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Protocol for Assessing the Gross-Motor Functions in Children between Age 3-10 Yrs: TGMD-2

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ABSTRACT:
The purpose of this study was to investigate the construct validity of second edition of Test of Gross Motor Development TGMD-2; Ulrich, 2000) and to assess the performance of locomotors and object control skills of Indian children (N=300) across age group between 3-10 years both Girls and Boys. The TGMD-2 was administered to 300 children from kinder garden as well as primary section of three schools. The internal consistency of TGMD-2 was found to be high (alpha=.679 foe locomotors subtest and alpha=.80 for object control subtest, with spearman's coefficient= .741 for locomotors subtest and .786 for object control subtest). The results show that the **difficulty level with age and gender**, **correlation of task with age, discriminating power show highly significant values.** The **Factor Analysis** which was determined using KMO &Barrett's test to determine the **Goodness-of-fit** which included **Chi square** was 301.935 and **Degrees of freedom** was 15 for Locomotors subtest and,624.070 and 15 respectively for object control subtest. The Exploratory factor validity test (which includes the Kaiser- Guttman method of extracting with Eigen values greater than 1 criterion the first factor had Eigen value=2.373 &1.033 for locomotors skills and 3.127 and 1.080 for object control subtest).). Based on the current results**, it is concluded that the TGMD-2 is an appropriate tool to assess the gross motor skills of school age children between 3-10 yrs.**

I. INTRODUCTION

During the early age i.e. from prenatal period to 8 yrs of life children undergo rapid growth which is influenced by environmental, dietary, racial, cultural factors[8]. This is regarded as the most vulnerable period in the as most of the acquisition of gross motor ,fine motor ,cognitive and psychomotor skills happens at this age owing to the early maturation of the CNS and if any insult to this ongoing process of brain development would result in severe developmental delay. The evidence from literature on cross- cultural research on Motor development have used normative data for understanding cultural differences have suggested that cultural differences do exists and that, childrearing practices and contextual factors have a powerful influence on motor development. We show that the timing of motor milestones, the shape of the developmental trajectory, the forms of children's movements, and some of the skills that children acquire all depend on cultural context[8].

From literature on normal development and acquisition of motor skill behaviors it is evident that some skills may be and others deficient and growth of CNS is ongoing process of developmental process through infancy and childhood[1]. The CNS begins to develop early in gestation around day 40 of embryonic life commencing the process of lifelong change. CNS can be identified quite early in gestation. Other neuronal elements display a **different style of maturation** exhibiting periods of regression characterized by initial overproduction followed by elimination of redundant elements. [1] During the differentiation stage of development, a number of these redundant neurons die off.

A similar elimination of redundant elements is seen for synapses formed postnatal and during childhood. These too have been observed to increase rapidly in early childhood, exceeding adult levels, then decrease to adult levels.

Brain growth quadruples in size from birth to adulthood; its increase is not due to a proliferation of neurons, the full complement of which is established prenatally. Nervous system receives millions of bits of information from different parts of sensory organs and then integrates all these to determine the response. Most of the activities of nervous system are initiated by sensory experience emanating from sensory receptors, whether it be visual, auditory or other kinds these sensory experience may be immediate or may be stored in the brain since hrs, days or years .Dennis describes skill development into 3 levels ,Emerging: where a skill is in its early stage of acquisition

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Where, Developing: where the capacity is partially acquired, **Established** in a skill is fully acquired. In prenatal period development is largely concerned with structural formation establishing the basic hardware of CNS. In contrast, post natal development is directed to elaboration of CNS, establishing connectivity is so vital for the system. The process of elaboration continues into early adolescence.CNS development is complex and thus happens in sequence and simultaneously neurolation progresses via rapid development of cells, neurons, glial cells which develop from neuroblasts and glioblasts. Three major mechanisms underlying this process are
Proliferation

Migration
Differentiation or organization

Post natal development of brain happens in 3 steps dendritic arborization, myelination and synaptogenesis. [1]

Motor skills are actions that involve the movement of muscles in the body. They are divided into two groups: gross motor skills, which are the larger movements of arms, legs, feet, or the entire body (crawling, running, and jumping); and fine motor skills, which are smaller actions, such as grasping an object between the thumb and a finger or using the lips and tongue to taste objects. Motor skills usually develop together since many activities depend on the coordination of gross and fine motor skills. Gross motor skills develop over a relatively short period of time. Most development occurs during childhood. However, soldiers, some athletes, and others who engage in activities requiring high degrees of endurance may spend years improving their level of muscle and body coordination and gross motor skills[2] .Acquisition of gross motor skills happens in cephalo -caudal direction i.e. Head control is achieved first followed by shoulder, arms elbow and hand. Every child reaches a stage of developmental milestones at different rates. The first gross motor skill infants learn usually is to lift their heads and shoulders before they can sit up, which, in turn, precedes standing and walking. Lifting the head is usually followed by head control. Although they are born with virtually no head or neck control, most infants can lift their heads to a 45-degree angle by the age of four to six weeks, and they can lift both their head and chest at an average age of eight weeks. Most infants can turn their heads to both sides within 16 to 20 weeks and lift their heads while lying on their backs within 24 to 28 weeks. By about nine to 10 months, most infants can sit up unassisted for substantial periods of time with both hands free for playing. One of the major tasks in gross motor development is locomotion, the ability to move from one place to another. Infants progress gradually from rolling (eight to 10 weeks) to creeping on their stomachs and dragging their legs behind them (six to nine months) to actual crawling (seven to 12 months). While infants are learning these temporary means of locomotion, they are gradually becoming able to support increasing amounts of weight while in a standing position. In the second half-year of life, babies begin pulling themselves up on furