infants have a complete visual system, but its physiological function is incomplete. In a term newborn, the axial length is shorter (~17 mm) and refractive power is higher (~85 dioptres). [57]Studies revealed that from birth to maturity, the size of the eye increases to three times of that at birth and the power decreases. Most of this growth is completed by the age of 3 years, but the ocular growth continues till 14-15 years. Average new born infant is hypermetropic with an error of around 2D. A rapid decline occurrs between 6 months to 2 years in normally developing eyes. A decrease towards emmetropia is seen. [57]

In an emmetropic eye, the light is focused on the retina and forms a sharp image. The axial length and total refractive power are in concordance. In a hyperopic eye, the light is focused behind the retina (too low refractive power or a too short axial length.) In a myopic eye, images are formed in front of the retina, (too high refractive power or too long axial length). The optical system needs a constantly matched axial length and refractive power relation during the growing years to function properly. This mechanism is known as the process of emmetropization and is aimed at minimizing refractive error. A normal ocular development depends on a clear optical image. [57] Visual deprivation in infancy leads to retention or increase in refractive errors. This has been proved by various studies:Akinci et al,(2008) noted that 97.4% of children with Down syndrome had ocular findings in contrast to 42.4% without Down syndrome. [58] Prevalence of refractive errors in the general population was 3.8 - 4.5%as compared to 44-60 % in Intellectual Disability group. [8] Strabismus,

nystagmus, and reduced contrast were higher in children with disabilities. Refractive errors were found in 43% to 86.5% of children with Down syndrome (London 2007-9). [59, 60] The prevalence of refractive error in children with special needs and normal healthy first grade students in Oman (2010) were 58.5% and 2.9%, respectively. [61] Myopes were more in this study. The rates of hyperopia (>1.00 D), myopia (≥1.00 D), and astigmatism (≥ ±1.00 D) in children with disability were found to be 18.6%, 24.3%, and 27.1%, respectively. It was significantly higher than in normal children [1.2% hyperopia / 2.2 % myopia /1.7% astigmatism]. In contrast, study by Castañeet al (1995) had 58.7% of hyperopes, 21.7% myopes and 19.5% astigmatism. [62] These studies were conducted on children in the age group of 5–16 years.

Amblyogenic factor lead to strabismus and loss of binocularity. Disrupted binocular vision affected the learning process. (France 2009) [65]52.5% of children with cerebral palsy had strabismus and 50% had significant refractive errors. Studies estimated the range of strabismus to be from 19% to 30% in children with Down syndrome. [63, 64]

Children with nystagmus had low vision and difficulty in fixating objects. Vora study (2010) found 4.3% of children with nystagmus. [61]

Refractive error in preterm children:

One of the factors influencing the refractive development was low birth weight. Myopia was more common in premature infants, ranging from 1% to 16%. Studies suggested that in preterm children having cerebral palsy, there was no added risk for development of refractive errors and strabismus. (Germany 2014) [66] On comparing low birth weight-preterm children with full-term children, the incidence of strabismus was found to be significantly higher. [67-71]

An Egyptian study (2015) done on normal children found visual impairment to be significantly higher among those with positive consanguinity. [72] A study in Iran (2015) on consanguineous marriage showed increased risk of strabismus in children. [73]

An amblyopia study found no associations with caesarean birth, but preterm and low birth weight children had high risk of having amblyopia. (Iran 2013) [74] A Chinese study (2007) found increased risk of severe astigmatism in children having history of birth by elective caesarean section. [75]

Effects of Intervention:

Shevell in 2005, studied children with GDD, **without intervention**, and found that 75% to 100% remained below their average scores, in a matched normative study. [3] Hence, intervention was essential in these children. As sensory visual input was the doorway to the development of the brain, this study concentrated on improving the visual input.

Qualitative analysis by Bader and Woodruff (1980), of behavioural variationsin mentally retarded persons, on correction with spectacles, showed improvement in the youngest group. [7] A questionnaire-based study on scholastic activities done in Pune (2016), concluded that vision improved in 26.4% of subjects with refraction. [76] A retrospective study by Watson (2007) done on CVI patients, found that 49 % improved in vision, with correction, after a mean duration of 6.5 years. [77]

2.5 Compliance: There is limited data on compliance for spectacle wear and factors associated with it. This aspect was crucial for the effectiveness of correction of refractive error. According to studies, frequent observations can assess the compliance of spectacle wear in relation to time. (Oman 2002) [78]One school visit was considered for rating compliance in a study done in Oman. They found younger students, males and those with myopia of less than 2.5D to be non-compliant after one year. [78] A Saudi Arabia (2013) study found that age was not a factor for non-compliance, but it was more in older and myopic children. [79] 29.5% of Indian school children were non-compliant (Pune 2013) [80] compared to more than 50% in Oman.

Important factors causing non-compliance to spectacles in school children were parental disapproval, broken spectacles and children feeling spectacles cause head ache. Parental disapproval was the main cause in studies from America [81], India [80] and Tanzania [82]. Children prescribed spectacles in hospital setting were more compliant, than those prescribed in school vision screening, as parents were present in the clinic and could be explained about the need and advantages of child wearing spectacles. [81] Children wearing spectacles during the unexpected school visit would be considered compliant, leading to low compliance. Another cause of non-wear was peer pressure. [83, 84]All these studies were done in school going children. This study focused on achieving higher compliance rate. The age group selected was children under five years as there is no peer pressure in this age. They were prescribed spectacles in a clinical setting, where parents willingly bring them for follow up treatment.

2.6 Justification: There are a high proportion of refractive errors in children with Global Developmental Delay. The need for eye care remains unnoticed or neglected, though it plays a major role in the development of the brain. This is because the child has complex needs and stress is laid on treating associated systemic anomalies. This avoidable visual disability, following untreated refractive error, further compromises the quality of life. Many considered any form of testing in these children "a waste of time", as they had no economically viable future. A child with disability puts a strain on the parents′ time, energy, and financial resources. Refractive error correction at an early age (crucial years of growth) prevents amblyopia and makes the child's life more productive. A South Indian study (2007) stresses upon the importance of studying small age-appropriate groups, as the refractive errors change with age. [85]

Prevalence of refractive errors in developmental disabilities has been studied. Qualitative analysis on behavioural improvement has been done. However, lacunae are still present in the area of quantification of DQ and behavioural improvement, as compared to visual improvement. Thus, this study attempts to bridge the gap.

3. MATERIALS AND METHODS:

Study Population: Source of data was subjects attending tertiary care teaching hospital of North Karnataka during November 2013 to March 2017. Subjects of age one to five years, attending Child Development Clinic in Paediatric department and diagnosed as having GDD were considered for the study. Those with refractive error and without anterior and posterior segment ocular pathologies were evaluated and enrolled.

Study design: Pre-Post.In a case series, a large sample size is not a mandate as it depends on the availability of the patients. Further, in pre-post design, larger number is not required as the pre-post distribution match.

Study duration: November 2013 to March 2017

Sample size: The expected cases of the improvable Refractive Error as per literature are 62%. Sample size has been computed with 80% power, 95% confidence interval of the estimate as per the literature. [88]

$$\mathbf{n} = \frac{(Z_{1-\alpha/2}+Z_{1-\beta})^2}{(p_2-p_1)^2} pq$$

$$\mathbf{n} = \frac{(1.96+0.64)^2}{(74.4-62)^2} * 62 * 38 = 103$$

74.4 is 20% improvement in the basal value 62%.

Null hypothesis:

Ho: There is no improvement in DQ and social behaviour after refractive error correction.

Sample Selection Criteria

INCLUSION CRITERIA:

- Written informed consent by legal guardian
- Children from 1-5 years of age
- Diagnosis of GDD
- Diagnosis of refractive error according to cut off points

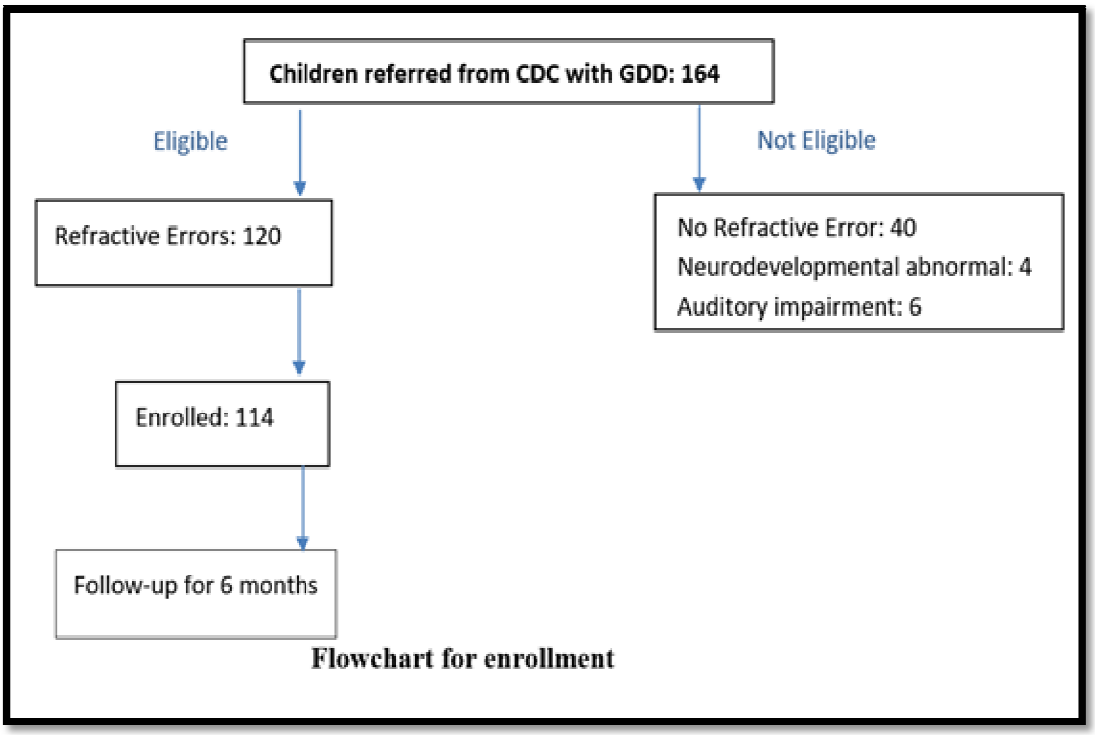
EXCLUSION CRITERIA:

- Progressive disorders like Neurodegenerative and Lysosomal storage disorders.
- Children with associated Cardiac or Renal disorders or any other major illness.
- Children with Muscular Dystrophy and Auditory abnormalities.
- Children with no perception of light, Glaucoma and congenital dystrophies of the eye.

Method of data collection:

After screening 164 consecutive children from 1-5 years of age diagnosed with GDD attending the Child Development Clinic and referred to Ophthalmology OPD of KLES hospital, 120 were found to have refractive error. On excluding the children with auditory abnormalities (eligibility criteria), 114 were enrolled after taking informed consent from the legal guardian/parent. They were followed up as per the standard operating procedure.

Study selection process: A flowchart showing enrollment of children in the study



A detailed history of the children including past and present ocular disorders, medical and surgical treatment, birth weight and term, consanguinity among parents and previous spectacle history was taken. Perinatal history was taken from the medical records provided by the parents.

Visual acuity was recorded with the preferential looking test. The Hirschberg's test was used to evaluate the visual axes. The cover–uncover test was performed to rule out strabismus. Uniocular and binocular movements were examined. The presence or absence of nystagmus was noted. The anterior segment was examined for abnormalities of the eyelid, conjunctiva, cornea, pupillary reaction and lens. Complete ocular examination including anterior segment examination, muscle balance and dilated fundoscopy was done. General and systemic examination was done.

In GDD, cognitive skills are ability to think, count and solve problems. Ability to express emotions and smile are social skills. Using language is speech and language skills. Ability to grasp objects, draw, sit, walk and run are fine and gross movements skills. Tasks like eating, dressing and bathing themselves are activities of daily living. [19] Etiological diagnosis of GDD was documented as diagnosed by the Pediatric neurologist.

Refraction: One drop of homatropine 2% or atropine 1% eye drops was instilled in each eye for cycloplegia and repeated after 15 minutes. Streak retinoscopy (Heine Optotechnik, Germany) was used for objective refraction at the distance of 66 cm. Refractive error values were compensated for this working distance and glasses prescribed. Near vision could not be tested as their distance vision could only be checked using tests based on preferential looking method. Lag of accommodation was tested on subsequent visit after cycloplegic refraction to prevent its influence. During these examinations, distance correction was placed and lag of accommodation was measured using Modified Nott s method of dynamic retinoscopy. Fixation target was held at 40 cm. In case of against movement, retinoscope was moved closer to find the neutral and the distance between the two, gave the lead of accommodation. For with movement, retinoscope was moved further from the subject until neutral was found and the difference was the lag of accommodation. For lead, movement was towards the subject. 0.5D to 0.75 D of lag was considered normal. If lag exceeded 1 D, and the child was above 2 years old and always in sitting posture, near addition was given.

Ethical Approvals:

Institutional Review Board Approval: Ethics Committee approval was obtained from University Ethics Committee at the beginning of the study. Informed Formal written

consent in English /Kannada /Marathi was taken from all parents of children enrolled in the study.

Tools used:

1. Visual Acuity by Teller Acuity Cards® II (TAC) [51]

Grating acuity is the visual angle subtended by a single stripe element or its reciprocal as cycles per degree. Ideally, resolution acuity should be 30 cycles per degree, making a standard Snellen acuity equivalent of 20/20, roughly. The TAC set includes 17 cards that test paediatric visual acuity from 20/20 to 20/3200. The digital print gives the Teller Acuity Cards® II optimal accuracy and lamination, better durability. Teller Acuity Cards® II set is of 25.5 x 55.5 cm, with 35% reflectance and gray in colour. These cards have square-wave gratings on one half of the card. (Contrast 60-70%) The spatial frequencies are (cycles/cm): 0.32, 0.43, 0.64, 0.86, 1.3, 1.6, 2.4, 3.2, 4.8, 6.5, 9.8, 13.0, 19.0, 26.0, and 38.0.Difference between cards is half octave. One octave is doubling of this spatial frequency. The 16^{th} card is called low vision card (large 0.23 cy/cm grating). The last card is a blank gray card. FPL is a "bias- free" PL method. In this, the observer doesn't know the location or frequency of stripes. Test distances for different age groups ranges from 9.5 cm to 84 cm.

Values were noted from the Age Norm Charts according to test distances. Visual acuity was recorded as the average of two readings in cycles /cm. Five groups were made with three levels of score in each, with a difference of 0.5 octave. A difference of one octave was significant and considered as visual improvement. The accuracy (test-retest reliability) of the acuity card test was one octave.

The procedure

The child was held or seated alone facing the tester, at the standard distance from the acuity cards. After attracting the child's attention, the card was held up and acuity was recorded based on the child's behavior such as fixation, pointing, and/or verbalization. The cards were presented and the finest grating that the child responded to, was noted as the child's acuity. To avoid bias of knowing the grating location, the tester would not look at the front of the card and the scrambled cards procedure, a truly masked testing was also used.

Test duration

5 minutes per eye was the average for children in the 1-year to 5-year age range. Children with very low vision or severe disabilities needed 10 to 15 minutes per eye.

Inter-observer agreement: The clinical utility of these tests was established by the high inter-observer agreement and inter-technique agreement. The handheld card test was faster than the earlier ones (within 2-3 Snellen lines of acuity). In forced choice preferential looking test, the stimulus location was judged by the infants looking behaviour (eye and head movements). The child’s eye and head movements, facial expressions and verbal responses provided a qualitative assessment towards the integrative subjective judgement.

2. Developmental quotient (DQ):

According to WHO (ICD 10), mental abilities are on a continuum. Quantitative definitions based on the DQ involved the chronological age and the mental age, which was the age equivalent at which the child functions on the test. Distribution of scores around the mean gave the standard deviation of a test. The standard deviation of below -2 to -5, were divided into mild, moderate, severe and profound mental retardation or developmental delay.

DQ was calculated by dividing the **developmental** age (DA) across domains by the chronological age (CA) and multiplying by 100. (DQ = DA/CA × 100). DQ assessment is needed for developmental remediation. A trained Child psychologist did the DQ assessment. Developmental assessment by Developmental Quotient was calculated as percentage of functional age compared to chronological age.

DQ evaluation methods: Different tools were used for the two age groups as they were age relevant.

1. In children below 2.5 years – DASII (Developmental Assessment Scales for Indian Infants) [27]
2. Above 2.5 years – PCDTP (Pandey's Cognitive Development Test for Pre–schoolers) [30]

DASII:

Dr.Pramila Phatak revised and standardized Baroda 1970 norms and in 1997, made the modified form as Developmental Assessment Scale for Indian Infants (DASII) selecting 67 motor and 163 mental items. She calculated the norms on 4141 test

records, on around 500 babies and validated by testing in many cities of India. It is used till 30 months of age. It is a point scale. Each item passed is evaluated and mental and motor scores are estimated by adding them up, on respective scales.50% placement age for mental quotient was used for analysis.

DQ (MOTOR/MENTAL) = (MOTOR/ MENTAL) Developmental age /
Chronological age * 100. DQ more than 85 is normal.

Developmental Mental Quotient was considered for analysis and mentioned as DQ, as mental development was the outcome variable. Standard scores were obtained from the age norm table using the summated raw scores.

PCDTP:

Hema Pandey's Cognitive Development Test for Pre-schoolers PCDTP (1992) was used in children older than two and a half years. The test re-test reliability was 0.95. This has verbal and non-verbal tests. The test was administered with the help of parents. There was no time limit. The child was seated comfortably and was given sufficient time. There were six subsets with each item given a score. (Conceptual skills, Information, Comprehension, Visual perception, Memory, Object vocabulary). It had high validity and Binet Scale - Form L and Form M -1960 revision correlation was 0.80. The test re-test reliability was 0.95. Test scores were recorded on the score cards. From the "raw" scores, the standard scores of the child as per his/her age were recorded from the age norm table and were grouped.

Grades of Intellectual Disability (ID) according to

International Statistical Classification of Diseases and Related Health Problems (ICD)-10: [86]

Borderline ID: 71-85

Mild ID: 50-70

Moderate ID: 35-49

Severe ID: 20-34

Profound ID: <20

DQ improvement/deterioration was defined as change in the grade of severity.

INTERVENTION:

The error in refractive condition of the eye resulting in blurred vision, due to improper focus of image on the retina is called Refractive Error. As the standard practice parameters set were for normal children, the cut off points for error were taken based on other similar studies in GDD. [7, 87]

Glasses were prescribed for:

- Myopia ≥ −0.50 Diopter (D)
- Hypermetropia≥ +1.00D
- Astigmatism≥ 1.00 D

Follow Up and Compliance Assessment:

Reassessment at follow up was done after six months for Visual acuity and Developmental Quotient estimation.Post-test behaviour of the children was assessed using Questionnaire. It comprised of three sections:

a. Gross Motor based skills

b. Fine Motor based skills

c. Behavioural changes of study subjects.

Questions, ten in number, were drawn from Adaptive Behaviour Scales (ABS), and modified as per the local needs, and validated before conduct of the study. [7]

Compliance factor was defined as wearing of spectacles for a minimum of six to eight waking hours. Parents were counseled regarding the importance of vision guided brain development and of wearing glasses. Follow up was done after first and third month to check the habit of wearing glasses. Compliance was noted on the basis of positive report of glass wear by the parents and the availability of glasses on them during the visit.

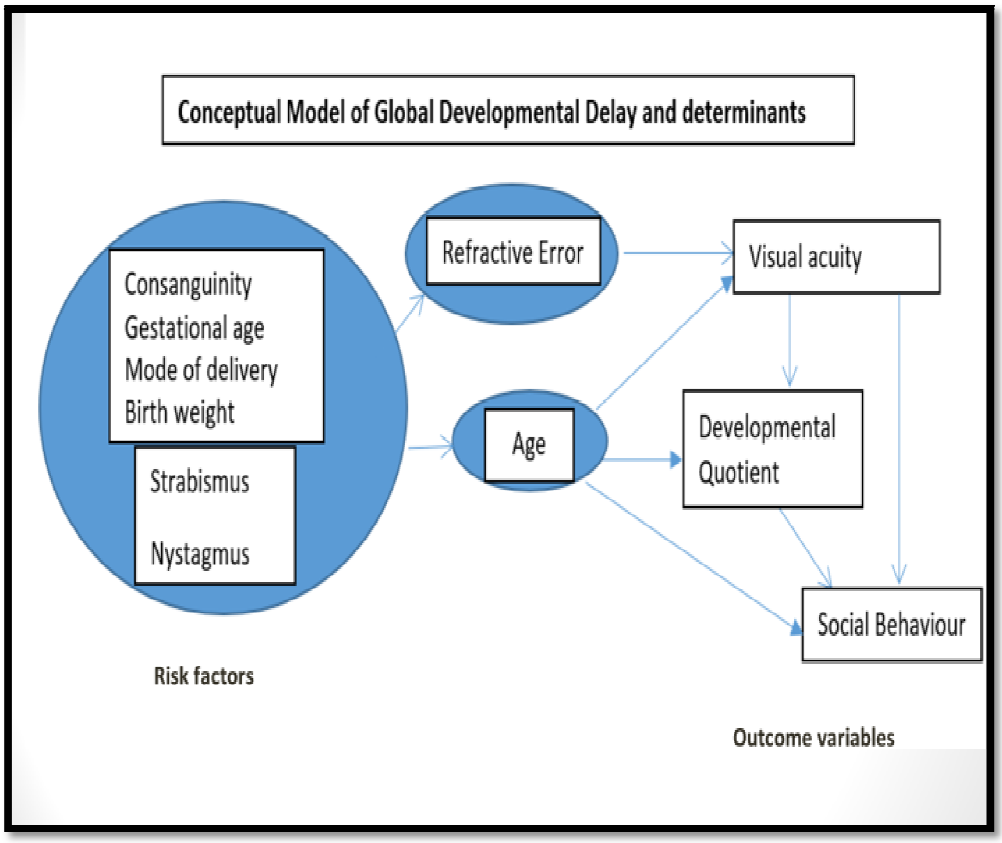
Collection and Analysis of Data

Information was collected using a standardized data collection form. All data collected in the study was electronically stored in Microsoft Excel sheet and coded. Data was password protected and subject information was available to restricted personnel. Final analysis of data of 100 children was done, after excluding children who were non-compliant with glasses (10) and children lost to follow up (4) at the time of reassessment, at six months. Quantitative variables like Refractive Error, Visual Acuity and DQ were converted into Interval Scale for analysis. As the number of children having profound ID was small, it was incorporated in the severe ID group for the analysis. In case of anisometropia, the eye with the higher refractive error was considered for analysis.

Chi square test was used for significance of explanatory variables in explaining Visual acuity, DQ and Social behavioral improvement after intervention. Statistical Package for Social Sciences (SPSS), Version 22.0, was used for data analysis.

Conceptual framework of the study:

Age and refractive error were the independent variables studied over the various risk factors. The dependent or outcome variables were visual acuity, developmental quotient and social behaviour.



4. RESULTS

This study was conducted in a tertiary care teaching hospital of North Karnataka from November 2013 to March 2017. The design was pre-post. Analysis was done for data of 100 GDD children with corrected refractive error. Evaluation was done for all variables in two age groups as: Combined age group (1-5 years) and separately for children under 2.5 years and at or above 2.5 years. Results were presented as Combined group and when the results in the two groups grossly differed, they were presented separately, as below.

Table 1: Developmental Quotient (DQ) by age

Age	Developmental Quotient (%)			
	Severe (≤35)	Moderate (35-50)	Mild (>50)	Total
<2.5 years	24(43)	22(39)	10(17.9)	56(100.0)
>2.5 years	7(15.9)	15(34.1)	22(50.0)	44(100.0)
Total	31(31.0)	37(37.0)	32(32.0)	100(100.0)

(Chi-Square:13.9; p < 0.001)

Table 1 reveals that severe ID prevalence was more in children less than 2.5 years (43%), whereas children with mild ID were more in age group above 2.5 years. (50%). Statistically significant distribution was seen. This was a hospital based study and the distribution would not be applicable to general population, and enrolment was done consecutively.

Table 2: Refractive Error by Gestational age

Gestation age	Refractive Error (%)			
	Myopia	**Hyperopia**	**Astigmatism**	**Total**
Preterm	**3(23.0)**	**9(69.2)**	**1 (7.7)**	**13(100.0)**
Term	**18(20.7)**	**62(71.3)**	**7(8.0)**	**87(100.0)**
Total	**21(21.0)**	**71(71.0)**	**8(8.0)**	**100(100.0)**

Table 2 reveals that out of the 100 babies, 13 were preterm whereas 87 were term babies. In both groups, hypermetropes were maximum. The number of pre term was too less to evaluate further, based on the sub-categorization of gestational age.

Table 3: Improvement in Vision by Gestation age

Gestation age	Improvement In Vision (%)			
	Deteriorated	**Remained same**	**Improved**	**Total**
Preterm	**4(30.8)**	**6(46.2)**	**3 (23.1)**	**13(100.0)**
Term	**3(3.4)**	**40(46.0)**	**44(50.6)**	**87(100.0)**
Total	**7(7.0)**	**46(46.0)**	**47(47.0)**	**100(100.0)**

(Chi square: 13.88; $p < 0.001$)

Table 3 reveals that Visual improvement was 50% in term, as compared to 23% in preterm born children, the differences were statistically significant. Deterioration in vision was significantly higher (31%) in preterm, when compared to 3% in term children.

TABLE 4: Refractive Error by Consanguinity

Consanguinity	Refractive Error (%)			
	Myopia	Hyperopia	Astigmatism	Total
Absent	9(16.7)	37(68.5)	8(14.8)	54(100.0)
Present	12(26.7)	34(73.3)	0(0.0)	46(100.0)
Total	21(21.0)	71(71.0)	8(8.0)	100(100.0)

Table 4 reveals that irrespective of consanguinity, hyperopia was more i.e., 73.3% in consanguineous and 68.5% in non-consanguineous marriage. Thus, consanguinity had no association with the type of refractive error. Myopes were more in children with history of consanguinity; though not statistically significant.

Table 5: Improvement in Vision by Consanguinity

Consanguinity	Improvement in Vision (%)		
	Remained same	Improved	Total
Absent	30(55.6)	24(44.4)	54(100.0)
Present	23(51.0)	23(49.0)	46(100.0)
Total	53(53.0)	47(47.0)	100(100.0)

Table 5 shows that improvement in non-consanguineous and consanguineous group was almost similar and not significant statistically. The history of consanguinity had no bearing on the outcome of refractive error correction.

Table 6: Strabismus (Visual Axis) by Refractive Error

Refractive Error	Visual Axis (%)			Total
	Orthophoria	Esotropia	Exotropia	
Myopia	15(21.7)	3(13.6)	3(33.3)	21 (21.0)
Hyperopia	48(69.6)	19(86.4)	4(44.4)	71(71.0)
Astigmatism	6(8.7)	0(0.0)	2(22.2)	8(8.0)
Total	69(100.0)	22(100.0)	9(100.0)	100(100.0)

Table 6 reveals that out of 100 babies, 69 had orthophoria, 22 esotropia and nine exotropia. 86.4% children with esotropia had hyperopia, but not statistically significant. Uncorrected hyperopia was the most common cause of esotropia. The distribution of exotropia was almost similar in all types of refractive errors.

Table 7: Developmental Quotient (Intellectual Disability) by Visual Axis

Visual Axis	Developmental Quotient (%)			
	Severe ID	Moderate ID	Mild ID	TOTAL
Orthophoria	22(32)	24 (34.8)	23 (33.3)	69 (100.0)
Esotropia	8 (36.4)	8 (36.4)	6 (27.3)	22 (100.0)
Exotropia	1(11.1)	5 (55.6)	3 (33.3)	9 (100.0)
Total	31(31.0)	37 (37.0)	32 (32.0)	100(100.0)

Table 7 reveals that esotropia was equally distributed in severe and moderate ID groups, whereas exotropia was more in moderate ID group. This had no statistical significance. As the study population was specific, with children who had GDD and refractive error, the percentage of squint was high, as compared to normal children without refractive error.

Table 8: Strabismus by Consanguineous marriage

Consanguinity	Visual Axis (%)			
	Orthophoria	Esotropia	Exotropia	Total
Absent	40 (74)	9(16.7)	5 (9.3)	54 (100.0)
Present	29(62)	13(28.9)	4(8.9)	46(100.0)
Total	69 (69)	22 (22)	9 (9.0)	100(100.0)

Table 8 reveals that though esotropia was more than exotropia in our study, differences were not statistically significant.

Table 9: Improvement in Vision by Visual Axis

Visual Axis	Improvement in Vision (%)		
	Remained same	Improved	Total
Orthophoria	38(55.0)	31(45.0)	69 (100.0)
Esotropia	11(50.0)	11(50.0)	22(100.0)
Exotropia	4(44.4)	5(55.6)	9(100.0)
Total	53(53.0)	47(47.0)	100(100.0)

Table 9 reveals no correlation between the improvement in vision and strabismus. In all the groups, approximately half the children improved. Thus, presence or type of squint was not significantly associated with visual improvement after correction.

Table 10: Nystagmus by Refractive Error

Refractive Error	Nystagmus (%)		
	Absent	Present	Total
Myopia	17(19.3)	4(33.3)	21(21.0)
Hyperopia	67(76.2)	4(33.3)	71(71.0)
Astigmatism	4(4.5)	4(33.3)	8(8.0)
Total	88(88.0)	12(12.0)	100(100.0)

Chi square: 14.65; p < 0.001

Table 10 reveals a statistically significant association between babies having refractive error with nystagmus. All types of refractive errors had nystagmus. Nystagmus was due to the low vision caused by refractive errors, rather than the type of refractive error causing it.

Table 11: Developmental Quotient (DQ) by Birth Weight

DQ	N	Mean	Std. Deviation
Severe	31	2767.71	1464.733
Moderate	37	3812.00	2827.287
Mild	32	3010.91	1365.528
Total	100.0	3231.92	2085.615

Table 11 reveals that the mean weight was above 2500 g in all groups and hence, no significant association was found between the low birth weight children and the severity of ID. 26 children had birth weight below normal.

Table 12: Improvement in Vision by Birth Weight

Birth Weight(g)	Improvement in Vision (%)		
	Remained same	Improved	Total
Very LBW (<2000)	6(66.7)	3(33.3)	9(100.0)
LBW (2000-2499)	12(70.6)	5(29.4)	17(100.0)
NORMAL (2500+)	35(47.3)	39(52.7)	74(100.0)
Total	53(53.0)	47(47.0)	100(100.0)

Table 12 reveals that visual improvement was seen in 52.7% of normal birth weight children compared to around 30% in low and very low birth weight babies. Vision in 71% of LBW and 67% of VLBW remained the same, irrespective of the type of refractive error. This was not statistically significant, owing to the small number of low birth weight children.

Table 13: Improvement in Vision by Mode of Delivery

Mode of Delivery	Improvement in Vision (%)		
	Remained same	Improved	Total
Normal	44(51.8)	41(48.2)	85(100.0)
Caesarian section	9(60.0)	6(40.0)	15(100.0)
Total	53(53.0)	47(47.0)	100(100.0)

Table 13 reveals that maximum cases had normal delivery and improvement noted was more in that group, but was not significant as the number was less in caesarian section group. The forceps delivery cases were merged with normal delivery for analysis. On sub categorization, least improvement was seen in forceps delivery cases, followed by caesarean section group.

Table 14a: Developmental Quotient by Refractive Error in age < 2.5 years

Refractive Error	Age <2.5 years Developmental quotient (%)			
	Severe ID	Moderate ID	Mild ID	Total
Myopia	3(33.3)	3(33.3)	3(33.3)	9(100.0)
Hyperopia	19(43.2)	19(43.2)	6(13.6)	44(100.0)
Astigmatism	2(66.7)	0(0.0)	1 (33.3)	3(100.0)
Total	24(42.9)	22(39.3)	10(17.9)	56(100.0)

Table 14b: Developmental Quotient by Refractive Error in age ≥2.5 years

Refractive error	Age ≥2.5 years Developmental quotient (%)			
	Severe ID	Moderate ID	Mild ID	Total
Myopia	1(8.3)	3(25.0)	8(66.7)	12(100.0)
Hyperopia	5(18.5)	11(40.7)	11(40.7)	27(100.0)
Astigmatism	1(20.0)	1(20.0)	3 (60.0)	5(100.0)
Total	7(15.9)	15(34.1)	22(50.0)	44(100.0)

Table 14c: Developmental Quotient by Refractive Error (1-5 years)

Refractive Error	Developmental Quotient (%)			
	Severe ID	Moderate ID	Mild ID	Total
Myopia	4(19.0)	6(28.6)	11(52.4)	21(100.0)
Hyperopia	24 (34.0)	30(42.0)	17(23.9)	71 (100.0)
Astigmatism	3(37.5)	1 (12.5)	4 (50.0)	8 (100.0)
Total	31(31.0)	37(37.0)	32(32.0)	100(100.0)

Table 14 (a-c) reveals that in children under 2.5 years who were evaluated by DASII, the pattern of distribution of refractive errors showed that errors were more in severe ID: 42.9%, followed by the moderate group: 39.3% and less in mild ID 17.9%. Hypermetropia was more in all groups.

In children of age 2.5 years and above, mild ID had maximum number of refractive errors: 50%, which was different from the pattern in children under 2.5 years old.

Hence, overall evaluation showed equal distribution of refractive errors in all grades of DQ. Hyperopes were more in all the grades, followed by myopes.

Table 15: Improvement in Vision by Refractive Error

Refractive Error	Improvement in Vision (%)		
	Remained same	Improved	Total
Myopia	**6(28.6)**	**15(71.4)**	**21(100.0)**
Hyperopia	**42(59.2)**	**29(40.8)**	**71(100.0)**
Astigmatism	**5(62.5)**	**3(37.5)**	**8(100.0)**
Total	**53(53.0)**	**47(47.0)**	**100(100.0)**

Table 15 reveals that though hyperopes were more in number, improvement was more in myopes (71.4%). $P < 0.041$. Myopes were more in the mild ID group and improvement was more in mild group. Thus, irrespective of the type of refractive error, improvement seen was in children with mild ID.

Table 16a: Developmental Quotient by Improvement in Vision (in <2.5 years)

AGE (<2.5 YEARS)			
DQ	Improvement in Vision (%)		
	Remained same	Improved	Total
SEVERE ID	17(70.8)	7(29.2)	24(100.0)
MODERATE ID	10(45.5)	12(54.5)	22(100.0)
MILD ID	3(30.0)	7(70.0)	10(100.0)
TOTAL	30(53.6)	26(46.4)	56(100.0)

Chi Square: 5.692; p< 0.058

Table 16b: Developmental Quotient by Improvement in Vision (≥2.5 years)

AGE (≥2.5 YEARS)			
DQ	Improvement in Vision (%)		
	Remained same	Improved	Total
SEVERE ID	6(85.7)	1(14.3)	7(100.0)
MODERATE ID	10(66.7)	5(33.3)	15(100.0)
MILD ID	7(31.8)	15(68.2)	22(100.0)
TOTAL	23(52.3)	21(47.7)	44(100.0)

Chi-Square: 8.073; p < 0.018

Table 16c: Developmental Quotient by Improvement in vision (1-5 Years)

DQ	Improvement in Vision (%)		
	Remained same	**Improved**	**Total**
SEVERE ID	**23(74.2)**	**8(25.8)**	**31(100.0)**
MODERATE ID	**20(54.0)**	**17(46.0)**	**37(100.0)**
MILD ID	**10(31.3)**	**22(68.8)**	**32(100.0)**
TOTAL	**53(53.0)**	**47(47.0)**	**100(100.0)**

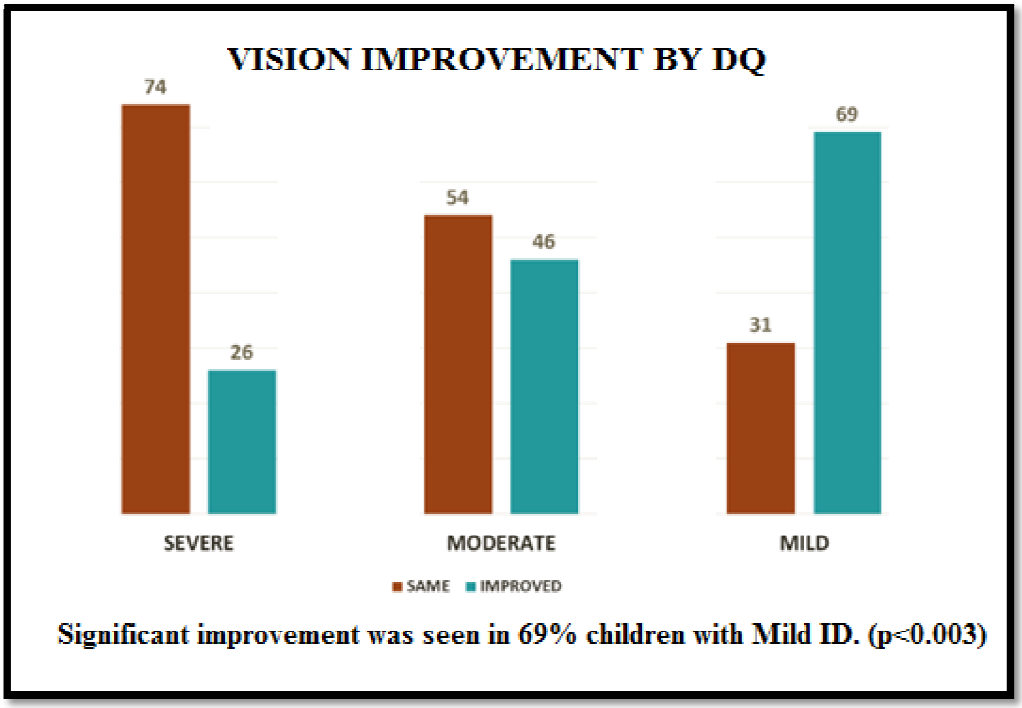
Chi-Square: 11.68; p< 0.003

Table 16a reveals that improvement was more in moderate and mild groups. 70% children in the mild ID group improved in the age group of <2.5years.

Table 16b reveals improvement in 68% of the mild group in children ≥2.5 years.

Table 16c reveals that overall 47 % showed improvement which was statistically significant. Around 69% improved in the mild ID group. In all groups, mild ID group showed maximum improvement. Better the DQ, more was the improvement seen in vision.

Graph 1: DQ by Improvement in vision (1-5 Years)



Significant improvement was seen in 69% children with Mild ID. (p<0.003)

Table 17a: Improvement in Vision by Social Behaviour

Social Behaviour	Improvement in Vision (%)		
	Remained same	Improved	Total
No change	37(82.2)	8(17.8)	45 (100.0)
Improved	16(29.0)	39(71.0)	55 (100.0)
Total	53(53.0)	47(47.0)	100(100.0)

Chi-Square: 28.04; p < 0.000

Table 17a reveals that out of 47 children who showed improvement in vision, 39 showed improvement in social behaviour. 71% of children with visual improvement, showed significant functional improvement. These changes were evident in their daily activities and affected their overall performance.

Table 17b: Social Behavioural change by Age

Social Behaviour	<2.5 years (%)	≥2.5 years (%)	Total
No change	26(57.8)	19(42.2)	45 (100.0)
Improved	30(54.5)	25(45.5)	55 (100.0)
Total	56 (56.0)	44 (44.0)	100(100.0)

Table 17b reveals that social behavioural improvement was seen in around 50 % of children in each age group. There was no significant change in the social behaviour between the two age groups, ruling out the age effect.

Table 17c: Developmental Quotient (DQ) by Social behavioural change

Social behaviour	DQ (%)			Total
	Severe	Moderate	Mild	
No change	21(46.7)	16(35.6)	8(17.8)	45 (100.0)
Improved	10(18.2)	21(38.2)	24(43.6)	55(100.0)
Total	31(31.0)	37(37.0)	32(32.0)	100(100.0)

Table 17c reveals that improvement in social behaviour was more with improved DQ levels. Severe ID: 18.2% < Moderate ID: 38.2% < Mild ID 43.6%

Children with better DQ showed more improvement in social behaviour. Mild and moderate ID groups, together constituted around 82% of improvement.

Table 18a: Post by Pre: Developmental Quotient (<2.5 years)

Age (<2.5 years)				
PRE DQ	**POST DQ (%)**			
	Severe	**Moderate**	**Mild**	**Total**
Severe	**19 (79.2)**	**3 (12.5)**	**2 (8.3)**	**24(100.0)**
Moderate	**4 (18.2)**	**11 (50.0)**	**7 (31.8)**	**22(100.0)**
Mild	**0(0.0)**	**1 (10.0)**	**9 (90.0)**	**10(100.0)**
Total	**23 (41.0)**	**15 (26.8)**	**18 (32.1)**	**56(100.0)**

Chi-Square :37.34; p < 0.000

Table 18a reveals that in severe ID group, 21 % and in moderate ID group, 32% improved. In Mild ID group, 90% remained constant. Overall 21.4% showed clinically and statistically significant improvement in DQ in <2.5 years group.

Table 18b: Post by Pre: Developmental Quotient (≥2.5years)

Age (≥2.5 years)				
PRE DQ	**POST DQ (%)**			
	Severe	**Moderate**	**Mild**	**Total**
Severe	**6(85.7)**	**1 (14.3)**	**0(0.0)**	**7(100.0)**
Moderate	**0 (0.0)**	**14 (93.3)**	**1 (6.7)**	**15(100.0)**
Mild	**0(0.0)**	**0 (0.0)**	**22 (100.0)**	**22(100.0)**
Total	**6 (13.6)**	**15 (34.1)**	**23 (52.3)**	**44 (100.0)**

Chi-Square: 74.67; p < 0.000

Table 18b reveals that in severe ID group, 14 % and in moderate, 6.7 % showed improvement. Overall 4.5% improved in DQ in above 2.5 years group. The pattern changed in the older group, where severe ID showed more improvement than moderate. However, mild ID group remained unchanged.

Table 18c: Post by Pre-intervention Developmental Quotient (1-5 years)

PRE DQ	POST DQ (%)			
	Severe	Moderate	Mild	Total
Severe	25(80.6)	4(12.9)	2 (6.5)	31(100.0)
Moderate	4 (10.8)	25 (67.6)	8 (21.6)	37(100.0)
Mild	0(0.0)	1 (3.1)	31 (96.9)	32(100.0)
Total	29(29.0)	30(30.0)	41(41.0)	100 (100.0)

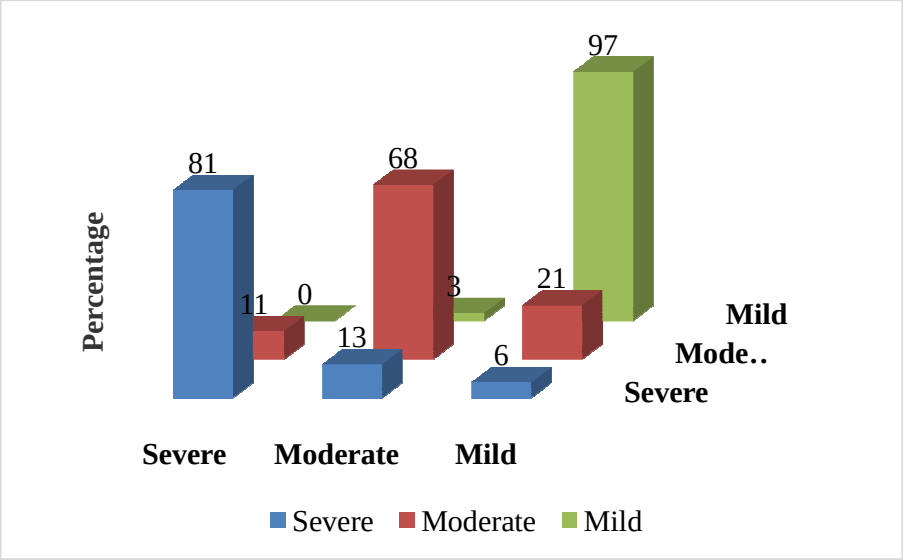
Chi square: 106.92; p < 0.000

Table 18c reveals that in the combined age group, 19.4% in severe ID group and 21.6% in moderate ID group improved. Moderate group showed maximum improvement.

(**<2.5 years group – 21.4% / ≥2.5 years group – 4.5%).

Overall improvement in DQ in children from 1 to 5 years: 14%. These changes in DQ, observed post intervention, after six months duration, were clinically and statistically significant.

Graph 2: Post by Pre-intervention Developmental Quotient (1-5 years)



5. DISCUSSION

The present study titled "**Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay**" was conducted in a tertiary care teaching hospital of North Karnataka from November 2013 to March 2017. A total of 100 children with GDD and refractive error were given refractive correction. Reassessment at six months follow up was done for Visual acuity and Developmental Quotient. Information regarding the change in behaviour was collected from the parent using the Post-test questionnaire. Discussion was done under the following headings:

5.1. GDD, Refractive Error and its determinants:

The present study consisted of 56 children below 2.5 years age and 44 children above or equal to 2.5 years. Among them, 45 were girls and 55 were boys.

Mackie et al (1998) studied refractive errors in the age range of 1 to 17 years. They found that refractive errors were more prevalent in children older than 5 years. [89] An American study (2008) proposed that the outcome variables in normal children during the first few years changed drastically with age, and this might apply to children with global developmental delay (GDD). [58] A South Indian study (2007) found that refractive errors changed with age. Study of higher range of age revealed a large number of changes. This study advised small age-appropriate groups to study the refractive errors and its determinants. [85] Hence, the unexplored area of children in the age group of one to five years was evaluated in this study. Further, evaluation of all variables was done as combined age group (1-5 years) and separately for children under 2.5 years/ 2.5 years and above.

Refractive error distribution in both the groups was significant. Refractive errors in the younger age group, were more in the severe ID group (43%) and less in the mild group (18%), which corresponds with other Indian studies (2011) [90]. This confirms the theory of better neurological development in cerebral association areas in milder GDD, leading to lesser errors. However, in older children, maximum number of children with refractive errors were seen in mild ID group (50%), which was different from the pattern in the younger group and other study results. The likely explanation of this being that, as it is a hospital-based study and not community based one, parents enthusiastic in the initial years, lose hope or enthusiasm leading to reduced patient follow up, in children with severe and profound ID. This stresses the need for counselling and creating awareness in parents about the importance of follow up care, as these children grow up.

The present study found myopia in 21%, hyperopia in 71% and astigmatism in 8% children. The study in Shanghai (2016) found low prevalence of myopia in 3 to 5 years, but increasing prevalence after 6 years, suggesting a strong environmental role of schooling on development of myopia. [91] A meta-analysis in 2017 done on normal children, reported astigmatism as the most common refractive error, followed by hyperopia and the least common was myopia. [92] Refractive errors were four times higher in children with disabilities than those in neurologically normal age matched children. [93] The Indian study done in 2007, on children with periventricular leukomalacia (PVL), stated that myopia started by the age of four years. [85] Arsen et al found 40% hyperopia, 21% astigmatism and 46% myopia. [58] Prevalence of hyperopia was 47%, myopia 41% and astigmatism 10% in a handicapped children house. [94] Distribution of hyperopia was similar in the present study, being more in moderate ID group (55%), followed by severe ID group (41%). But the distribution of

astigmatism and myopia were unlike the present study (which were more in mild ID group). In all the groups, hyperopes were maximum (71 %), but this was not statistically significant. The range of refractive errors was large (-7 D to +5.5 D). The distribution in majority of children was low to moderate hyperopia. However, the presence of moderate and high myopia, lead to an increased refractive error range.

In this study, cerebral palsy was the most common cause, found in 40 children, followed by syndromic causes like Down syndrome, Seckel syndrome and miscellaneous like mitochondrial dystrophy in 12 children. Though in 48 children, in spite of rigorous work-up the cause could not be identified. Watson et al expected that visual outcome depended on the etiology of CVI, but surprisingly found no relationship between the etiology and improvement in visual function, similar to this study. [77]

Out of 13 preterm babies, only two had periventricular leukomalacia (PVL). Hyperopes were in majority in both term and pre-term children. In a study done on preterm babies without GDD, incidence of hypermetropia was more. [95] Gestation and incidence of refractive errors showed an inverse relationship. A study on cerebral palsy children, compared refractive errors in preterm with term and showed no statistical significant difference between the two groups for hyperopia, myopia and emmetropia, similar to this study. The preterm group showed a significant increase in astigmatism. According to them, prematurity is not an added risk for refractive error development. [66]This study showed a higher prevalence of hyperopia, irrespective of consanguinity.

A study on cerebral palsy found strabismus in 50% of the subjects, whereas in the general population it was 3%. They attributed this high incidence to lesions in the sub

cortical oculomotor center or cerebellum which disrupt binocular vision. [96]Disrupted binocular vision hinders the learning process. A South Indian study found 81.6% strabismus (esotropia in 58%) and 36.8% nystagmus. The high prevalence was due to these studies being done in specific populations. [85] Many studies estimated the range from 14 to 39%. [58,61,97,98]

The percentage of strabismus and nystagmus were more in our study, as the study population was children having refractive errors (31% and 12% respectively). A study on Down syndrome found that 10 out of 11 strabismus cases had esotropia with a high prevalence of hyperopia, similar to the present study. [99] But an Indian study with 15.7 % strabismus showed exotropia in 54% children. [90]

Children with strabismus had a mean IQ lower than those without. [90] There was a significant correlation between refractive errors and strabismus with that of low IQ. [100] An Indian study showed no association between severity of mental retardation, strabismus and refractive error,[101]similar to the present study. Distribution of esotropia was similar in all types of disability. However, study with a larger sample could suggest a definitive pattern.

A study on normal children showed that strabismus (esotropia) was more in consanguineous couples. [73] Though esotropia was more than exotropia in our study, difference was not significant between consanguinity and squint, similar to an Egyptian study done on normal school going children. [102]

5.2. Improvement in vision after intervention

Spectacles were prescribed and the children were followed up according to the protocol. Accommodation was within a normal range of +0.5D to 0.75D in moderate hyperopes and in cases of corrected high myopes. According to Brookman, no correlation was found between accommodation and refractive error, except in highly hyperopic kids. [103] In this study, only four cases with hyperopia of more than 4 D had a lag of 1D. As this is a borderline lag and these children had minimal visual performance in sitting position, near correction was not advised.

Compliance for spectacle wear was 91% in this study. This high positive response was the result of parental counselling stressing on the impact of good vision on the overall development of the child. They were also counselled regarding the right "critical" age to correct vision, resulting in maximum benefit. However, compliance was judged on the basis of availability of spectacles on the child, at the time of hospital visit and parents substantiating the same.

On comparing the birth weight, 26 children were born below normal weight. The mean weight was above 2500 g in all groups and hence, no significant correlation with developmental quotient was found. Studies showed that low birth weight lead to increase in myopia. Astigmatism also showed significant positive correlation with birth weight. [95] But, hyperopia was more in this study. In this study, visual improvement was seen in 53 % of normal weight babies, as compared to less than 34 % in low weight babies. However, it was not statistically significant owing to the small number of low birth weight children.

On evaluating the mode of delivery, forceps delivery cases which were merged with normal delivery cases, because of the small number, showed less improvement compared to others.The improvement in vision and **consanguinity** had no statistically significant association. Moreover, there was no significant difference between **type of squint** and visual improvement.

Preterm children with cerebral palsy had visuo-perceptual impairment (VPI), i.e., difficulty in processing and analyzing complex visual information. [104]Poorer visual outcome was seen in preterm with optic radiation injury, than visual cortex injury seen in term babies, because of lack of nerve fiber plasticity in optic radiation compared to cortical neurons. [105] Critical developmental period insult in premature infants lead to extensive visual pathway damage. [106] Low birth weight preterm children without GDD, at 8 years of age, received a 3 -year intervention from birth to 3 years. They showed a moderate difference related to the intervention in both cognitive and academic skills; but reduction in these effects on discontinuing the intervention was noted. [107] In the present study, visual improvement was 50% in term, as compared to 23% in preterm born children, the differences were statistically significant. Moreover, 30% pre-term children showed deterioration in vision in comparison to 3% term children. This could be associated with the fact that majority of children born preterm where falling in the profound and severe ID group, who showed very less improvement or deterioration in vision. Thus, preterm children with GDD would need aggressive and continued intervention. Further, sub-categorization of pre-term needs to be studied.

5.2.1. Improvement in vision by Refractive error

Improvement in vision in myopes was observed in 15 (71%) children compared to 29 (41%) hyperopes. Myopes were more in the mild ID category. Though the improvement was not statistically significant, it can be observed that as majority of hyperopes were in the severe ID group, improvement is slower or less in children with low DQ. Amblyopia could also be an affecting factor. Visual development has a sensitive or critical period. Any abnormal visual experience during this period causes amblyopia. Hyperopia until the age of 4 years caused amblyopia in children. [108,109] Normal developmental regulation towards emmetropia was not impaired by early correction of this hyperopia.[110]This implies that sustained efforts and follow up for longer period could show improvement in children with lower DQ. Moreover, the distribution in myopia and hyperopia group was unequal, to draw a valid conclusion regarding which refractive error shows more improvement. As visual improvement was noted more in relation to the grading of DQ (as in, myopes with mild ID improved more than hyperopes in severe ID), it can be observed that, irrespective of the type of refractive error, the baseline DQ levels determine the amount of improvement. Better the DQ, more the visual improvement.

5.2.2. DQ by Improvement in vision

Based on a Pune study, one fourth (26.4%) of children with learning disabilities in the age group of 1- 16 years had improved vision with refraction and became socially active. [90] In a retrospective study done on CVI patients, 49% showed improvement in vision with correction, after a mean duration of 6.5 years. [77] It revealed no statistical relationship between the age and change in visual acuity. A questionnaire-based study found that the youngest age group of 0-6 years showed maximum

improvement. [7]In the present study, 47% children showed clinically and statistically significant improvement in vision. Unlike other studies, irrespective of the age group, visual improvement was more in mild ID group (69%) than in severe ID (26%) group. Observations were made that children with better DQ were the ones who responded faster to the visual correction. According to Bader (1980), mild or borderline category was usually the socio-culturally deprived children and they had a better chance of improvement after correction, than the severe category. The better development of cerebral association areas in mild ID could also be an explanation for this improvement. The present study proved that children with mild ID had improvement in their functional vision and in DQ test scores. Longer follow up might be needed to achieve the same amount of change in the lower DQ groups.

5.2.3. Social behavior

Evaluation based on questionnaire revealed that, parents perceived an evident change in the social behavior of the children. In cases where only few questions in the questionnaire reported a positive change, were not reflected in the quantitative analysis. Nevertheless, parents were happy with the changes seen in their child's temperament. This highlighted the effect of improved sensory input, which made the world around them clear and better. The questionnaire based on motor and behavioral activities found a significant improvement in social behavior of children whose vision improved after correction. Out of 47 who showed improvement in vision, 39 (71 %) of them showed improvement in social behavior, which was clinically and statistically significant. Age related change in behavior was not significant, stressing the importance of intervention in these formative years. This was one of the few studies quantifying and associating the improvement in behavior with DQ. Children with

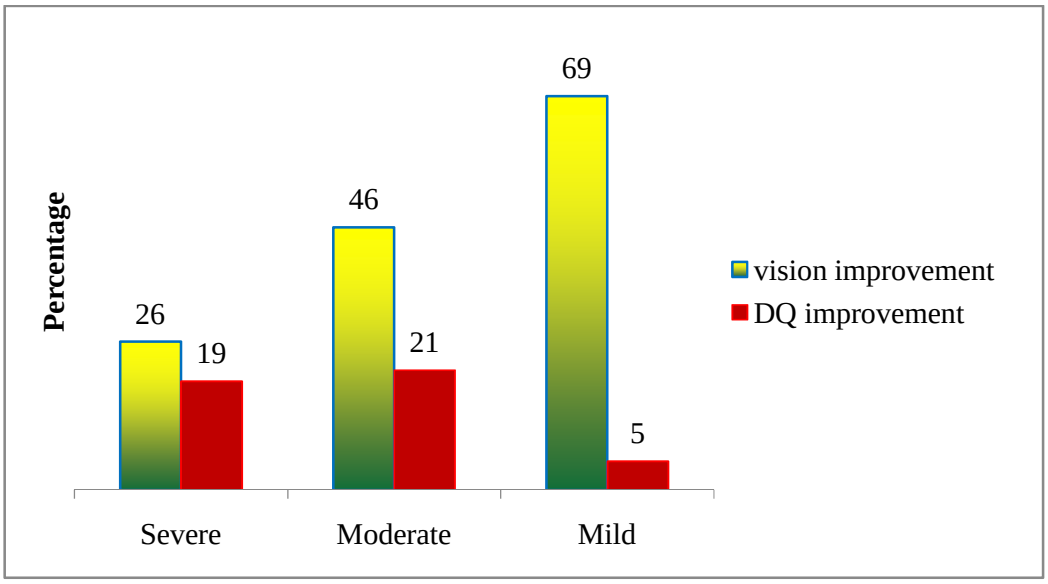
mild ID improved grossly in social behavior (44%), followed by moderate ID. This followed the pattern of improvement in vision and can be attributed to betterment of functional vision. A simple intervention had a significant impact on the functioning of the child on a daily basis.

5.2.4. Post by Pre-intervention Developmental Quotient

In children below 2.5 years, in the mild ID group, 1(10%) deteriorated to moderate ID, rest were remarkably constant. Overall 12 (21.4%) showed improvement in DQ.

In children above 2.5 years, in the mild group, 1(5%) improved to borderline on sub grouping. Overall 2 (4.5%) improved. Thus, in the younger children, improvement was more in the moderate ID group after refractive error correction (32%), than in other groups. In the older children, improvement was more in the severe group (14%). On evaluating the combined age group, overall improvement in DQ was statistically significant at 14 %, rejecting the null hypothesis.

Graph 3: Improvement in DQ in relation to improvement in vision



Mild ID group showed improvement in vision in 22 (68.8%) while DQ remained largely constant. But deterioration was very less compared to other groups, proving that the maximum capacity had been attained in them. The need of these children was functional improvement. Though, visual growth occurred, neural plasticity came down and the scope of exponential improvement in DQ via intellectual development reduced. This was the most likely explanation for minimal DQ improvement in spite of maximum visual improvement in the mild ID group. The improvement seen in severe ID group could be explained by the Watson et al theory of "**more room for improvement**". Watson et al study concluded that the worse vision group improved better than the initially better vision group. [77] They found that the worse group had "more room for improvement" which lead to greater change. They also said that the better vision group was expected to show substantial improvement which didn't occur. The findings in the present study substantiate this theory. The effect of improvement in functional vision on overall intellectual development and efficiency of the child are immense. Bader and Woodruff study showed improvement in the new

glass group and in the youngest age group (0-6 years). [7] They reviewed the effects in behavior qualitatively, after two months of glasses and concluded that improvement in the ability to walk, grasp objects, etc. was not due to maturation. This holds good for the present study too, as the follow up period was of six months.

Our study deduced that spectacles change the spatial perceptions and thus result in improvement in DQ. It proved the hypothesis that more change occurs in the younger age groups. Significant age effect was seen as the younger group improved more than the older.

A 2018 review report concluded that the treatment goals in these children were changing and the concentration was on “Deinstitutionalization” and “Mainstreaming”. [111] This study was a step towards achieving this goal and focused on quantitative evaluation of DQ improvement in relation to visual improvement.

6. CONCLUSION

The youngest age group of 1-5 years was studied exclusively, after giving refractive correction and assessment was done for visual acuity, intellectual development via DQ and social behavioral changes. The improvement seen in the short span of six months could not be attributed to maturation. It was seen that as age increased, the amount of improvement decreased, proving the age effect. Thus, confirming the fact that the earlier the intervention, greater the improvement in their DQ. The younger age group with severe ID improved better with intervention, as neural plasticity was better. Even in the children with persistent delay, the functional outcome improved, implying that children were able to adapt better to their environment. In spite of severe neuro-ophthalmological damage in these children and difficulty in quantifying visual acuity, prolonged observation showed that visual perception was conserved. Hence, it was important to persevere and continue to habilitate and rehabilitate.

The multifaceted therapy in children with GDD was costly. It includes multidisciplinary integrated approach such as educational resources, occupational therapy, speech and language therapy, social service intervention. Harmful effects of sensory visual deprivation on the development and functioning could be dampened by spectacles therapy. This was a simple and easily available cost-effective strategy. Also, from a Pediatrician's view point, in the mild and moderate ID group, significant cognitive improvement leads to increased scholastic performance, getting these children into mainstream.

In the backdrop of increasing neurological cases in Indian scenario, the cause of which is multi factorial like poor parental care, consanguinity and nutritional issues, this study stressed on the need for awareness among the treating pediatricians,

ophthalmologists and parents/care takers regarding early ophthalmic care. Hence, in children having global developmental delay and refractive errors, mandatory refraction and prescribing glasses at an early age creates a positive impact on functional vision and scholastic aptitude.

7. LIMITATIONS

Although children with incomplete medical records were excluded from the study (to reduce bias), there still remains a possibility of recall bias, as data on prenatal and perinatal risk factors were collected retrospectively.

Lack of comparable numbers in various types of refractive errors, term-preterm children and different modes of delivery limited the comparative analysis of these variables.

The presence of a control group would have boosted the results. However, it was not ethically feasible and hence, pre post design was adopted.

Compliance for duration of wearing glasses was based on the parents' observations.

Visual evaluation was based on the child's eye-neck movement. Thus, motor co-ordination of the eyes and neck was essential and a low motor ability would give a false negative test.

Overall treatment of the child was multi factorial. Though caution was excised to reduce confounding factors, it was not possible in such cases to completely exclude the co-morbidities.

8. RECOMMENDATIONS FOR FUTURE RESEARCH

- Further studies comparing the different types of refractive error, within the various grades of GDD, with long term follow up is suggested.
- The timing of actual testing in children with GDD needs to be addressed, as to the right age at which the yield would be optimal.
- Sub categorization of pre-term children, on the basis of gestational age, with more number in each group needs to be studied.
- Also, the influence of maternal health and education, the aspects of quality of life and social support by the family need to be addressed.

9. IMPLICATIONS

These results are useful in clinical management of GDD, by providing quantitative information regarding visual impairment and chances of improvement.

It provides assistance in setting up guidelines for early childhood intervention programs by schools and rehabilitation work by social agencies. It alleviates parental anxiety and helps in genetic counselling.

In this view, implementing mandatory quantitative evaluation of visual acuity and refractive correction in children with GDD, would go a long way in the overall development of the child. The child can benefit from Individualized Education Plan (IEP) provided based on these evaluations.

10. SUMMARY

GDD, a chronic condition of early onset developmental disabilities, has disturbances in the attainment of motor, cognitive or language and social skills. This has a continuous and significant impact on the child's development. By definition, "GDD is a significant delay (at least 2 SD below mean) in at least two of the following major Developmental Domains

1. Gross and Fine motor
2. Speech and Language
3. Cognition
4. Social and Personal Development
5. Activities of Daily Living.

Typically, a delay in two domains implies delay across all domains".

This is a new paediatric morbidity on the rise. This puts a huge emotional, economic and social burden on the individual, family and the society at large.

Children with GDD had associated sensory deficits such as primarily visual defects, largely leading to their poor performance. The poor performance was wrongly attributed to their poor IQ and lead to improper grading of their disability. Studies showed that without any intervention, these children continued to fare poorly in their developmental age. The main aim was to deinstitutionalise these children and bring them to mainstream. There were studies on the prevalence of visual defects, especially refractive error in these children. Refractive error was ten-fold more than in normal children. This called for timely intervention, i.e., in their critical formative years.

Though children were more receptive in the first five years, this area was relatively unexplored.

This study attempted to intervene, correct the refractive errors and observe the change in their developmental quotient and social behaviour. The null hypothesis was “there will be no improvement in DQ and social behaviour after refractive error correction”. The outcome variables were visual acuity, DQ and social behavioural changes.

The sample consisted of 56 children below 2.5 years age and 44 children above or equal to 2.5 years. 45 were girls and 55 of them boys. Children in the younger age group with refractive errors were more in the severe ID group, than mild and moderate ID groups. This confirmed the theory of better neurological development in cerebral association areas in milder GDD.

After refractive correction, significant visual improvement in response to refractive correction in term children was seen, when compared to preterm. Thus, preterm children with GDD need aggressive and continued intervention. Significant improvement in visual acuity was seen in 47% children. Irrespective of the age group, mild ID group improved the most and least improvement was seen in severe ID group. Observation could be made that children with better DQ were the ones who responded faster to visual correction.

Out of 47children who showed improvement in vision, 39 (71 %) of them showed improvement in social behaviour, which was clinically and statistically significant. Age related change in behaviour was not significant, upon the importance of intervention in the formative years. This was one of the few studies quantifying and associating the improvement in behaviour with DQ. Children with mild ID improved

grossly in social behaviour, followed by moderate ID. This followed the pattern of improvement in vision and could be attributed to betterment of functional vision.

On evaluating the combined age group, the overall improvement in DQ was statistically significant at 14 %, rejecting the null hypothesis. Mild ID group showed visual improvement in up to 69%, but the moderate and severe groups showed better improvement in DQ. This paradox, minimal DQ improvement, in spite of maximal visual improvement was explained by the Watson theory of "more room for improvement" i.e., the limit of neural plasticity of the cortex in these subjects, who had a primary cerebral damage, limited the exponential improvement in DQ. Further, though improvement was less, deterioration was also less in this group, proving that the maximum capacity to improve had been attained. These children would need functional improvement, so that they show scholastic improvement and thus, join the mainstream. Though visual improvement and functional vision were reported in few questionnaire-based studies, quantitative evaluation of DQ improvement in relation to visual improvement was an unexplored area. This study focused on that lacuna and found that null hypothesis was rejected. Vision improved in the mild group, irrespective of the age, leading to improvement in social behaviour.

Earlier, the concept was, most of these children would not become productive members of society and would need institutionalized care. Health care cost was also gross. But this study showed otherwise. With intervention, the younger age groups with severe ID showed more improvement, as neural plasticity was better. Earlier the intervention, greater the improvement in their DQ. Even in children with persistent delay, the functional outcome was better. This implied that children were able to adapt better to their environment.

In spite of severe neurological and neuro ophthalmological damage and difficulty in quantifying the visual acuity, prolonged observation shows conservation of visual perception in these children. Hence, it is important to persevere and continue to habilitate and rehabilitate. This study stressed on the need for awareness among the treating Paediatricians, Ophthalmologists and parents regarding early and mandatory ophthalmic examination. The multifaceted therapy in children with GDD is costly. Simple, cost-effective strategy is spectacles which makes a spectacular positive impact, in case of children with GDD.

11. BIBLIOGRAPHY

1. Shevell M. Global developmental delay and mental retardation or intellectual disability: conceptualization, evaluation, and etiology. Pediatr Clin North Am. 2008 Oct;55(5):1071-84.
2. Rydz, D., Shevell, M. I., Majnemer, A., & Oskoui, M. (2005). Topical Review: Developmental Screening. *Journal of Child Neurology*, *20*(1), 4–21.
3. Shevell M, Majnemer A, Platt RW, Webster R, Birnbaum R. Developmental and functional outcomes at school age of preschool children with global developmental delay. J Child Neurol. 2005 Aug;20(8):648-53.
4. Luckasson R, Borthwick-Duffy S, Buntinx W H E, Coulter D L, Craig E M, et al. The AAMR AD HOC Committee on Terminology and Classification. Mental retardation: Definition, classification, and systems of supports. 10th ed. Washington DC, US: American Association on Mental Retardation. 2002.
5. Shevell M, Ashwal S, Donley D, Flint J, Gingold M, Hirtz D, et al. Practice parameter: evaluation of the child with global developmental delay: report of the Quality Standards Subcommittee of the American Academy of Neurology and The Practice Committee of the Child Neurology Society. Neurology. 2003. Feb 11;60(3):367-80.
6. Boyle CA, Yeargin-Allsopp M, Doernberg NS, Holmgreen P, Murphy CC, Schendel DE. Prevalence of selected developmental disabilities in children 3-10 years of age: the Metropolitan Atlanta Developmental Disabilities Surveillance Program, 1991. MMWR CDC Surveill Summ. 1996 Apr 19;45(2):1-14.

7. Bader D, Woodruff ME. The effects of corrective lenses on various behaviours of mentally retarded persons. Am J Optom Physiol Opt. 1980 Jul;57(7):447-59.

8. Salt A, Sargent J. Common visual problems in children with disability. Archives of Disease in Childhood. 2014;99:1163-1168.

9. Johnson RA,Zaba JN. The visual screening of adjudicated adolescents. Journal of Behavioral Optometry. Vol 10, No 1, 1999.

10. Troilo D. Neonatal eye growth and emmetropisation—A literature review. Eye. 1992;6(2):154-160.

11. McBrien NA, Barnes DA. A review and evaluation of theories of refractive error development. Ophthalmic Physiol Opt. 1984;4(3):201-13.

12. Warburg M. Why are the blind and severely visually impaired children with mental retardation much more retarded than the sighted children? Acta Ophthalmol Suppl. 1983;157:72-81.

13. Wolf M, Risley T, Mees H. Application of operant conditioning procedures to the behaviour problems of an autistic child. Behaviour Research and Therapy. 1963;1(2-4):305-312.

14. Levy B. Incidence of Oculo-Visual Anomalies in an Adult Population of Mentally Retarded Persons. Optometry and Vision Science. 1984;61(5):324-326.

15. Seal A, Robinson G, Anne M. Children with Neurodevelopmental Disabilities: The Essential Guide to Assessment and Management. Kelly and Jane Williams London: Mac Keith Press 2013 65.00 (Soft back), pp 743 ISBN: 978-1-908316-62-2.

16. Berger I, Slobodin O, Aboud M, Melamed J, Cassuto H. Maturational delay in ADHD: evidence from CPT. Frontiers in Human Neuroscience. 2013 Oct 25;7.https://doi.org/10.3389/fnhum.2013.00691.

17. Elliott H. Sherr, Michael I, Shevell M. Global Developmental Delay and Mental Retardation/Intellectual Disability. Swaimans Pediatric Neurology Principles and Practice. 5th ed. 418-423p.

18. The Role of Adaptive Behavior Assessment. In: Reschly DJ, Myers TG, Hartel CR editors. National Research Council (US) Committee on Disability Determination for Mental Retardation. Mental Retardation: Determining Eligibility for Social Security Benefits. Washington (DC): National Academies Press (US); 2002. Ch 4.

19. Amanda M. The Everything Parent's Guide to Special Education.A Complete Step-by-Step Guide to Advocating for Your Child with Special Needs. Everything. 2014 May. 304 p. ISBN13: 9781440569678

20. Mithyantha R, Kneen R, McCann E, et al. Arch Dis Child 2017;102: 1071–1076

21. Bélanger S, Caron J. Evaluation of the child with global developmental delay and intellectual disability. Paediatrics& Child Health. 2018;23(6):403-410.

22. Boyle CA, Lary JM. Prevalence of selected developmental disabilities in children 3-10 years of age: The Metropolitan Atlanta Developmental Disabilities Surveillance Program, 1991. Morbidity and Mortality Weekly Report. 1996;45(SS02):1–14.

23. Webster A, Feiler A, Webster V. Early Intensive Family Intervention and Evidence of Effectiveness: Lessons from the South West Autism Programme. Early Child Development and Care. 2003;173(4):383-398.

24. Bayley N.Bayley Scales Of Infant Development. 2nd Ed. Psychological Corporation.1993.

25. Newborg J, Stock JR, Wnek L, Guidubaldi J, Svinicki J. 1984. Battelle developmental inventory: Examiner's manual. Allen, TX: DLMLINC Associates.

26. Frankenburg WK, Dodds J, Archer P, Shapiro H, Bresnick B. The Denver II: a major revision and restandardization of the Denver Developmental Screening Test. Pediatrics.1992 Jan;89(1):91-7.

27. Phatak P. Developmental Assessment Scales for Indian Infants (DASII) – Revised Baroda Norms Manual, 1997.

28. Batshaw ML. Mental retardation. Pediatr Clin North Am. 1993 Jun;40(3): 507-21.

29. Gresham FM, Reschly DJ. Dimensions Of Social Competence: Method Factors in the Assessment of Adaptive Behavior, Social Skills and Peer Acceptance. Journal of School Psycholog. 1987. 25, 108-117.

30. Pandey, H. Pandey's Cognitive Development test forpreschoolers Manual. The Psychological Corporation, Kacher Ghat, Agra. 1992. p1-15.

31. Hubel DH, Wiesel TN, Le Vay S. Plasticity of ocular dominance columns in monkey striate cortex. Philosophical Transactions of Royal Society of London, 278. 1977. p377-409.

32. Vaegan, Taylor D.Critical period for deprivation amblyopia in children. Transactions of the Optical Society of the United Kingdom.1980. p 432-439.

33. Illingworth RS. Delayed visual maturation. Arch Dis Child 1961; 36: 407–9.

34. Beauvieux M. La ceciteapparente chez le nouveau-ne la pseudoatrophie grise du nerf optique. Arch Ophthalmol.1947; 7: 241–9.

35. Uemera Y, Agucci Y, Katsumi O. Visual development delay. OphthalPaediatr Genet 1981; 1: 4–11.

36. Hertz BG. Acuity card testing of retarded children. Behav Brain Res. 1987 May;24(2):85-92.

37. Teller DY, McDonald MA, Preston K, Sebris SL, Dobson V. Assessment of visual acuity in infants and children: The acuity card procedure. Dev Med Child Neurol 1986;28:779-89.

38. Dobson V, Mayer DL, Lee CP. Visual acuity screening of preterm infants. Invest Ophthalmol Vis Sci.1980;19:1489–1505.

39. Kubatko-Zielińska A, et al. Evaluation of visual acuity of small children with preferential looking methods. KlinOczna. 1993 May;95(5):180-2.

40. Mayer DL, Beiser AS, Warner AF, Pratt EM, Raye KN, Lang M. Monocular Acuity Norms for the Teller Acuity Cards Between Ages One Month and Four Years. Investigative Ophthalmology & Visual Science, March 1995, Vol. 36, No. 3.

41. Friendly D, Jaafar M, Morillo D. A Comparative Study of Grating and Recognition Visual Acuity Testing in Children With Anisometropic Amblyopia Without Strabismus. American Journal of Ophthalmology. 1990;110(3):293-299.

42. Getz LM, Dobson V, LunaB,Clay M. Interobserver Reliability of the Teller Acuity Card Procedure in Pediatric Patients. Investigative Ophthalmology & Visual Science.1996Jan.Vol. 37, No. 1.

43. Nawratzki I, Auerbach E, Rowe H. The electrical response in retina and occipital cortex following photic stimulation of normal and amblyopic eyes. Am J Ophthalmol. 1966 Mar;61(3):430-5.

44. Douthwaite W. Visual acuity prediction using the visual evoked response. Ophthalmic and Physiological Optics. 1987;7(4):421-424.

45. Dobson V, Teller DY.Visual acuity in human infants: a review and comparison of behavioral and electrophysiological studies. Vision Res. 1978;18(11): 1469-83.

46. Barrett BT, Bradley A, McGraw PV. Understanding the neural basis of amblyopia. Neuroscientist. 2004 Apr;10(2):106-17.

47. Flom M, Heath G, Takahashi E. Contour Interaction and Visual Resolution: Contralateral Effects. Science. 1963;142(3594):979-980.

48. O'Regan J, Jacobs A. Optimal viewing position effect in word recognition: A challenge to current theory. Journal of Experimental Psychology: Human Perception and Performance. 1992;18(1):185-197.

49. Simmers A, Gray L, Winn B. The effect of abnormal eye movements upon visual acuity. Ophthalmic and Physiological Optics. 1996;16(3):253.

50. McDonald M, Sebris S, Mohn G, Teller D, Dobson V. Monocular Acuity in Normal Infants. Optometry and Vision Science. Am J Optom Physiol Opt. 1986;63(2):127-134.

51. [Internet]. Eiiwebassets.s3.amazonaws.com. 2019 [cited 25 April 2019]. Available from: http://eiiwebassets.s3.amazonaws.com/s/steroptical/pdf/other-manuals/TAC_II_manual.pdf

52. Mayer DL Beiser AS Warner AF Pratt EM Raye KN Lang JM. Monocular acuity norms for the Teller Acuity Cards between ages one month and four years. Invest Ophthalmol Vis Sci. 1995;36:671–685.

53. Preston K, McDonald M, Sebris S, Dobson V, Teller D. Validation of the Acuity Card Procedure for Assessment of Infants with Ocular Disorders. Ophthalmology. 1987;94(6):644-653.

54. Dobson V, Carpenter NA,Bonvalot K, Bossler J. The acuity card procedure: inter observer agreement in infants with perinatal complications. Clin Vision Sci. 1990;6:39–48.

55. Mash C, Dobson V, Carpenter N. Inter observer agreement for measurement of grating acuity and interocular acuity differences with the Teller Acuity Card procedure. Vision Res. 1995;35:303–312.

56. Robbins SL, Christian WK, Hertle RW, Granet DB. Vision testing in the pediatric population. Ophthalmol Clin North Am. 2003 Jun;16(2):253-67.

57. [Internet]. Pdfs.semanticscholar.org. 2019 [cited 25 April 2019]. Available from: https://pdfs.semanticscholar.org/c444/494e0c8a6251aa8a93156ee636c31fc44d51.pdf\

58. Akinci A, Oner O, Bozkurt O, Guven A, Degerliyurt A, Munir K. Refractive errors and ocular findings in children with intellectual disability: A controlled study. Journal of American Association for Pediatric Ophthalmology and Strabismus. 2008;12(5):477-481.

59. Kim U, Hwang JM. Refractive errors and strabismus in Asian patients with Down syndrome. Eye (Lond). 2009;23:1560–4.

60. Stephen E, Dickson J, Kindley AD, Scott CC, Charleton PM. Surveillance of vision and ocular disorders in children with Down syndrome. Dev Med Child Neurol. 2007;49:513–5.

61. Khandekar R, Natrajan S, Al-Hadrami K, Vora U. Refractive error and visual functions in children with special needs compared with the first grade school students in Oman. Middle East African Journal of Ophthalmology. 2010;17(4):297-302.

62. Castañe M, Peris E, Sanchez E. Ocular dysfunction associated with mental handicap. Ophthalmic Physiol Opt. 1995;15:489–92.

63. Yurdakul NS, Ugurlu S, Maden A. Strabismus in Down syndrome. J PediatrOphthalmol Strabismus. 2006;43:27–30.

64. Jönelid B, Annerén G, Holmström G. Children and adolescents with Down syndrome. Continuous ophthalmological monitoring crucial. Lakartidningen. 2002;99:29–32.

65. Kapoula Z, Ganem R, Poncet S, Gintautas D, Eggert T, Brémond-Gignac D, et al. Free exploration of painting uncovers particularly loose yoking of saccades in dyslexics. Dyslexia. 2009;15:243–59.

66. Kozeis N, Panos G, Zafeiriou D, de Gottrau P, Gatzioufas Z. Comparative Study of Refractive Errors, Strabismus, Microsaccades, and Visual Perception Between Preterm and Full-Term Children With Infantile Cerebral Palsy. Journal of Child Neurology. 2014;30(8):972-975.

67. Erkkila H, Lindberg L, Kallio AK. Strabismus in children with cerebral palsy. Acta Ophthalmol Scand. 1996;74:636-638.

68. Flynn JT. Strabismus. A Neurodevelopmental Approach. New York: Springer-Verlag; 1991.

69. Fradsen AD. Occurrence of Squint: A Clinical Statistical Study on the Prevalence of Squint and Associated Signs in Different Groups and Ages of the Danish Population. Copenhagen: HK Kristensen; 1960.

70. O'Connor AR, Stephenson TJ, Johnson A, et al. Strabismus in children of birth weight less than 1701 g.Arch Ophthalmol. 2002;120:767-773.

71. Von Noorden GK. Binocular Vision and Ocular Motility. 4thed. St Louis, MO: Mosby; 1990.

72. Yamamah G, Talaat Abdel Alim A, Mostafa Y, Ahmed R, Mahmoud A. Prevalence of Visual Impairment and Refractive Errors in Children of South Sinai, Egypt. Ophthalmic Epidemiology. 2015;22(4):246-252.

73. Bagheri M, Farvardin M, Saadat M. A study of consanguineous marriage as a risk factor for developing comitant strabismus. J Community Genet. 2015;6(2):177–180.

74. Mazarei M, Fard MA, Merat H, Roohipoor R. Associations of refractive amblyopia in a population of Iranian children. J Optom. 2013;6(3):167–172.

75. Yi JL, Jin H. Causes of children's amblyopia and the effects of delivery mode on development of amblyopia. Int J Ohthalmol. 2007;7:215–216.

76. Gogate P. Prevalence of Ocular Disorders in Learning Disabled Children and Their Functional Visual Performance Before and After Providing Spectacle Correction. Delhi Journal of Ophthalmology. 2016;27(3).

77. Watson T, Orel-Bixler D, Haegerstrom-Portnoy G.Longitudinal quantitative assessment of vision function in children with cortical visual impairment.Optom Vis Sci. 2007 Jun;84(6):471-80.

78. Khandekar R, Al Raisi AJ. Compliance of spectacle wear and its determinants among schoolchildren of Dhakhiliya region of Oman: a descriptive study. SQU J ScienRes:Med Sci. 2002;1:39–43.

79. AldebasiYH. A descriptive study on compliance of spectacle-wear in children of primary schools at Qassim Province, Saudi Arabia Int J Health Sci (Qassim). 2013 Nov; 7(3): 291–299.

80. Gogate P, Mukhopadhyaya D, Mahadik A, Naduvilath TJ, Sane S, Shinde A, et al. Spectacle compliance amongst rural secondary school children in pune. Indian J Ophthalmol. 2013;61:8–12.

81. Messer Dawn H, Lynn Mitchell G, Daniel Twelker J, Crescionimabel. Spectacle wear in children given through a school based program. Optom and Vision Sci. 2012;(89):19–26.

82. Odedra N, Wedner SH, Shigongo ZS, Nyalali K, Gilbert C. Barriers to spectacle use in Tanzanian secondary school students. Ophthalmic Epidemiol. 2008;15:410–7.

83. Keay L, Zeng Y, Munoz B, He M, Friedman DS. Predictors of early acceptance of free spectacles provided to junior high school students in China. Arch Ophthalmol. 2010;128:1328–34.

84. World Health Organization. Elimination of avoidable visual disability due to refractive errors. Report on informal planning Meeting WHO/PBL/00.79 pp2. 2000;4:46.

85. Jethani J. Ocular defects in children with cerebral palsy. Indian J Ophthalmol. 2007 Sep-Oct;55(5):397.

86. Mental and behavioural disorders. Chapter V. International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)-WHO Version for;2016(F00-F99)

87. van Splunder J, Stilma JS, Bernsen RM, Arentz TG, Evenhuis HM.Refractive errors and visual impairment in 900 adults with intellectual disabilities in the Netherlands. Acta Ophthalmol Scand. 2003 Apr;81(2):123-9.

88. Kaiti R, Pradhan A ,Dahal HN , Shrestha P . Pattern and Prevalence of Refractive Error and Secondary Visual Impairment in Patients Attending a Tertiary Hospital in Dhulikhel, Nepal.Kathmandu Univ Med J (KUMJ). 2018 Apr-Jun;16(62):114-119.

89. Mackie RT, McCulloch DL, Saunders KJ, Day RE, Phillips S, Dutton GN.Relation between neurological status, refractive error, and visual acuity in children: a clinical study. Dev Med Child Neurol. 1998 Jan;40(1):31-7.

90. Gogate P, Soneji FR, Kharat J, Dulera H, Deshpande M, Gilbert C.Ocular disorders in children with learning disabilities in special education schools of Pune, India. Indian J Ophthalmol. 2011 May-Jun;59(3):223-8.

91. Ma Y, Qu X, Zhu X, Xu X, Zhu J, Sankaridurg P et al. Age-Specific Prevalence of Visual Impairment and Refractive Error in Children Aged 3–10 Years in Shanghai, China. Investigative Opthalmology& Visual Science. 2016;57(14):6188.

92. Hashemi H, Fotouhi A, Yekta A, Pakzad R, Ostadimoghaddam H, Khabazkhoob M. Global and regional estimates of prevalence of refractive errors: Systematic review and meta-analysis. J CurrOphthalmol. 2017 Sep 27;30(1):3-22.

93. Howland HC, Sayles N. Photorefractive studies of normal and handicapped infants and children. Behav Brain Res. 1983 Oct;10(1):81-5.

94. McQuaid RD, Arvidsson J. Vision examination of children in Riyadh's handicapped children house. J Am Optom Assoc. 1992 Apr;63(4):262-5.

95. Verma M, Chhatwal J, Jaison S, Thomas S, Daniel R. Refractive errors in preterm babies.Indian Pediatr. 1994 Oct;31(10):1183-6.

96. Pigassou-Albouy R, Fleming A. Amblyopia and strabismus in patients with cerebral palsy. Ann Ophthalmol. 1975 Mar;7(3):382-4, 386-7.

97. Govind A, Lamba PA.Visual disorders in cerebral palsy. Indian J Ophthalmol. 1988 Apr-Jun;36(2):88-91.

98. Katoch S, Devi A, Kulkarni P. Ocular defects in cerebral palsy.Indian J Ophthalmol. 2007 Mar-Apr;55(2):154-6.

99. Yurdakul NS1, Ugurlu S, Maden A.Strabismus in Down syndrome. J PediatrOphthalmol Strabismus. 2006 Jan-Feb;43(1):27-30.

100. Nielsen SL, Skov L, Jensen H.Visual dysfunctions and ocular disorders in children with developmental delay. II. Aspects of refractive errors, strabismus and contrast sensitivity. Acta Ophthalmol Scand. 2007 Jun;85(4):419-26.

101. Joshi RS, Somani AA.Ocular disorder in children with mental retardation. Indian J Psychiatry. 2013 Apr;55(2):170-2.

102. Saad A, El-Bayoumy BM. Environmental risk factors for refractive error among Egyptian school children. 2007.13(4): 819-828.

103. Brookman KE. Ocular accommodation in human infants. Am J OptomPhysiol Opt. 1983;60:91–99.

104. Abercrombie M, Gardiner P, Hansen E, Jonckheere J, Lindon R, Solomon G et al. Visual, Perceptual and Visuomotor Impairment in Physically Handicapped Children. Perceptual and Motor Skills. 1964;18(2):561-625.

105. Cioni G, Fazzi B, Ipata AE, Canapicchi R, van Hof-van Duin J. Correlation between cerebral visual impairment and magnetic resonance imaging in children with neonatal encephalopathy. Dev Med Child Neurol 1996;38: 120–32.

106. Lambert SR, Hoyt CS, Jan JE, Barkovich J, Flodmark O. Visual recovery from hypoxic cortical blindness during childhood. Computed tomographic and magnetic resonance imaging predictors. Arch Ophthalmol1987;105:1371–7.

107. McCarton C, et al. Results at age 8 years of early intervention for low-birth-weight premature infants: The Infant Health and Development Program. The Journal of the American Medical Association. 1997; 277: 126-132.

108. Abrahamsson, M., Fabian, G., and Sjöstrand, J. Refraction changes in children developing convergent or divergent strabismus. Br J Ophthalmol. 1992; 76: 723–727.

109. Mutti DO, Mitchell GL, Jones LA, Friedman NE, Frane SL, Lin WK, Moeschberger ML, Zadnik K. Accommodation, acuity, and their relationship to emmetropization in infants. Optom Vis Sci. 2009 Jun;86(6):666-76.

110. Atkinson J, Anker J, Bobier W, et al. Normal emmetropization in infants with spectacle correction for hyperopia. Invest Ophthalmol Vis Sci. 2000; 41: 3726–3731.

111. McCarron, M., Lombard-Vance, R., Murphy, E., Sheaf, G., O'Donovan, M-A., McCallion, P., et al. Quality-of-life outcomes and costs associated with a move from congregated settings to community-living arrangements for people with an intellectual disability: An evidence review. Peer-reviewed Health Research Board evidence review (report). Submitted to the Health Research, 2018.

ANNEXURE I – CONSENT FORM

Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay

- Your decision about your child participating in this study is voluntary. This means you are free to decide on behalf of your child to participate in this study or not.
- You are free to stop study treatment and study-related activities at any time and without the need of giving any reason.
- If you do not want to participate in this study, then this decision will not affect your medical care.

Goals of clinical research:

1. To find a treatment that may be better or safer than currently available treatment
2. To gain knowledge that may benefit others, even though at this time no one can be sure that this research treatment will be helpful for you

Purpose of this study:

Children with Global developmental delay may also suffer from eye problems called refractive error. This means the image falling on the eye is not on the retina and they have blurred vision. If this condition is not treated with glasses, they may have low vision all their life. This further affects their overall development and they may be falsely termed as very poor development, because their eyesight is poor. Hence, this study will help to improve their eyesight and see the effect on their overall development.

Procedure:

If you agree for your child to be a part of the study you will be asked the relevant perinatal history and your child will be subjected to relevant clinical ocular examination. You may have to answer certain questions pertaining to the disease and if selected for the intervention group, (i.e., wearing of spectacles) will undergo a protocol for refraction i.e., checking the number of the eye and DQ assessment (developmental assessment)and will answer a questionnaire regarding your child's everyday activities. Your study participation will last for up to six months.

Risk and Benefit

The only risk and possible discomfort the child might get is while putting eye drops for the refraction testing. It might lead to minimal burning sensation. This is a routine procedure for eye check-up, for all paediatric age group.

Alternatives

Taking part in this study is voluntary. You may choose for your child, to not take part in this study, or if you decide to take part you can later change your mind and withdraw from the study. Your decision will not change the present or future health care or other services that you receive. The study doctor or sponsor may stop your participation in this study any time. If you choose not to take part in the study your child will receive standard treatment for patients with your child's condition.

Privacy and Confidentiality

All information collected about your child during the course of this study will be kept confidential to the extent permitted by law. The code numbers will identify your child in this research record.

Institutional / Sponsors Policy

Does not apply to this research.

Financial Incentives for Participation

You will not be charged any amount for the investigations subjected to your child, other than the standard care of management. You will not receive compensation or reimbursement for taking part in this study.

Authorization to Publish Results

Information from this study may be published but identity of your child will be confidential in any publication.

Consent Statement

I voluntarily agree on behalf of my child to take part in this study by signing below. I may withdraw at any time. I am not giving up any of my child‘s legal rights by signing this form. My signature below indicates that I have read, or it has been read to me, this entire consent form, and have had all my questions answered.

Name of Study Participant or legally authorized representative:

Signature / Thumb Print:

In case of the queries during study or in future you may contact following person.

Principal investigator	:	Dr. Smitha.K.S.	Phone: 09964319436
Research Guide	:	Dr. V. D. Patil	Phone:

Name of Witness: Signature:

Investigator Name: Signature:

Date:

Place:

ANNEXURE II – ETHICAL CLEARANCE

KLE UNIVERSITY
(Formerly known as KLE Academy of Higher Education & Research, Belgaum)
[Declared as Deemed-to-be-University u/s 3 of the UGC Act, 1956 vide Government of India Notification No.F.9-19/2000-U.3(A)]
'Accredited 'A' Grade by NAAC
Office of the Registrar, KLE University,
JNMC Campus, Nehru Nagar, Belgaum-590 010, Karnataka State, India
☎: 0831-2444444/2493779 **FAX:** 0831-2493777 **Web:** http://www.kleuniversity.edu.in **E-mail:** info@kleuniversity.edu.in

Ref.No.KLEU/Ethic/2012-13/D-4566. Date:18-3-2013.

To,
Dr.Smitha K.S.
Ph.D.Scholar,2012-13
K.L.E. University, Belgaum.

Dear Research Scholar

Sub:- Regarding Ethical Clearance.

The KLE University Ethics Committee on Human Subjects for Ph. D Research Project met on 8th March 2013 to consider your application for approval of the research project **"EVALAUTION OF IMPACT OF EARLY CORRECTION OF REFRACTIVE ERRORS IN CHILDREN WITH GLOBAL DEVELOPMENTAL DELAY".**

As there are no ethical issues involved in your proposed research project., the committee has provided approval for this research project.

You are requested to report to Ethical Committee of the following:

1. Any deviation from or change of the protocol.
2. All serious adverse events.
3. Any changes in study documents.

(Dr. Hema Dhumale)
Member Secretary,
Ph.D. Ethical Committee(Human),
K.L.E. University,
Belgaum.

(Prof. Sudha A.Raddi)
Chairman
Ph.D. Ethical Committee(Human),
K.L.E. University,
Belgaum.

CC to: - The Director Academic Affairs, KLE University
- The Director Research Foundation, KLE University
- The Registrar, KLE University
- Special Officer to Hon. Vice Chancellor, KLE University, Belgaum

ANNEXURE III- PROFORMA

Impact of Refractive Error Correction on Mental and Visual Development in Children with Global Developmental Delay

Name: OP.No:

Age: Date:

Sex:

Address:

Birth order:

Socioeconomic status:

Parent's/ guardian's name:

Relation:

Mother tongue:

Chief complaints:

Who detected the problem first?

History of presenting illness:

Past history: h/o use of spectacles

Birth history:

Antenatal

Fever with rashes No(0)/ Yes(1)

PIH No(0)/ Yes(1)

Others No(0)/ Yes(1)

Gestation period: ☐☐ weeks

Birth weight: ☐☐☐☐ grams

Delivery: normal (0)forceps (1) CS (2)

CRY: Immediate(0) delayed(1)

History of: Oxygen therapy No(0)/ Yes(1)

Neonatal jaundice No(0)/ Yes(1)

Convulsions No(0)/ Yes(1)

Others No(0)/ Yes(1)

Milestones: normal (0) delayed (1)

Family history: Pedigree

Consanguinity: absent(0) present(1)

General physical examination:

Nutritional status:

Systemic examination:

CNS normal(0)/ abnormal (1)

CVS normal(0)/ abnormal (1)

PA normal(0)/ abnormal (1)

RS normal(0)/ abnormal (1)

Gross anomalies: absent(0) present(1)

Auditory anomaly: absent (0) present(1)

Ocular examination:

Head posture normal(0)/ abnormal (1)

Facial symmetry symmetrical(0) asymmetrical(1)

Visual axes parallel(0) unparallel(1)

VISUAL ACUITY	**RE**	**LE**
Fixes/Follows light		
TAC/ PLT		

VISION ASSESSMENT:RE LE

Vision with TELLER ACUITY CARD: ☐☐☐☐ ☐☐☐☐

	RE			LE		
	AT 38cm	55cm	84cm	38cm	55cm	84cm
I.OBSERVATION						
II.OBSERVATION						

Total duration of the test:

BINOCULAR VISION AND MOTILITY:
Orthophoria(0) esotropia(1) exotropia(2)
Cover test
Hirschberg test
Krimsky test

Extra ocular movements: normal(0) restricted(1)

Nystagmus: absent(0) present(1)

OCULAR HEALTH ASSESSMENT
ANTERIOR SEGMENT: normal(0) abnormal(1)
POSTERIOR SEGMENT: normal(0) abnormal (1)

REFRACTION RECORD

Cycloplegic Retinoscopy	RE	LE
Working distance		

Subjective Refraction

Eyes	SPH	CYL	Axis	V/A

Supplemental testing:

Electrodiagnostic testing

BERA

MRI

Developmental Quotient/ IntelligenceQuotient:

Pediatric diagnosis:

Ophthalmic diagnosis:myopia(0) hypermetropia(1) astigmatism(2) amblyopia(3)

FOLLOW UP:

DATE:

DQ/IQ:

	RE	LE
Vision with TELLER ACUITY CARD	☐☐☐☐	☐☐☐☐

	RE			LE		
	AT 38cm	55cm	84cm	38cm	55cm	84cm
I. OBSERVATION						
II. OBSERVATION						

Total duration of the test:

QUESTIONNAIRE: deteriorated(0) no change(1) improved(2) cannot say(3)

I SOCIAL BEHAVIOURAL CHANGES:

1.Has eye to eye contact changed? ☐

2.Has concentration span changed? ☐

3.Has frequency of temper tantrums changed? ☐

4.Has amount of supervision required changed? ☐

II. GROSS MOTOR SKILLS:

5.Has head posture changed? ☐

6.When eating has spillage changed? ☐

7.Has balancing/ walking ability changed? ☐

III.FINE MOTOR SKILLS:

8. Reaching objects? ☐

9. Grasping objects? ☐

10.Has quality of the end product changed? ☐

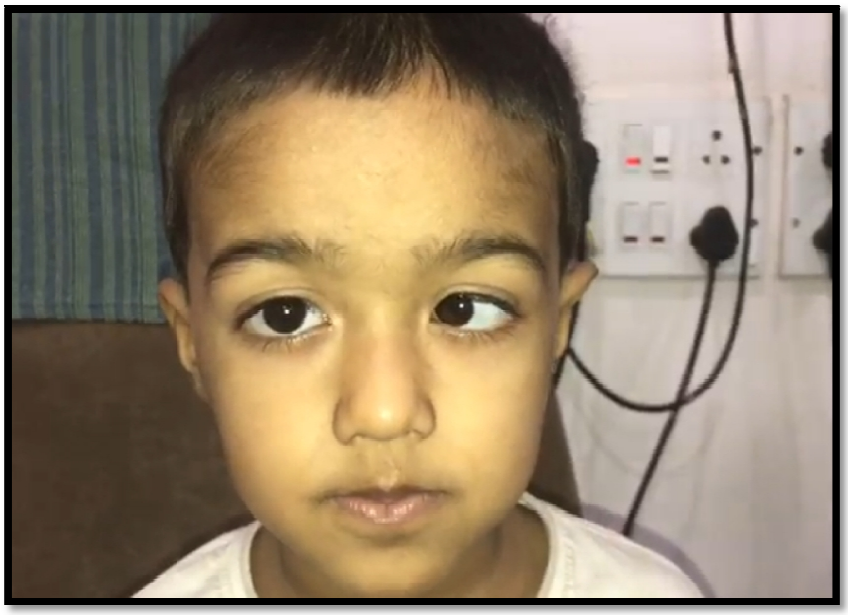
ANNEXURE IV – PHOTOS

DASII SET

Retinoscopy

DASII test

Vision test with Teller Acuity Cards



Child with Strabismus

Child with Spectacles

ISSN 2542-6214

VOL. 12 | Issue 2 | May-August 2019

INDIAN Journal of HEALTH SCIENCES AND BIOMEDICAL RESEARCH KLEU

www.ijournalhs.org

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH Deemed-to-be-University
EMPOWERING PROFESSIONALS

An Official Publication of
KLE Academy of Higher Education and Research, Belagavi

Wolters Kluwer

Medknow

Original Article

Access this article online

Quick Response Code:

Website: www.ijournalhs.org

DOI: 10.4103/kleuhsj.kleuhsj_315_18

Impact of refractive error correction on mental and visual development in children with global developmental delay

K. S. Smitha, V. D. Patil[1], Mahesh D. Kamate[1], Madhav Prabhu[2], Umesh Harakuni, O. P. Rakshitha

Abstract:

PURPOSE: The purpose of the present study is to evaluate visual acuity and refractive status in children with global developmental delay (GDD) and to study the effect of early correction of refractive errors on vision and developmental quotient (DQ).

METHODS: In this case series data with pre–post design, 100 consecutive children from 1 to 5 years of age diagnosed with GDD attending the child development clinic and referred to ophthalmology were evaluated for ocular complaints, status of visual acuity, and type of refractive error. Glasses were prescribed on the basis of cycloplegic retinoscopy. Etiological diagnosis and DQ were documented. Follow-up was done after 6 months for visual acuity, DQ, and qualitative questionnaire administered for the caretaker. Statistical analysis was done using the Chi-square test.

RESULTS: Fifty-six children were <2.5 years of age and 44 children were >2.5 years. Severe GDD prevalence was more in children <2.5 years (43%) and mild GDD in >2.5 (50%). Of 47 who showed improvement in vision, 39 (71%) showed improvement in social behavior also, which was statistically significant. In children <2.5 years, more improvement in DQ was seen in the moderate intellectual disability group after refractive error correction. However, in the children of 2.5 years and above, more improvement was seen in the severe group. Overall, improvement in DQ in children from 1 to 5 years was statistically significant at 14%.

CONCLUSION: Harmful effects of sensory visual deprivation on the development and functioning can be dampened by a simple and cost-effective approach of spectacles therapy which makes a spectacular effect in the case of children with GDD.

Keywords:

Developmental quotient, global developmental delay, refractive error

Introduction

Global developmental delay (GDD) is a developmental disability in children <5 years of age and refers to a significant delay in at least two of the major developmental domains: gross/fine motor; speech/language; cognition; social and personal development; and activities of daily living. Generally, all domains are affected.[1] A study done in 2005 focused on the outcomes or natural history of children diagnosed early in life with developmental delay, without any intervention, after a mean duration of 4 years and found that 75%–100% of the children remained below the mean scores compared to age-matched normative data. They found persistent poor performance at school age in both developmental and functional outcomes.[2] GDD has a primary initiating factor of cerebral damage and secondary

Departments of Ophthalmology, [1]Pediatrics and [2]Medicine, J. N. Medical College, KLE Academy of Higher Education and Research, Belagavi, Karnataka, India

Address for correspondence:
Dr. K. S. Smitha, Department of Ophthalmology, J. N. Medical College, KLE Academy of Higher Education and Research, Belagavi - 590 010, Karnataka, India.
E-mail: smitha290780@gmail.com

How to cite this article: Smitha KS, Patil VD, Kamate MD, Prabhu M, Harakuni U, Rakshitha OP. Impact of refractive error correction on mental and visual development in children with global developmental delay. Indian J Health Sci Biomed Res 2019;12:117-22.

compounding factors such as associated visual or auditory defects.[3] Visual impairments range from 13% to 50% and audiologic impairments of 18%.[4] Visual impairments affect intellectual development and motor achievement by hampering neurological development.[5,6] The American Association of Neurologists says that the diagnosis in their formative years leads to better outcome.[7]

Johnson and Zaba study found that of the various ocular manifestations, refractive error is the most common (20%–60%) and 80% of learning by children is through the visual information.[8] The process of emmetropization involves or is guided by visual feedback mechanism.[9] Thus, visual deprivation in infancy leads to retention or increase in refractive errors. Although intellectual disability (ID) is not treatable, visual impairments benefit from early intervention.[10] Vision is central in early interaction and motor development. Intervention at this crucial age is important as the child is most receptive and hence should not be missed.

Intervention is aimed at improving the disturbed visual sensory input, to enhance child's neurological development through visual support and increase the educational gains and decrease dependence on social institutions, providing economic and social benefit.

Studies are lacking in the youngest age group with GDD, i.e., under 5 years with quantification of visual acuity and development quotient (DQ), before and after treatment. Thus, we aimed at correcting this important sensory input of vision at the young age of 1–5 years and evaluating its effect on visual and mental development and factors which are affecting it.

Objectives

To study the effect of early correction of refractive errors in children of age 1–5 years with GDD on Vision and Developmental Quotient (DQ) and their determinants.

Methods

Children of age below 5 years attending the Child Development Clinic in Paediatric Department and diagnosed with GDD were taken for the study. The study comprised 100 consecutive GDD children attending tertiary care teaching hospital of North Karnataka during May 2014 to June 2017. Study design was pre-post. The data about perinatal history of children and consanguinity were collected from Medical Records. Children with refractive errors without other ocular anomalies were considered for the study. The expected cases of the improvable refractive error as per the literature were 15%–61%. Sample size was computed with 80% power and 15% minimum expected improvement, as 100.

The protocol was approved by the Ethics Committee, and as the kids are doubly vulnerable because of age and inability to process information, written informed consent was obtained from parents/legal guardians. Children with progressive neurodegenerative conditions, auditory, and other systemic abnormalities which could act as confounding factors were excluded. After screening 164 consecutive children from 1 to 5 years of age diagnosed with GDD, 120 were found to have refractive error. Complete ocular examination of the anterior segment and dilated fundoscopy was done to rule out any other ocular abnormalities. After exclusions, 114 fitting the eligibility criteria were enrolled. Final data analysis was done in 100 children excluding children noncompliant with glasses and who were lost to follow-up at the time of reassessment after 6 months.

GDD children of age 1–5 years were assessed on the following variables: visual acuity, refractive error, and DQ. Follow-up was done after 6 months for the same, along with a questionnaire for the caretaker. Compliance factor was defined as wearing of spectacles for a minimum of six waking hours.

- Vision assessed with preferential looking test using Teller acuity cards. The accuracy (test-retest reliability) of the acuity card test is one octave. A difference of one octave was significant as per the norms and considered as visual improvement.[11] Assessments were made by two different observers with a break of few hours in between and had high interobserver agreement
- As the standard practice parameters are set for normal children, the cutoff points for refractive error were taken based on other studies of GDD.[12,13]

Glasses were prescribed based on these cutoffs on the basis of wet retinoscopy (with atropine to nullify accommodation):

- Myopia of more than –0.50 diopter (D)
- Hypermetropia of more than +1.00 D
- Astigmatism more than 1.00 D.
- DQ – under 2.5 years– DASII (Developmental Assessment Scales for Indian Infants)[14]

Above 2.5 years – Pandey's Cognitive Development Test for Preschoolers (PCDTP).[15]

ICD-10 – DQ is divided into grades according to the levels of severity.[16]

- Mild ID: 50–70
- Moderate ID: 35–49
- Severe ID: 20–34
- Profound ID: <20.

(As the number of children having profound ID was small, it was incorporated in the severe ID group for the

analysis). This testing was done by the Child Psychologist of the Child Development Center of Pediatric Neurology Department.

DQ improvement/deterioration was defined as the change in the grade of severity.

- The questionnaire had three groups of questions for gross motor, fine motor, and behavioral changes of study children. Questions were drawn from adaptive behavior scales which had previous validation.[12]

Statistical analysis

Quantitative variables such as refractive error, visual acuity, and DQ were converted into interval scale for analysis. Data were in ordered scale; contingency tables were made for descriptive presentation. Chi-square test was used to study the impact of explanatory variables on visual acuity, DQ, and social behavior. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp., was used for data analysis.

Results

In this study, 56 children were <2.5 years of age and 44 children >2.5 years. Forty-five were girls and 55 were boys. In children <2.5 years, 43% were in the severe ID group, whereas 50% of children in the older group had mild ID, which was statistically significant ($P < 0.001$).

Of the 100 babies, 13 were preterm whereas 87 were term babies. About 50% of term children had improvement in vision compared to 23% in preterm, whereas 4 (30%) of preterm children showed deterioration in vision compared to 3 (3%) in term children.

On the evaluation of DQ by refractive error, in all the grades of DQ, the number of children having hyperopia was the highest [Table 1, $P < 0.07$]. Improvement in vision in myopes was 71.4% which was the highest although not statistically significant. Statistically significant improvement was seen in 69% of children with mild ID [Table 2, $P < 0.003$]. On comparing post by pre-DQ, statistically significant improvement in DQ in 14% of children from 1 to 5 years was noticed at [Table 3, $P < 0.000$].

Table 1: Developmental quotient by refractive error

Refractive error	Developmental quotient/DQ (%)			
	Severe ID	Moderate ID	Mild ID	Total
Myopia	4 (19.0)	6 (28.6)	11 (52.4)	21(100.0)
Hyperopia	24 (34.0)	30 (42.0)	17 (23.9)	71 (100.0)
Astigmatism	3 (37.5)	1 (12.5)	4 (50.0)	8 (100.0)
Total	31 (31.0)	37 (37.0)	32 (32.0)	100 (100.0)

DQ: Developmental quotient, ID: Intellectual disability

Table 2: Improvement in vision by developmental quotient

DQ	Improvement in vision (%)		
	Remained same	Improved	Total
Severe ID	23 (74.2)	8 (25.8)	31 (100.0)
Moderate ID	20 (54.0)	17 (46.0)	37 (100.0)
Mild ID	10 (31.3)	22 (68.8)	32 (100.0)
Total	53 (53.0)	47 (47.0)	100 (100.0)

DQ: Developmental quotient, ID: Intellectual disability

Table 3: Post- by predevelopmental quotient

Pre-DQ	Post-DQ (%)			
	Severe	Moderate	Mild	Total
Severe	25 (80.6)	4 (12.9)	2 (6.5)	31 (100.0)
Moderate	4 (10.8)	25 (67.6)	8 (21.4)	37 (100.0)
Mild	0 (0.0)	1 (3.1)	31 (96.9)	32 (100.0)
Total	29 (29.0)	30 (30.0)	41 (41.0)	100 (100.0)

DQ: Developmental quotient

Discussion

Most of the previous studies have a wide range of age. Hence, we have concentrated exclusively on children under 5 years having GDD with refractive errors, (the crucial period of brain development) intervention at this period makes the maximum impact.

The evaluation of DQ was by DASII in children <2.5 years and by PCDTP in >2.5 years. Hence, the evaluation for all variables was also done separately in these two age groups. In our study, 56 children were below 2.5 years of age and 44 children were at 2.5 years and above.

We found a significant distribution of DQ in both the groups:

- Severe ID children were more in children <2.5 years (43%)
- Children with mild ID were more in age group >2.5 years (50%).

Although equal distribution of children was seen in all three grades of ID, younger group had more of severe form and older group had more of the mild form. This could be explained on the basis that this was a hospital-based study and not community based as in other studies, as parents of children with severe and profound ID, who usually have other associated disabilities too, enthusiastically pursuing treatment initially lose hope leading to reduced hospital visits.

In this study, cerebral palsy was the most common cause, found in 40 children followed by syndromic causes such as Down syndrome, Seckel syndrome, and miscellaneous in 12 children. In 48% cases, cause could not be identified in spite of rigorous workup. No relationship was found between the etiology of chronic venous insufficiency (CVI) and timing of the insult on the improvement of visual function.[17]

Gestational period and birth weight

Kozeis *et al*. 2015 study found that prematurity is not an added risk for refractive error development.[18] Similarly, refractive error distribution was not significant in preterm and term babies, but there was significant correlation in response to the refractive correction. Term children improved more than preterm. This stresses the need for rigorous management in preterm children.

Refractive error by developmental quotient

McQuaid and Arvidsson report that refractive errors are four times higher than in neurologically normal age-matched children and the prevalence of hyperopia is more. Moreover, refractive errors increase significantly with severity of ID. Distribution of hyperopia was similar in our study.[19-21]

The distribution in the majority of children was low-to-moderate hyperopia. However, there are children with moderate-to-high myopia, thus increasing the range of refractive errors (−7 D to +5.5 D). Although hyperopes were more in number, improvement in vision seen was more in myopes at 15 (71.4%). Hyperopia in the age group of 1–4 years was associated with amblyopia.[22] Although hyperopia is present in most of the children which could be normal to that age in normal children, we feel that in children with GDD, the fact that they are causing amblyopia, with the added delay, justifies the need for correction, unlike the children without delay.

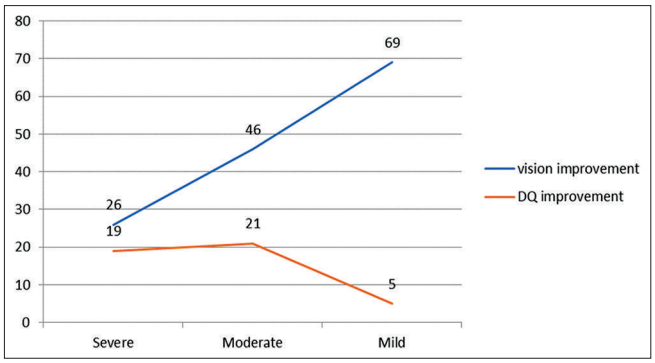
Pigassou-Albouy studied a group of cerebral palsy which found strabismus in 50%, whereas in general population, it is 3%.[23] Of 100 babies, 69 had orthophoria, 22 had esotropia, and 9 had exotropia. Nineteen (86.4%) children with esotropia had hyperopia. The high incidence could be attributed to the fact that they are done in specific populations, similar to an Aravind Hospital Study.[24]

Social behavioral change

Of 47% children, who showed improvement in vision, 39 (71%) showed improvement in social behavior also, which was clinically and statistically significant, and it was not age related. Maximum improvement seen in behavior in the mild ID group (44% improved) was similar to pattern of improvement in vision and can be attributed to betterment of functional vision.

Improvement in vision in relation to improvement in developmental quotient

A study done in Pune on the improvement in scholastic activities concluded that 26.4% of children had their vision improved with refraction.[25] A retrospective study by Watson done on CVI patients found that 49% improved in vision after correction after a mean duration of 6.5 years.[22] In our study, 47% improved



Graph 1: Improvement in vision in relation to the improvement in developmental quotient (%)

Table 4: Improvement in vision by improvement in developmental quotient

ID	Improvement in vision (%)	Improvement in DQ (%)
Severe	8 (26)	6 (19)
Moderate	17 (46)	8 (21)
Mild	22 (68.8)	1 (5)

DQ: Developmental quotient, ID: Intellectual disability

which was clinically and statistically significant [Table 4 and Graph 1].

The improvement seen in vision was more in mild ID group (69%), followed by the moderate (46%) and least seen in severe ID (26%) children.

Even though maximum improvement in vision was seen in mild ID group, DQ largely remained same. This is contrary to what one would expect. However, deterioration was also very less compared to other groups. It was also seen that the amount of improvement was less in the moderate ID group than the severe group in the older age children stressing the Watson *et al*.'s theory. They concluded that the worse vision group improved better than the initially better vision group, as worse group had "more room for improvement" that leads to greater change. This explains the improvement seen in the severe ID group in our study.

Although visual growth occurs, neural plasticity comes down, and the scope of exponential improvement in DQ through intellectual development and motor achievement reduces, which explains the minimal DQ improvement in spite of maximum visual improvement in the mild ID group. Longer follow-up of up to 6 years in few other studies has also shown that severe ID group has more room for improvement, which was proved in our study, quantitatively.

Is this just an age effect...??

Bader and Woodruff study showed the improvement in the new glass group and in the youngest age group (0–6 years). They reviewed the effects qualitatively

in behavior after 2 months and assumed that the improvement in ability to walk, grasp objects, balance, etc., was not due to maturation.[12] They deduced that spectacle changes the spatial perceptions and results in improvement. In our study, the improvement seen on follow-up after 6 months is a short span and cannot be attributed to maturation. This was confirmed by our analysis of 20 children with GDD without refractive error after 6 months who showed no statistically significant difference/improvement in DQ, ruling out the age effect.

Conclusion

In both age groups, severe and moderate groups show better improvement in DQ than mild ID group. However, it is also seen that as age increases, the amount of improvement decreases. Thus, proving the fact that the earlier the intervention, greater the improvement in their DQ, as neural plasticity is better.

These results are useful in the diagnosis and clinical management by providing quantitative information about visual impairment. It is useful in alleviation of parental anxiety, assistance in early childhood intervention programs, and genetic counseling. In this view, implementing mandatory quantitative evaluation of visual acuity and refractive corrections in children with GDD would go a long way in the overall development of the child.

The multifaceted therapy in children with GDD is costly. Spectacles are simple, easily available, and cost-effective strategy. In the backdrop of increasing neurological cases in the Indian scenario, the cause of which is multifactorial such as poor parental care, consanguinity, and nutritional issues, this study stresses on the need for awareness among the treating pediatricians, ophthalmologists, and parents/caretakers regarding early ophthalmic care and the simple approach of prescribing glasses which make a spectacular effect in case of children with GDD.

Limitations

Perinatal history was collected retrospectively, which could lead to minimal bias. Compliance in wearing glasses for full waking hours could not be achieved.

Recommendations

The age at which these tests would give optimal results should be addressed. Furthermore, the aspects of quality of life and social support by the family need to be addressed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Shevell M. Global developmental delay and mental retardation or intellectual disability: Conceptualization, evaluation, and etiology. Pediatr Clin North Am 2008;55:1071-84.
2. Shevell M, Majnemer A, Platt RW, Webster R, Birnbaum R. Developmental and functional outcomes at school age of preschool children with global developmental delay. J Child Neurol 2005;20:648-53.
3. Sumpter EA. Mental retardation-a handbook for the primary physician. Am J Dis Child 1976;130:221.
4. Shevell M, Ashwal S, Donley D, Flint J, Gingold M, Hirtz D, *et al*. Practice parameter: Evaluation of the child with global developmental delay: Report of the quality standards subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society. Neurology 2003;60:367-80.
5. Freeman RD, Thibos LN. Electrophysiological evidence that abnormal early visual experience can modify the human brain. Science 1973;180:876-8.
6. Blakemore C, Cooper GF. Development of the brain depends on the visual environment. Nature 1970;228:477-8.
7. Majnemer A. Benefits of early intervention for children with developmental disabilities. Semin Pediatr Neurol 1998;5:62-9.
8. Johnson RA, Zaba JN. The visual screening of adjudicated adolescents. J Behav Optom 1999;10:13-7.
9. Troilo D. Neonatal eye growth and emmetropisation – a literature review. Eye (Lond) 1992;6 (Pt 2):154-60.
10. Bruce K, Shapiro, Mark L Batshaw. Intellectual disability. In: Nelson Textbook of Pediatrics. 19th ed. Philadelphia: W.B Saunders; 2011. p. 122-9.
11. Dobson V, McDonald MA, Teller DY. Visual acuity of infants and young children: Forced-choice preferential looking procedures. Amer Orthoptic J 1985;35:118-25.
12. Bader D, Woodruff ME. The effects of corrective lenses on various behaviors of mentally retarded persons. Am J Optom Physiol Opt 1980;57:447-59.
13. van Splunder J, Stilma JS, Bernsen RM, Arentz TG, Evenhuis HM. Refractive errors and visual impairment in 900 adults with intellectual disabilities in the Netherlands. Acta Ophthalmol Scand 2003;81:123-9.
14. Phatak P. Developmental Assessment Scales for Indian Infants (DASII) – Revised Baroda Norms Manual; 1997
15. Pandey H. Pandey's Cognitive Development Test for Preschoolers Manual. The Psychological Corporation. Kacher Ghat, Agra: National Psychological Corporation: 1992. p. 1-15.
16. World Health Organization. International Classification of Diseases. 8th Revision. Geneva: World Health Organization; 1968.
17. Watson T, Orel-Bixler D, Haegerstrom-Portnoy G. Longitudinal quantitative assessment of vision function in children with cortical visual impairment. Optom Vis Sci 2007;84:471-80.
18. Kozeis N, Panos GD, Zafeiriou DI, de Gottrau P, Gatzioufas Z. Comparative study of refractive errors, strabismus, microsaccades, and visual perception between preterm and full-term children with infantile cerebral palsy. J Child Neurol 2015;30:972-5.
19. McQuaid RD, Arvidsson J. Vision examination of children in Riyadh's handicapped children house. J Am Optom Assoc 1992;63:262-5.
20. Howland HC, Sayles N. Photorefractive studies of normal and handicapped infants and children. Behav Brain Res 1983;10:81-5.
21. Akinci A, Oner O, Bozkurt OH, Guven A, Degerliyurt A,

Munir K, *et al*. Refractive errors and ocular findings in children with intellectual disability: A controlled study. J AAPOS 2008;12:477-81.
22. Abrahamsson M, Fabian G, Sjöstrand J. Refraction changes in children developing convergent or divergent strabismus. Br J Ophthalmol 1992;76:723-7.
23. Pigassou-Albouy R, Fleming A. Amblyopia and strabismus in patients with cerebral palsy. Ann Ophthalmol 1975;7:382-4, 386-7.
24. Jethani J. Ocular defects in children with cerebral palsy. Indian J Ophthalmol 2007;55:397.
25. Gogate P, William JR, Shinde A, Bhushan S. Prevalence of ocular disorders in learning disabled children and their functional visual performance before and after providing spectacle correction. Delhi J Ophthalmol 2017;27:186-9.

pISSN- 2349- 2562 eISSN- 2349- 2570

JEBMH

Journal of Evidence Based Medicine and Healthcare

www.jebmh.com

Volume 4 / Issue 35 / May 01, 2017

Indexed in-

1. DOAJ
2. Index Copernicus (ICV 2015 - 78.84)
3. Google Scholar
4. InfoBase Index- (IBI Factor 2016 - 3.78)
5. WHO HINARI
6. BASE
7. J-Gate

Official Publication of :
International Society for Evidence Based Medical Practice

All articles published in JEBMH are now assigned unique DOI numbers.

PREVALENCE OF REFRACTIVE ERROR, STRABISMUS AND AMBLYOPIA AMONG CHILDREN WITH NORMAL DEVELOPMENT OR GLOBAL DEVELOPMENTAL DELAY/INTELLECTUAL DISABILITY ATTENDING OPHTHALMOLOGY OPD AT KLES HOSPITAL, BELAGAVI- A RETROSPECTIVE STUDY

Smitha K. S[1], Vishwanath D. Patil[2], Mahesh Kamte[3], Umesh Harakuni[4], Shalini Singh[5], Shikhir Malhotra[6], Nihal Gomes[7]

[1]Associate Professor, Department of Ophthalmology, JN Medical College, Belagavi.
[2]Professor, Department of Paediatrics, JN Medical College, Belagavi.
[3]Professor, Department of Paediatrics, JN Medical College, Belagavi.
[4]Professor, Department of Ophthalmology, JN Medical College, Belagavi.
[5]Postgraduate Student, Department of Ophthalmology, JN Medical College, Belagavi.
[6]Undergraduate, Department of Ophthalmology, JN Medical College, Belagavi.
[7]Undergraduate, Department of Ophthalmology, JN Medical College, Belagavi.

ABSTRACT

BACKGROUND

Global developmental delay/intellectual disability are on a rise in children in the present time. Ocular and visual anomalies are frequently associated with it of which refractive errors are the most frequent. This if goes unnoticed leads to strabismus and amblyopia.

MATERIALS AND METHODS

This study aims to assess the prevalence of refractive error, strabismus and amblyopia among children with normal development or global developmental delay/intellectual disability attending ophthalmology OPD at KLES Hospital, Belagavi. Case records of all 200 new patients less than or equal to 12 years of age group who attended KLES, Dr. Prabhakar Kore Hospital between January 2015 and December 2015 were retrospectively reviewed.

RESULTS

The male:female ratio was 1.22:1. Out of the total evaluated 200 cases, 130 cases were with normal development and 70 with GDD/ID. Refractive errors were 85%, whereas the cases of amblyopia was 45.50% and strabismus 39.50%. Amblyopia with refractive error having GDD/ID was stastically significant as compared to amblyopia with refractive error having normal development (p=0.001).

CONCLUSION

Refractive error was the most common ocular disorder seen. Refractive error with amblyopia is more in children with GDD/ID as compared to normal children. Owing to the high percentage of visual anomalies, ophthalmological referral becomes essential in children with developmental anomalies.

KEYWORDS

Refractive Error, Strabismus, Amblyopia.

HOW TO CITE THIS ARTICLE: Smitha KS, Patil VD, Kamte M, et al. Prevalence of refractive error, strabismus and amblyopia among children with normal development or global developmental delay/intellectual disability attending Ophthalmology OPD at KLES Hospital, Belagavi- A retrospective study. J. Evid. Based Med. Healthc. 2017; 4(35), 2114-2117. DOI: 10.18410/jebmh/2017/411

BACKGROUND

In children, visual impairment is a serious disability and its management under the campaign of vision 2020 is a main priority of World Health Organization.[1] An estimate of 285 million people around the world are visually impaired. 19 million being children below the age of 12 years. 43% of the population is visually impaired due to refractive errors, which is the principle cause of visual impairment in children.[2] A condition of the eye in which the eye fails to focus the image on the retina resulting in blurred vision is known as refractive error.[3] Strabismus is a condition where there is misalignment of the eyes and in coordination between the extraocular muscles, adversely affecting the binocularity, stereopsis or depth of perception. Amblyopia is a developmental defect of spatial visual processing that occurs in the central visual pathways of the brain.[4] A critical period is the time when, if cortex is deprived of normal stimulation, the functions and development will be permanently disrupted. Strabismic suppression causes reduced activity in cortical cells leading

Financial or Other, Competing Interest: None.
Submission 29-03-2017, Peer Review 04-04-2017,
Acceptance 18-04-2017, Published 28-04-2017.
Corresponding Author:
Dr. Shalini Singh,
Plot No. 96, CITB Colony,
Gandhi Nagar, Dharwad.
E-mail: shalini.singh43@gmail.com
DOI: 10.18410/jebmh/2017/411

to amblyopia and amblyopia in this age will result in permanent visual impairment.[5] Uncorrected refractive error can result in strabismus and amblyopia. In children, strabismus is a common factor contributing to amblyopia. There is an increase in frequency of ocular, visual anomalies and refractive error in children with global developmental delay.[6] Uemera et al presented a classification of delayed visual maturation. It has 3 categories, type 1 being patients with visual maturation delay with no other anomalies, type 2 are patients with visual maturation delay who are mentally retarded or have a seizure disorder, whereas type 3 children are with visual abnormality and a superimposed visual maturation delay.[7] Of the various ocular manifestations, refractive error is the most common finding (51%) followed by strabismus (18%).[8]

Objectives

To study the prevalence of refractive error, strabismus and amblyopia in children under 12 years of age with normal development or with global developmental delay/intellectual disability attending the Ophthalmology OPD of KLES, Dr. Prabhakar Kore Charitable Hospital and MRC over a period of one year.

MATERIALS AND METHODS

This is a hospital-based retrospective study done to know the prevalence of refractive error, amblyopia and strabismus in children attending Paediatric Ophthalmology OPD of our hospital referred from paediatrics and Child Development Centre. Case records of all new patients less than or equal to 12 years old who presented to KLES, Dr. Prabhakar Kore Charitable Hospital and MRC between January 2015 and December 2015 were retrospectively reviewed. Global developmental delay is defined as performance that is two standard deviation or more below the mean on age-appropriate, standardised norm-referenced testing in at least two or more developmental fields of gross/fine motor, cognition, social/personal and activities of daily living.[9,10] This study included the cases of GDD/ID who had undergone DQ/IQ test referred from the child development center to Ophthalmology OPD of KLES, Dr. Prabhakar Kore Charitable Hospital and diagnosed by the paediatric neurologist. Children attending ophthalmology OPD with complaints of blurring of vision, deviation of eyes, delayed milestones and children with best corrected visual acuity less than 6/9 (20/30) on Snellen's chart on examination were included in the study. Data was stored for age, sex, clinical diagnosis of refractive error, strabismus and amblyopia with or without global developmental delay/intellectual disability. This data was statistically analysed. The Chi-square test was used to compare variables and a p value less than 0.05 was considered statistically significant. Ratio and percentages were calculated and tabulated. The results were described, summarised and presented in tables.

RESULTS

Records of 200 patients were evaluated with a male:female ratio of 1.22:1. Out of the total evaluated 200 cases, 130 cases were with normal development and 70 with GDD/ID. We observed that patients aged 2-6 yrs. old were the largest group (45.50%).

	0-1 Year	2-6 Years	7-12 Years	Total
Refractive error	22	73	75	170
Amblyopia	11	51	29	91
Strabismus	8	43	28	79

Table 1. Number of Cases of Refractive Error, Amblyopia and Strabismus According to Age Group

22 cases of age group 0-1 year, 73 cases of age group 2-6 years and 75 cases of age group 7-12 years were diagnosed with refractive errors, which were the most common ocular disorder seen (85%). Wherein, 32.94% children were cases of global developmental delay/intellectual disability and 67.06% had normal development. 11 cases of age group 0-1 year, 51 cases of age group 2-6 years and 29 cases of age group 7-12 years were diagnosed with amblyopia, which was 45.50% and 8 cases of age group 0-1 year, 43 cases of age group 2-6 years and 28 cases of age group 7-12 years were diagnosed with strabismus that was 39.50%. Age group of 7-12 years have maximum number of refractive errors (44.11%). It was observed that 2-6 years of age group has highest number of amblyopia cases (56.04%) and strabismus was more common in the age group of 2-6 years (54.43%).

	0-1 Year	2-6 Years	7-12 Years	Total
Amblyopia with refractive error	10	42	26	78
Amblyopia without refractive error	1	9	3	13

Table 2. Number of Cases of Amblyopia with or without Refractive Error According to Age Group

10 cases of age group 0-1 year, 42 cases of age group 2-6 years and 26 cases of age group 7-12 years were had amblyopia with refractive error. In contrast to this, 1 case of age group 0-1 year, 9 cases of age group 2-6 years and 3 cases of age group 7-12 years had amblyopia without refractive error.

7 cases of age group 0-1 year, 27 cases of age group 2-6 years and 19 cases of age group 7-12 years were diagnosed as strabismus with refractive error, wherein 1 case of age group 0-1 year, 16 cases of age group 2-6 years and 9 cases of age group 7-12 years had strabismus without refractive error.

	0-1 Year	2-6 Years	7-12 Years	Total
Strabismus with refractive error	7	27	19	53
Strabismus without refractive error	1	16	9	26

Table 3. Number of Cases of Strabismus with or without Refractive Error According to Age Group

Esotropia was found to be the commonest type of strabismus (56.96%). Children with global developmental delay/intellectual disability having refractive error with amblyopia were more in number (54.92%) as compared to children with normal development having refractive error with amblyopia. In contrast to this, children with normal development having refractive error with strabismus were more in number (62.50%) as compared to children with global developmental delay/intellectual disability having refractive error with strabismus.

	0-1 Year	2-6 Years	7-12 Years	Total
Amblyopia with refractive error having GDD	8	23	10	41
Amblyopia with refractive error having ND	2	18	16	36

Table 4. Number of Cases of Amblyopia with Refractive Error having GDD vs. ND According to Age Group

8 cases of age group 0-1 year, 23 cases of age group 2-6 years and 10 cases of age group 7-12 years had amblyopia with refractive error having GDD/ID. In contrast to this, 2 cases of age group 0-1 year, 18 cases of age group 2-6 years and 16 cases of age group 7-12 years were diagnosed as amblyopia with refractive error having normal development. This was statically significant as with Chi-square test, the p value is 0.001 (for 95% confidence interval). However, cases of age group 0-1 year, 10 cases of age group 2-6 years and 6 cases of age group 7-12 years had strabismus with refractive error having GDD/ID. 2 cases of age group 0-1 year, 18 cases of age group 2-6 years and 15 cases of age group 7-12 years had strabismus without refractive error having normal development.

	0-1 Year	2-6 Years	7-12 Years	Total
Strabismus with refractive error having GDD	5	10	6	21
Strabismus with refractive error having ND	2	18	15	35

Table 5. Number of Cases of Strabismus with Refractive Error having GDD vs. ND According to Age Group

There was no statistical significance as Chi-square for 95% confidence interval was p=0.667.

DISCUSSION

This hospital-based retrospective study was done to know the prevalence of refractive error in children with normal development, which was 67.04% and in global development delay/intellectual disability children was 32.94%. This high prevalence can be explained by the fact that it includes children referred with specific complaints of headache, blurring of vision and deviation of eyes.

We found that in our study strabismus is more (39.50%) as compared to a report carried out in Iraq, which showed the prevalence of strabismus as 12.1%.[9]In contrast to a study done in China,[10] proportion of esotropia was more in our study correlating with other studies done in India. It was observed that in our study refractive error with amblyopia is more in children with GDD/ID as compared to normal children and this was statistically significant as, p=0.001. This could be explained by the fact that it is a spectrum of disease involving delayed and stunted development of the brain and the eye. Evaluation of visual acuity is difficult and maybe underestimated and enough efforts are not taken to evaluate visual acuity in them. The fact that refractive error itself is undiagnosed and neglected in children with GDD/ID having complex needs where the stress is on treating the associated systemic anomalies, thus losing out on the crucial years of growth, which makes all the difference when treated.

Limitations

This being a convenience sampling, prevents its generalisation to the population as a whole as it overestimates the incidence compared to the population. However, the strength of our study is it gives a general view of the pattern of prevalence of amblyopia and strabismus in children with refractive error. It also gives a comparative picture of the prevalence of the same in children with normal development and in children with GDD/ID. This helps in focusing our screening programs on the youngest age groups and also creates awareness among the paediatricians and healthcare providers to stress on the importance of ophthalmic examination and visual screening of children with GDD at an early age.

CONCLUSION

Referral to ophthalmic care is quite essential in children with GDD/ID and normal development for their overall development and optimum care.

REFERENCES

[1] Gilbert C, Foster A. Childhood blindness in the context of vision 2020-the right to sight. Bull World Health Organ 2001;79(3):227-232.

[2] Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. Br J Ophthalmol 2012;96(5):614-618.

[3] Elkington A, Frank H, Greaney M. Clinical optic. Oxford: Blackwell Science Ltd 1999.

[4] Eggers HM. Amblyopia. In: Diamond GR, Eggers HM, eds. Strabismus and paediatric ophthalmology. London: Mosby 1993:1-17.

[5] Wiesel TN, Hubel DH. Single-cell responses in striate cortex of kittens deprived of vision in one eye. J Neurophysiol 1963;26:1003-1017.

[6] Haugen OH, Aasved H, Bertelsen T. Refractive state and correction of refractive errors among mentally retarded adults in a central institution. Acta Ophthalmology Scand 1995;73(2):129-132.

[7] Uemura Y, Agucci Y, Katsumi O. Visual development delay. Ophthal Paeditr Genet 1981;1:4-11.

[8] Solomon CB, Bindu N. Ocular associations in children with developmental delay. Kerala J Ophthalmology 2011;23(4)367-371.

[9] Salman MS. Padiatric eye diseases among children attending outpatient eye department of Tikrit teaching hospital. Tikrit J Pharmac Sciences 2010;7(1):95-103.

[10] Fu J, Li SM, Liu RL, et al. Prevalence of amblyopia and strabismus in a population of 7th grade junior high school students in central China: the Anyang Childhood Eye Study (ACES). Ophthalmic Epidemiol 2014;21(3):197-203.

(p) ISSN 2320 - 0367
(e) ISSN 2320 - 0375
October-December 2015

National Journal Of Medical And Dental Research

NJMDR

Affiliated to Association of Orthopaedics Surgical and Dental Sciences

Indexed in Index Copernicus International

Editor in-chief
D. R. Galfat

www.njmdr.co.in

Original Article National Journal of Medical and Dental Research, October-December 2015: Volume-4, Issue-1, Page 32-35

Refractive Error And Visual Function In Children Attending The Out Patient Department At Kle's Dr. Prabhakar Kore Hospital And Medical Research Centre

Smitha K S[A], V.D. Patil[B], Mahesh Kamte[B], Umesh Harakuni[C], Shivam Sethi[D]

[A] - Assistant Professor, Department of Ophthalmology and Department of Medicine, Jawaharlal Nehru Medical College, Belgaum

[B]- Professor, Department of Pediatrics, J N Medical College, Belgaum

[C]-Professor, Department of Ophthalmology and Department of Medicine, Jawaharlal Nehru Medical College, Belgaum

[D]- Post graduate student, Department of Ophthalmology and Department of Medicine, Jawaharlal Nehru Medical College, Belgaum

Ophthalmology

Corresponding Address

Dr. Shivam Sethi
Charaka PG Boys Hostel
Room Number 80,
Jawaharlal Nehru Medical College, Belgaum
Karnataka. Pin code 590010
Mob 9686858428;
Email: shivam_64466@hotmail.com

Abstract:

Developmental disabilities are on a rise in children in the present time. Ocular and visual anomalies are frequently associated with it of which refractive errors are the most frequent. This if goes unnoticed leads to intellectual disability in them. This study aims to assess all the children attending the Ophthalmology OPD for any refractive error and give correction for it. It also aims to identify the children with developmental disabilities and classify the refractive errors in them and provide rehabilitation. 113 consecutive children from 1-15 years of age who attended the Ophthalmology OPD from October 2014 to September 2015 were evaluated for Demographic data, ocular complaints, status of visual acuity and type of refractive error. 75% out of 68 children with ID had refractive errors. Hypermetropia accounted for the higher proportion of cases in both normal and special needs. Owing to the high percentage of refractive error, ophthalmological referral becomes essential in children with developmental disabilities.

Keywords: Childhood Blindness, Refractive Error, and Developmental Disabilities

Introduction:

Developmental disabilities are on the raise in children, with a 5-10% prevalence.[1] A developmental disorder is described as failure of a specific ability to present within the expected time frame. Delayed development proceeds similar to normal development but at a slower rate.

There is an increasing frequency of ocular and visual anomalies among children with developmental delay.[2] Of the various ocular manifestations, refractive error is the most common finding (51%), followed by optic atrophy (21%), strabismus (18%) and cortical visual impairment (11%).[3]

Although ID is not treatable, associated impairments are amenable to intervention and benefit from early identification and vision is one of them. Undetected visual impairment may lead to an underestimation of intellectual ability.[4] Warburg reports that mentally handicapped children with visual impairments are inappropriately classed as profoundly handicapped more often than sighted children with equivalent levels of mental handicap.[4] All this occurs because of unidentified, uncorrected refractive errors. This hampers their sensory input going to the brain development. This applies for the syndromic and non-syndromic distinctions too.

The objectives of the study were to evaluate the all the children attending ophthalmology OPD for ocular complaints; to assess the refractive status and give correction with spectacles; to know the associated Developmental disability if any.

Materials and methods:

All consecutive children from 1-15 years of age attending the Ophthalmology outpatient department were included in the study.

Progressive neurodegenerative conditions like Neurodegenerative disorders and children with no perception of light were excluded. The study conducted from October 2014 to September 2015.

Method:

All consecutive children from 1 to 15 years of age attending the Ophthalmology OPD of KLES hospital were enrolled after taking informed consent from the legal guardian/ parent.

Demographic data, ocular complaints, status of visual acuity and type of refractive error were included in the questionnaire.

Visual Acuity was measured at a distance of 6 meters using the Snellen E Chart and was classified as per WHO classifications: ≥6/18, <6/18-6/24, ,6/24-6/60, <6/60-3/60, and <3/60- NLP. Children in whom the above method was not feasible Preferential looking test using Teller acuity cards (TAC) were used to asses the Vision.

Complete ocular examination was done including anterior segment examination by slit lamp and torch. Posterior segment examination was carried out by dilated fundoscopy.

Glasses are prescribed on the basis of cycloplegic retinoscopy.

Definitions and Statistical Analysis:

The patients were classified into three age groups (<5 years, 6-10 years, 11-15 years) and evaluated. Term global developmental delay/GDD is reserved for children younger than five years, whereas the term intellectual disability/ ID is usually applied to older children, when IQ testing is more valid and reliable.[5,6]

Statistical analysis was carried out with SPSS 20.0 statistics package. All the children with ocular disorders were prescribed spectacles. Caretakers were counseled regarding the environment of the child, which is to be made low vision friendly.

Results:

Description of the Study Population:

A total of 113 children were examined during the study period. Out of them 62 (54.9%) were males and 51 (45.1%) were females with mean age of 4.25 years ± 3.02 (age range 1-15 years).

Table 1:
Study Population

Gender	Number
Male	62
Female	51
Total	113

Table 2:
Age Groups

Age Groups	Number
Under 6 years	77
6-10 Years	31
11-15 Years	5
Total	113

Table II depicts the Age Groups in which the subjects were classified. Most of the children were in the age group below 6 years (68.1%) followed by 6-10 years (27.4%) and above 10 years (4.4%).

Table 3:
Subject Classification

	Number
Normal	45
Special needs	68
Total	113

Table III depicts that Out of the total subjects evaluated, 68(60.2%) presented with intellectual disability, which is considerable high owing to the fact that the study was carried out in the children attending the outpatient department for some complaints.

Status of Refractive Error:

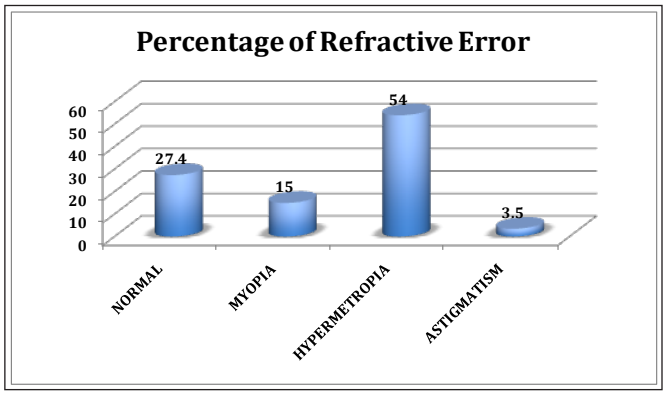


Figure I: Prercentage of refractive error

As shown in the figure 1, in the present study maximum children were diagnosed with Hypermetropia followed by myopia and astigmatism while 27.4% children were without any refractive error.

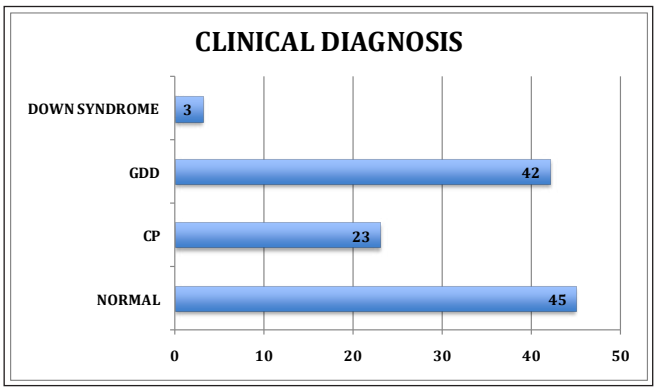


Figure II: associated clinical disease

Figure 2 shows that maximum children were free of any associated disease. 42 children had Global developmental delay, 23 children had some form of cerebral palsy and 3 cases of Down syndrome presented to the outpatient department.

Discussion:

Visual impairments affect intellectual development and motor achievement by hampering neurological development i.e., defects of the ocular refractive system reduce the visual input, which further inhibits sensory, perceptual and cognitive development.[8] Unrecognized visual impairment is a missed chance for adequate treatment

American association of neurologists says that early diagnosis of a child with global delay may improve outcome i.e., in their formative early years

Prompt identification and correction of refractive errors makes a huge impact on their daily functioning, as this is "treatable visual impairment".

Most of the studies evaluating ocular findings in individuals with intellectual disability done from a public health perspective have been on adults. This being a major constraint, since at this age, they develop amblyopia and are beyond any treatment.

We have tried to focus our study on the paediatric age group but subject's upto 15 years of age are include in the study.

Limitation: all subjects recruited were from hospital ophthalmic outpatient department, so these may not be representative of the general population as a whole.

If taken from general population, then the difference between the two groups would probably be more marked.

The ID groups included patients as young as one year of age, where as the children with normal development usually attend the hospital at a slightly later age-majority falling in the 1-15 years age group. Age is a significant factor because many outcome variables change drastically with age in the normal children in the first few years.

Uncorrected refractive errors are the main cause of vision impairment in children of both categories according to WHO.[9] This issue remains unaddressed in majority of countries all over the world.

In our study, 75% out of 68 children with ID had refractive errors. The study done in Oman had a prevalence of 58.5% in children with special needs.[10]

Castanet et al. study showed a prevalence of 58.7% in a similar setting. All these studies were carried out on mentally challenged kids in the age range of 5-16 years.[10] The Oman study also found 80% prevalence of refractive errors in children with Down syndrome.[10] Since our study included children under 5 years kids also and majority of cases were of Global developmental delay, followed by cerebral palsy, explains the higher prevalence of refractive errors.

Our study also had a high proportion of refractive errors in normal children, i.e., 68.8%. This disproportional prevalence can be explained by the fact that these kids are

the ones attending the hospital with some ocular complaints, in contrast to other studies done in healthy school going children.[10]

Hypermetropia accounted for the higher proportion of cases in both normal and special needs, correlating with all other studies. However, there was no difference in the pattern of distribution of various refractive errors in both the groups.

Conclusion:

Referral to ophthalmic care is quintessential for their overall development and optimum care.

References:

1. Shevell, M et al. Practice Parameter: Evaluation of the child with global developmental delay. Neurology 60, February 1(2003): 367-80.

2. Olav H. Haugen, Henry Aasved, Torstein Bertelsen. Refractive state and correction of refractive errors among mentally retarded adults in a central institution. Acta Ophthalmol Scand.1995;73:129-132.

3. Charmaine Bridgette Solomon MS, Bindu N MS. Ocular associations in children with developmental delay. Kerala Journal of Ophthalmology.2011;367-371.

4. Warburg M. Why are the blind and severely visually impaired children with mental retardation much more retarded than the sighted children? Acta Ophthalmol Suppl. 1983;157:72-81.

5. Simeonsson RJ, Simeonsson NW. Developmental surveillance and intervention. In: Hoekelman RA, Adam HM, Nelson NM, Weitzman ML, Wilson MH, eds. Primary pediatric care, 4th ed. St. Louis: Mosby, 2001; 274–282.

6. Kinsbourne M, Graf WD. Disorders of mental development. In: Menkes JH, Sarnat HB, eds. Child neurology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2001; 1155–1211.

7. Bruce K,Shapiro, Mark L Batshaw. Intellectual Disability.In: Nelson Textbook of Pediatrics, 19th ed. Philadelphia: WB Saunders, 2011;122-129.

8. Bader D, Woodruff ME. The effects of corrective lenses on various behaviors of mentally retarded persons.Am J Optom Physiol Opt. 1980 Jul;57(7):447-59.

9. Levy B. Incidence of oculo-visual anomalies in an adult population of mentally retarded persons. Am J Optom Physiol Opt. 1984 May;61(5):324-6.

10. Urmi Vora, Rajiv Khandekar, Sarvanan Natrajan, Khalfan Al-Hadrami, Refractive error and Visual Function in children with special needs compared with first grade school students in Oman. Middle East Afr J Ophthalmol. 2010 Oct-Dec: 17(4):297-302.

ISSN (e) : 2320-7582
ISSN (p) : 2278-7526
www.medicainnovatica.org

INDEXED

Medica Innovatica

Jul - Dec 2014 | Volume 3 | Issue 2

An International peer reviewed biannual medical journal

An official publication of
B.V.V.Sangha's
S. Nijalingappa Medical College and H. S. K. Hospital and Research Centre
BAGALKOT-587102, KARNATAKA, INDIA.

Prevalence of ocular manifestations in children with developmental delay

KS Smitha, P Harshavardhan, SB Patil, BK Bhagyajyoti, VG Sheetal, SVKathyayini
Department of Ophthalmology, JN Medical College, KLE University, Belgaum. Karnataka

Abstract

Aim: This is a study conducted in children with developmental delay, to describe the prevalence of various ocular abnormalities in children with developmental delay.

Materials and methods : Children under 12 years with developmental delay attending the child development clinic and referred to department of ophthalmology for eye examination were studied for the presence of ocular manifestations by undergoing a complete ophthalmic examination and the prevalence of different conditions was statistically analysed.

Results : Children with developmental delay were studied over a period of 12 months and ocular manifestations were seen in 83.6% of cases. Amongst the various ocular manifestations, refractive error was found to be the most common finding (59.7%). The second common diagnosis was optic atrophy (9.7%) followed by strabismus (8.69%), cortical visual impairment (4.3%) and ptosis (1.08%).

Conclusion : Visual handicap plays a significant role in overall disability of developmental delay children. Hence an early ophthalmologic screening and intervention in these children can help to substantially improve the developmental and academic achievement.

Key Words: Developmental delay, Refractive error, Strabismus, Optic atrophy, Amblyopia.

Introduction

Developmental delay is operationally defined as significant delay in two or more developmental domains. The developmental domains are Gross motor, Vision and fine motor, Speech, Hearing and language, Personal/social. Significant delay is defined as performance or ability of two standard deviations or more below the mean on accepted norm-referenced developmental testing i.e. Denver Developmental Screening Test.

It has been reported that certain deficits often go untreated either through lack of diagnosis or unawareness of their importance in developmental delay population and they receive less than average care. High on the list of such deficits are vision and audition. Amblyopia is one entity which has always been less investigated in children with developmental delay and assessment and management of visual deprivation in challenged children is a complex challenge to the treating clinician. The main aim of this study was to show the ocular characteristics of a group of developmental delay children of different intelligent quotient (IQ) and age who were examined and provided with visual care.

We have several published studies using animal models that have shown the dramatic effects that various forms of sensory disturbance and deprivation can have on the developing visual system. Hence this attempt was made to study the prevalence and ocular abnormalities as a part of ophthalmological screening examination for patients referred from pediatric clinic of our hospital as, development and academic achievement can be enhanced in the formative early years.

Address for Correspondence
Dr. Sheetal V Girimallanavar, Post Graduate, Department of Ophthalmology
J. N. Medical College, KLE University Belgaum-590010, Karnataka, India.
E-mail:- sheetal.girimallanavar@gmail.com

Materials and methods

Study design- Prospective study This study was conducted in the department of Ophthalmology in children under 12 years with developmental delay over a period of one year. Scale used to assess developmental delay- Social quotient, emotional quotient, intelligence quotient. Only children fulfilling criteria of developmental delay in this test as assessed by a pediatric specialist and pediatric psychologist were included in the study. Patients were included in the study only after obtaining an informed consent from the parents. Family history regarding consanguinity or affected family members were asked for. Ocular complaints regarding visual inattention, deviation of eyes, nystagmus, abnormal head posture were enquired.

Ophthalmological assessment included routine ocular examination with special reference to structural observation of external eye, examination of strabismus, visual acuity testing, complete cycloplegic refraction (with atropine) and detailed fundus examination. The biggest challenge was evaluation of vision and visual correction in these children who had delayed development. The visual acuity testing was hence done beginning from central steady maintained vision to clear fixation preference using Teller Acuity Cards for children below 3 years, Lea Symbol chart for children above three years and who are unable to read alphabets on Snellen chart and Snellen chart for the rest as, conventional testing methods are often impractical and unsuccessful for a reliable estimation of visual deficiency. Other ocular investigations like slit lamp examination was done in indicated cases. The data obtained was evaluated statistically .

Results

Table 1. Distribution of patients according to age of presentation and their percentage

Age at presentation	6 Months - 1 year	1–3 years	3-7 years	7-10 years	10-12 years
Percentage	28.26%	35.8%	27.1%	4.3%	4.3%

Table shows that highest number of patients were between 6 months to 1 year of age

Table 2. Distribution of patients according to gender

Gender	Males	Females
Number	65	27
Percentage	70.6%	29.3%

Table shows male children had high prevalence of ocular manifestation

Consanguinity: Consanguinity between parents was seen in 12cases.

Ocular Features

Table 3. Distribution of patients according to refractive errors

Refractive status	Hypermetropia	Myopia	Astigmatism
Number	35	10	10
Percentage	38.04%	10.86%	10.86%

Table shows that hypermetropia is more common than myopia and astigmatism

Table 4. Distribution of patients according to type of strabismus

Strabismus	Esotropia	Exotropia
Percentage	37.5%	62.5%

Table shows that exotropia was more common than esotropia

Table 5. Distribution of patients according to other manifestations like cataract, cortical visual impairment, optic atrophy, ptosis

Others	Cataract	Cortical Visual Impairment (CVI)	Optic Atrophy	Ptosis
Number	None	4	9	1
Percentage	None	4.34%	9.78%	1.08%

Table shows that optic atrophy was highest amongst other types of manifestation

Discussion

Majority of patients with developmental delay have associated visual and ocular abnormalities. Visual impairment delays or alters both visual and general development of the child. Though there is substantial evidence documenting increased frequency of ocular and visual anamolies among mentally and developmentally challenged children they are overlooked as they have other associated handicaps.

Over a course of one year 92 children under the age of 12 years with developmental delay were screened. Of the 92 children studied, 65 were males and 27 were females forming 70.6% and 29.3% respectively. In a study by Wu H J et al[1] sex distribution was found to be 68% males and 32% females which is similar to our study. Presentation age was found to be maximum of around 35.8% (Table 1,2) around the age group of 1 to 3 years suggesting that the parents are aware of the condition at this age and try maximally for medical assistance during this period and with growing years their enthusiasm and hope fade. History of consanguinity was present in 12 cases constituting 13.04% . The non ophthalmic diagnosis in majority of these cases was cerebral palsy. Ocular manifestations in children with developmental delay were seen in 83.6% cases in this study. This is comparable with studies conducted by Akinci A et al[2] who reported that 77% of children with intellectual disability had ocular features. Another study by Katoch S et al3 found that 68% of children with cerebral palsy had visual morbidity. The high incidence of visual morbidity in this population is probably related to the lesions in the subcortical oculomotor centres or cerebellar lesion. The most common ocular manifestation noted in this study were refractive errors (59.7% cases) (Table 3). It has been noted in few studies that these kids have a tendency of going towards wide ranges of spherical refractive values both in myopic and hypermetropic direction and many studies have even shown that hypermetropia accounts for maximum percentage in these children which is similar to findings in children without any developmental delay. Even our study showed majority having hypermetropia (38.04%) compared to myopia (10.86%). Only difference was seen in a study showing maximum of myopes, this could be explained by the fact that different forms of cerebral palsy might present with different type of refractive error, say myopia is reportedly more frequent in spastics while hypermetropia in dyskinetics. As age advances the refractive errors change. Optic atrophy was the second most common finding seen in 9.7% cases. Strabismus was seen in 8.69% of cases, cortical visual impairment in 4.3% and ptosis in 1.09% (Table 4,5).

Bankes et al[4] studied 200 children with developmental delay and found refractive errors in 49%, squint in 37%, nystagmus in 7.5% and other features like cataract, optic atrophy and retinopathy of prematurity. Akinci A et al[2] studied refractive errors and ocular findings in children with multiple disabilities and found that 77% of patients with intellectual disability had ocular findings.

Children with intellectual disability had more strabismus, nystagmus, hypermetropia and astigmatism than controls and increasing severity of intellectual disability was related to higher prevalence of the above features. Mets M B et al[5] studied causes of childhood blindness and visual loss in an institution for severely mentally retarded children and found bilateral optic atrophy to be the most common cause of visual loss(65%). The second most common cause was cortical visual impairment followed by chorioretinal scars.

Cortical visual impairment is thought to be the end-result of hypoxic ischemic insult to the developing brain in-utero and worsens the visual outcome in these patients. But it is also seen that these are the patients who improve drastically with visual rehabilitation.

Only 16.3% of the children screened had normal vision. 59.7% had refractive errors confirming that this group accounts for the big chunk of low vision in these children.

Conclusion

In developmentally delayed children visual handicap plays an important role in the overall morbidity. Hence all pediatricians must be encouraged to seek ophthalmologic assistance in management of these children and help to substantially improve the developmental and academic achievements.

References

1. *Wu HJ, Tsai RK, Dept of Ophthalmology,Kaohsing University,Taiwan, Kaohsing J Med Sci 2000.16(8)422-428.*
2. *Akinci A, Oner O, Bozkurt OH, Guven A, Degerliyurt A, Munir K.Refractive errors and ocular findings in children with intellectual disability: a controlled study. J AAPOS. 2008;12(5):477-81.*
3. *Katoch S, Devi A, Kulkarni P. Ocular defects in cerebral palsy. Indian J Ophthalmol. 2007 Mar-Apr;55(2):154-6.*
4. *Kennerley JL, Bankes. Eye Defects of Mentally Handicapped Children. British Medical Journal, 1974, 2, 533-535.*
5. *Mets MB. Childhood blindness and visual loss: an assessment at two institutions including a "new" cause. Trans Am Ophthalmol Soc. 1999; 97:653-96.*

Source of Support : **Nil**
Conflict of Interest : **None Declared**

SL No.	Name	Age	Sex	Gestation Period	Gestation period weeks	Delivery	Milestones	Consanguinity	Vision with teller acuity card		Visual Axis	Extra Ocular Movement	Nystagmus	Refractive Error	Subjective Refraction		Pre Development quotient			Post Development quotient			Vision with teller acuity card		Social Behavioural Changed	Pre	Post	Birth Weight
									RE1	LE1				0,1,2,3	RE	LE	MEQ1	MOQ1	PCDTP 1	MEQ2	MOQ2	PCDTP 2	RE2	LE2				
slno	name	Age	Sex	gp	weeks	Delivery	miles	cons	VNR1	VNL1	VAX	EOMS	NYS	REF	RE	LE	MEQ1	MOQ1	PCDTP1	MEQ2	MOQ2	PCDTP2	VNR2	VNL2	SOC. BEH	DQ1	DQ2	BW
1	LAXMI	5	1	1	37	0	1	1	0.32	0.32	0	0	0	1	+3.0	+3.0	99	99	39	99	99	41	0.32	0.32	1	39	41	
2	SOHAM SHINDE	1.6	0	0	32	0	1	0	0.43	0.43	0	0	0	0	-3.0	-3.0	44	42	99	47	43	99	0.86	0.86	2	44	47	1900
3	MISBAH U C	3	1	1	39	2	1	1	6.5	6.5	0	0	0	0	-1.5	-2..0	99	99	67	99	99	72	9.8	9.8	2	67	72	3000
4	NAGALINGA KRISHNA PATTAR	1.6	0	1	38	0	1	2	0.64	0.64	0	0	0	1	+5.0	+5.0	13.1	30.3	99	44.6	40.32	99	2.4	2.4	2	30	40	2800
5	DIVYA VASANTH KUMAR	2.6	1	1	40	0	1	1	0.23	0.23	0	0	0	1	+3.0	+3.0	99	99	30	99	99	19	0.23	0.23	1	30	19	2900
6	SIDDHARTH BADIGER	1.6	0	1	40	1	1	0	0.32	0.32	0	0	1	2	+1.5	+1.5	7.6	5.8	99	9.1	6.7	99	0.32	0.32	1	7.6	9.1	3600
7	PRAYAKTA	5	1	1	39	0	1	0	19	19	2	0	0	0	-0.75	-0.5	99	99	55	99	99	61	38	38	2	55	61	3000
8	VEKATESH UMARJI	4	0	1	40	1	1	1	13	13	2	1	1	0	-1.5	-3..5	99	99	65	99	99	69	19	19	2	65	69	3000
9	SHRIDEVI OSI	1	0	1	40	0	1	1	0.32	0.32	0	0	1	0	-5.0	-6.0	51.13	35.83	99	67.77	41.38	99	0.86	0.86	2	51	67.7	3500
10	UMAR RIYAZ	1	0	1	40	0	1	0	0.23	0.23	0	0	0	1	+4.0	+4.0	99	99	99	99	99	99	0.23	0.23	1	23	26	2800
11	CHANNABASAYYA HEREMATH	3	0	1	39	0	1	0	0.23	0.23	0	0	0	1	+2.5	+2.5	99	99	30	99	99	19	0.23	0.23	2	30	19	2700
12	PAVAN KUMAR MELKAR	1	0	1	40	2	1	0	0.64	0.64	0	0	0	1	+3.5	+2.5	26	17.1	99	35	22.1	99	1.6	1.6	2	26	35	4000
13	RITESH GOUDA	1	0	1	40	0	1	0	0.23	0.23	2	0	1	1	+1.0	+1.0	22.3	38.1	99	26	12.2	99	0.23	0.23	1	22.3	26	2800
14	POONAM	1.2	1	1	38	0	1	1	0.43	0.43	0	0	0	1	+2.0	+2.0	46.87	46.25	99	52	51	99	1.6	1.6	2	46.9	52	3000
15	BHOOMIKA	1.2	1	1	40	0	1	0	26	26	1	0	0	1	+2.5	+2.5	45.71	30.7	99	56	47	99	38	38	2	45.7	56	3000
16	FARHAN MALIK	1.5	0	0	28	0	1	0	0.32	0.32	0	0	1	2	+1.0	+1.5	19	13.3	99	22.46	14.2	99	0.32	0.32	1	19	22.5	2000
17	SANVI S PATIL	1	1	1	38	0	1	0	0.32	0.32	1	0	0	1	+4.0	+4.5	39.16	35.83	99	42.22	41.38	99	0.64	0.64	2	39.2	42.2	2800
18	ASAD BEGAMAN	1.1	0	1	37	2	1	1	0.23	0.23	0	0	0	1	+3.0	+3.0	25.1	38.13	99	31.77	12.22	99	0.23	0.23	1	25.1	31.8	1750
19	ASAD	1	0	1	38	0	1	1	0.32	0.32	1	0	0	1	+2.0	+2.5	19.1	23.6	99	13	28.1	99	0.64	0.64	2	19.1	13	2750
20	VAISHNAVI HATTI	1	1	1	39	0	1	1	0.32	0.32	0	0	0	0	-3.0	-3.0	25.2	13.3	99	36.6	23.71	99	0.64	0.64	2	25.2	36.6	2000

SL No.	Name	Age	Sex	Gestation Period	Gestation period weeks	Delivery	Milestones	Consanguinity	Vision with teller acuity card		Visual Axis	Extra Ocular Movement	Nystagmus	Refractive Error	Subjective Refraction		Pre Development quotient			Post Development quotient			Vision with teller acuity card		Social Behavioural Changed	Pre	Post	Birth Weight
									RE1	LE1				0,1,2,3	RE	LE	MEQ1	MOQ1	PCDTP 1	MEQ2	MOQ2	PCDTP 2	RE2	LE2				
slno	name	Age	Sex	gp	weeks	Delivery	miles	cons	VNR1	VNL1	VAX	EOMS	NYS	REF	RE	LE	MEQ1	MOQ1	PCDTP1	MEQ2	MOQ2	PCDTP2	VNR2	VNL2	SOC. BEH	DQ1	DQ2	BW
21	IKRA BASTWAD	2.6	1	1	38	0	1	1	19	26	0	0	0	1	+3.0	+3.0	99	99	51	99	99	56	19	19	2	51	56	2500
22	PRAJWAL MUDAYAL	5	0	1	38	0	1	1	0.43	13	1	0	0	0	-7.0	-5.0	99	99	25.8	99	99	28	0.64	19	1	25.8	28	2700
23	SARFARAJ	1.2	0	1	37	0	1	0	0.23	0.23	0	0	0	1	+4.0	+4.0	25.1	13.2	99	26	12.2	99	0.23	0.23	0	25.1	26	2200
24	GANESH	5	0	1	40	0	1	0	1.6	1.6	0	0	0	1	+2.5	+2.5	99	99	44.1	99	99	48	3.2	3.2	2	44.1	48	3000
25	MOIZE M LODHI	1	0	1	37	0	1	0	0.23	0.23	1	1	0	1	+2.0	+2.0	38.13	38.13	99	13.3	12.2	99	0.23	0.23	1	38.1	13.3	3500
26	HERAWAE YASHIN MAIBOOB	2.9	0	0	28	0	1	0	0.32	0.32	0	0	0	1	+3.0	+3.0	99	99	38	99	99	41	0.32	0.32	1	38	41	2300
27	LAKKAPPA	5	0	1	38	0	1	0	0.23	0.23	0	0	1	2	-2.0	-2.0	99	99	26	99	99	28	0.23	0.23	1	26	28	2900
28	VIJAYLAXMI PATIL	1.6	1	1	40	0	1	0	19	19	0	0	0	1	+3.0	+3.0	56.38	52.22	99	60	60	99	26	26	2	56.4	60	3000
29	ASHWINI	2	1	1	38	0	1	1	19	19	0	0	0	1	+3.5	+3.5	50.8	47.08	99	53.13	51.33	99	26	26	2	50.8	53.1	2800
30	DARSHAN THONGALE	1	0	0	36	0	1	0	0.23	0.23	0	0	0	1	+1.0	+1.0	26.1	11.66	99	30	12.22	99	0.23	0.23	1	26.1	30	2600
31	SANVI PATIL	1.3	1	1	37	0	1	0	0.32	0.32	1	0	0	1	+4.0	+4.0	50	9.33	99	49.3	10.1	99	0.32	0.32	1	50	49.3	3500
32	AARIF MOHAMMAD RAFIQ	5	0	1	37	0	1	1	19	19	0	0	0	1	+1.0	+2.0	99	99	54.1	99	99	59	38	38	2	54.1	59	1500
33	IRAWWA	1	1	1	38	0	1	1	0.23	0.23	1	0	0	0	-2.5	-2.5	26	12.2	99	30.1	38.12	99	0.23	0.23	1	26	30.1	2300
34	RANJEETA HADIMANI	4	1	1	39	0	1	1	0.43	0.43	0	0	0	0	-5.0	-5.0	99	99	51	99	99	59	0.86	0.86	2	51	59	3000
35	SWEETY MALAVI	1.3	1	1	38	0	1	1	1.3	1.3	0	0	0	1	1.5	1.5	41.33	36.13	99	48.09	40.47	99	2.4	2.4	2	41.3	48.1	3000
36	ARJUN SHINDE	1.4	0	1	39	0	1	0	0.23	0.23	0	0	0	1	+3.0	+3.0	99	99	36	99	99	38	0.23	0.23	2	36	38	9999
37	SANSKAR LAXMAN SALAI	2	0	1	40	0	1	0	0.23	0.23	2	0	0	1	+3.0	+3.0	41.6	11.1	99	47.6	12.2	99	0.23	0.23	1	41.6	47.6	2750
38	NAITIK	1.6	0	1	39	0	1	1	0.86	0.86	0	0	0	1	+1.0	+1.0	42.22	19.22	99	50.83	39.16	99	1.6	1.6	2	42.2	50.8	2000
39	RADHIKA	3	1	1	38	2	1	0	0.32	0.32	0	0	0	1	+6.0	+6.0	99	99	55	99	99	61	0.64	0.64	2	55	61	2700
40	BHAVANI	3.3	1	1	39	2	1	1	0.23	0.23	1	0	0	1	+1.0	+1.5	99	99	47.5	99	99	48	0.23	0.23	1	47.5	48	2000
41	MALLAMMA	3.1	1	1	40	0	1	0	0.23	0.23	0	0	0	1	+1.0	+1.0	99	99	45.9	99	99	50	0.32	0.32	2	45.9	50	2800
42	PRAJWAL PUJAR	3.6	0	1	38	0	1	0	0.23	0.23	0	0	0	0	-4.0	-4.0	99	99	64	99	99	69	0.32	0.32	1	64	69	9999
43	BHARATI HADPAD	3	1	1	37	0	1	0	0.23	0.23	0	0	0	1	+5.0	+3.0	99	99	45	99	99	48	0.23	0.23	1	45	48	3000
44	PRITAM PUNJATI	4	0	0	35	0	1	0	0.64	0.64	0	0	0	1	+1.0	+1.0	10	5.53	46	12	7.2	46	0.64	0.64	1	10	12	2200
45	PRAJWAL TALWAR	3	0	1	38	0	1	0	0.23	0.23	0	0	0	1	+1.5	+1.5	99	99	51	99	99	59	3.2	3.2	2	51	59	3000
46	RIYA BALI	1.1	1	1	37	0	1	0	0.64	0.64	1	0	0	1	+2.0	+1.0	62.5	53	99	67.7	54.4	99	0.86	0.86	2	62.5	67.7	2700
47	MEHABUBI SANADI	2.4	1	1	39	0	1	1	0.23	0.23	1	0	0	1	+2.0	+2.0	5.13	9.28	99	99	99	52	0.32	0.32	2	5.13	52	9999
48	NAVEED AZAD	1	0	1	39	2	1	1	0.23	0.23	1	0	0	1	+3.5	+3.5	39.16	27.5	99	48.3	36.6	99	0.32	0.32	2	39.2	48.3	3500
49	SHARAVANI	1.3	1	1	39	0	1	0	0.32	0.32	1	0	0	1	+2.5	+2.0	58.13	50	99	61	62	99	0.43	0.43	2	58	61	2600

SL No.	Name	Age	Sex	Gestation Period	Gestation period weeks	Delivery	Milestones	Consanguinity	Vision with teller acuity card		Visual Axis	Extra Ocular Movement	Nystagmus	Refractive Error	Subjective Refraction		Pre Development quotient			Post Development quotient			Vision with teller acuity card		Social Behavioural Changed	Pre	Post	Birth Weight
									RE1	LE1				0,1,2,3	RE	LE	MEQ1	MOQ1	PCDTP 1	MEQ2	MOQ2	PCDTP 2	RE2	LE2				
slno	name	Age	Sex	gp	weeks	Delivery	miles	cons	VNR1	VNL1	VAX	EOMS	NYS	REF	RE	LE	MEQ1	MOQ1	PCDTP1	MEQ2	MOQ2	PCDTP2	VNR2	VNL2	SOC. BEH	DQ1	DQ2	BW
50	APOORVA MAILLIKARJUN	3	1	1	38	0	1	0	0.23	0.23	0	0	0	2	+1.25	+1.75	99	99	59	99	99	61	38	38	1	59	61	2300
51	AGAM	1.1	0	0	28	0	1	0	0.64	0.64	0	0	0	1	+2.0	+2.0	25.38	19.38	99	27.89	20.52	99	0.23	0.23	2	25.4	27.9	1100
52	SUKANYA TALWAR	3.6	1	1	38	0	1	1	0.86	0.86	0	0	0	1	+3.0	+3.0	99	99	52	99	99	58	1.3	1.3	2	52	58	2500
53	KAVYA	5	1	1	40	0	1	0	19	19	0	0	0	1	+0.5	+0.5	99	99	50	99	99	56	19	19	2	50	56	2000
54	CHAYA NAIK	3	1	1	40	0	1	0	3.2	3.2	0	0	0	1	+2	+2	99	99	13	99	99	41	3.2	3.2	2	13	41	3200
55	ARFA ABBAS BALIKATTI	2.2	1	1	39	0	1	1	4.8	4.8	2	0	0	1	+2.0	+2.0	38.46	36	99	99	99	52	9.8	9.8	2	38.5	52	9999
56	RASHMI LAKKUNDI	1	1	1	38	0	1	0	3.2	3.2	0	0	0	2	0.75	+1.0	59.16	41.38	99	67.7	51.6	99	4.8	4.8	2	59.2	67.7	2400
57	SHRADHA GOUDAR	4.10	1	1	40	0	1	0	4.8	4.8	0	0	0	1	+2.0	+2.0	99	99	55	99	99	61	19	19	2	55	61	2700
58	KARTIK SADANAND BAGI	1	0	1	40	0	1	1	0.23	0.23	0	0	1	0	-2.5	-2.0	59.16	12.5	99	61.3	38.88	99	0.23	0.23	1	59.2	61.3	2000
59	SUDHANVA D KULKARNI	1	0	1	39	1	1	0	0.23	0.23	0	0	0	1	+3.0	+3.0	24	11.6	99	32	12	99	0.23	0.23	1	24	32	2700
60	SANEKIYA PATIL	2	1	0	32	0	1	1	0.23	0.23	0	0	0	1	+2.0	+2.0	22	5.8	99	26	5	99	0.23	0.23	1	22	26	2000
61	DIVYA N MULABADI	4	1	1	40	0	1	0	4.8	4.8	0	0	0	2	+3.0	+2.0	99	99	61	99	99	65	19	19	2	61	65	3000
62	SANJANA	2	1	1	40	0	1	0	0.23	0.23	0	0	0	0	-0.5	-0.5	51.13	10	99	52	12.2	99	0.32	0.32	1	51.1	52	3000
63	PRAVEEN S MATHAPATI	1	0	1	39	1	1	1	0.23	0.23	0	0	0	1	+2.0	+2.0	38	10.3	99	26.2	12.2	99	0.23	0.23	1	38	26.2	2400
64	SANJANA PANDAV	1	1	1	40	0	1	1	0.23	0.23	0	0	0	1	+5.5	+5.5	22.1	10.6	99	24.16	11.33	99	0.23	0.23	1	22.1	24.2	2800
65	ANANYA SHILAR	4.6	1	1	40	0	1	0	38	38	1	0	0	1	+3.5	+3.5	99	99	70	99	99	74	38	38	2	70	74	2900
66	VAISHNAVI	4	1	1	38	0	1	1	1.3	1.3	1	0	0	1	+5.0	+5.0	99	99	61	99	99	65	1.6	1.6	2	61	65	2750
67	SPANDANA K TOLE	1	1	1	39	0	1	1	9.8	13	2	0	0	1	+1.5	+2.0	44.1	19.5	99	73.8	40.5	99	19	19	2	44.1	73.8	2900
68	VIJAYGOUDA PATIL	1	0	1	40	0	1	1	0.64	0.64	0	0	0	1	+1.5	+1.5	43.04	34.78	99	49.65	42.06	99	0.23	0.23	2	43	49.7	2800
69	IRANNA MATHAPATI	4	0	1	39	0	1	1	0.23	0.23	0	0	0	1	+1.5	+1.5	99	99	41	99	99	45	0.23	0.23	1	41	45	2700
70	RIHAN RAJ MOHAMMAD	4.6	0	0	30	0	1	0	0.32	0.32	0	0	1	0	-6.0	-8.0	99	99	38	99	99	41	0.43	0.43	1	38	41	1000
71	ASAD BAGAVAR	1.1	0	1	38	2	1	1	0.23	0.23	0	0	0	1	+3.0	+3.0	26	12.2	99	30	13	99	0.23	0.23	1	26	30	1750
72	POOJA JAMNAL	5	1	1	39	0	1	0	19	19	0	0	0	0	-2.0	-3.0	99	99	51	99	99	58	19	19	2	51	58	2900
73	CHANDAN B JADIYANNAVAR	1.1	0	1	39	2	1	1	0.23	0.23	2	0	0	0	-3.5	-3.5	40.43	19.17	99	42.06	19.41	99	0.32	0.32	2	40.4	42.1	2600
74	ADARSH	1.6	0	1	38	2	1	1	0.32	0.32	1	1	0	1	+3.0	+3.0	39.44	38.88	99	38.33	26.5	99	0.32	0.32	2	39.4	38.3	2500
75	KAUSHAL ARLEKAR	3.3	0	1	38	2	1	0	1.6	1.6	2	0	0	2	-3.0	-3.0	99	99	61	99	99	65	1.6	1.6	1	61	65	2700
76	VIRAJ Y POR	0.10	0	1	41	2	1	1	3.2	3.2	1	0	0	1	+4.5	+4.5	58	100	99	152.5	61.66	99	2.4	2.4	1	58	153	4200
77	VINAYAK HUNARIKATTI	0.1	0	1	39	0	1	1	0.32	0.32	1	0	0	1	+3.5	+4.0	26.16	38.13	99	19.77	13.88	99	0.43	0.32	2	26.2	19.8	2500
78	SONIYA GOUDANNAVAR	5	1	1	38	0	1	1	0.23	0.23	0	0	0	0	-1.5	-1.5	99	99	46	99	99	48	0.23	0.23	1	46	48	2500

SL No.	Name	Age	Sex	Gestation Period	Gestation period weeks	Delivery	Milestones	Consanguinity	Vision with teller acuity card		Visual Axis	Extra Ocular Movement	Nystagmus	Refractive Error	Subjective Refraction		Pre Development quotient			Post Development quotient			Vision with teller acuity card		Social Behavioural Changed	Pre	Post	Birth Weight
									RE1	LE1				0,1,2,3	RE	LE	MEQ1	MOQ1	PCDTP 1	MEQ2	MOQ2	PCDTP 2	RE2	LE2				
slno	name	Age	Sex	gp	weeks	Delivery	miles	cons	VNR1	VNL1	VAX	EOMS	NYS	REF	RE	LE	MEQ1	MOQ1	PCDTP1	MEQ2	MOQ2	PCDTP2	VNR2	VNL2	SOC. BEH	DQ1	DQ2	BW
79	VISHAL HANDINAMANE	1	0	1	38	0	1	1	0.23	0.23	0	0	0	1	+2.0	+2.0	26.16	38.13	99	18.33	13.33	99	0.23	0.23	1	26.2	18.3	1500
80	SUKSHA YADAV	2.4	1	0	34	2	1	0	4.8	4.8	0	0	0	1	+1.0	+1.5	38.78	15.35	99	17.3	17.5	99	0.23	0.23	1	38.8	17.3	1900
81	SNEHA ADAVI	1	1	1	40	0	1	0	0.23	0.23	1	0	1	1	+1.5	+0.5	38.13	20.83	99	38.57	18.57	99	0.23	0.23	2	38.1	38.6	3000
82	GAURAV GAVADE	5	0	0	36	2	1	0	19	19	0	0	0	1	+2.0	+2.0	99	99	51	99	99	67	19	19	1	51	67	2200
83	MD.SAVEEL	0.10	0	0	34	0	1	0	2.4	1.3	1	0	0	1	+1.5	+1.5	19.5	35	99	19.77	36.38	99	0.23	0.23	1	19.5	19.8	2200
84	ARJUN UMESH ANGADI	2.8	0	1	39	0	1	0	4.8	4.8	0	0	0	0	-1.5	-1.5	128.6	69	99	99	99	56	6.5	6.5	2	129	56	3000
85	KAMESH HOSURI	3	0	0	32	0	1	0	0.23	0.23	0	0	0	0	+1.5	+1.5	99	99	42	99	99	42	0.32	0.32	1	42	42	2600
86	ABHISHEK INDI	4	0	1	40	0	1	1	0.64	0.64	0	0	0	1	+1.5	+1.5	99	99	46	99	99	48	0.64	0.64	1	46	48	3750
87	SHARANBASU TELAGINMARI	3	0	1	37	0	1	0	0.32	0.32	0	0	0	1	+1.5	+1.5	4.16	3.88	99	5.47	3.57	99	0.32	0.32	1	4.16	5.47	2500
88	YALLAPPA	1	0	1	38	0	1	1	0.23	0.23	0	0	1	1	+3.0	+3.0	38.13	38.13	99	12.77	7.77	99	0.23	0.23	2	38.1	12.8	9999
89	ABHI ANGADI	3	0	1	40	2	1	0	0.23	0.23	2	0	1	2	+1.5	+2.0	99	99	44	99	99	44	0.23	0.23	2	44	44	3700
90	ANKITA SHEKAR PATIL	3	1	0	35	0	1	1	0.32	1.6	1	0	0	1	+5.0	+3.0	99	99	45	99	99	49	0.23	0.23	2	45	49	750
91	AMOGORIDDA TEMATTI	2.3	0	1	38	0	1	1	0.23	0.23	0	0	0	1	+2.0	+2.0	45.19	20.13	99	46	19.2	99	0.23	0.23	1	45.2	46	9999
92	SMITHA JADHAV	5	1	1	38	0	1	1	38	38	0	0	0	0	-5.0	-5.0	99	99	55	99	99	61	26	38	2	55	61	3000
93	SHREYA HALAPUR	1	1	1	37	0	1	1	0.23	0.23	1	0	0	0	-1.5	-1.5	25	12	99	34.2	19	99	0.23	0.23	2	25	34.2	2900
94	KADAPPA	2	0	1	40	2	1	0	2.4	2.4	0	0	0	1	+1.0	+1.0	45.18	58.57	99	99	99	72	4.8	4.8	1	45.2	72	2500
95	AYESHA LATIF	2	1	1	39	0	1	0	19	19	0	0	0	0	-2.0	-2.0	45	59	99	51	62	99	38	38	2	45	51	9999
96	SHRAVANI UMESH	1	1	1	38	0	1	0	0.23	0.23	0	0	0	1	+2.0	2.0	26	13.6	99	30	13.8	99	0.23	0.23	1	26	30	2900
97	ADARSH MARUTI DALAVANI	4.10	0	1	39	0	1	0	0.23	0.23	0	0	0	1	+1.5	+1.5	99	99	40	99	99	42	0.23	0.23	0	40	42	2900
98	AMOGH SANJU TANGADI	2	0	1	40	0	1	1	0.23	0.23	1	0	1	1	+4.0	+4.5	19.3	10.51	99	50.5	12.12	99	0.43	0.43	1	19.3	50.5	2750
99	MAHESH	3	0	1	39	0	1	1	4.8	4.8	0	0	0	1	+1.0	+0.5	99	99	50	99	99	57	19	19	2	50	57	3000
100	MAKTUMSAB	5	0	1	40	0	1	0	3.2	3.2	0	0	0	1	+1.5	+1.5	99	99	45	99	99	49	4.8	4.8	2	45	49	2000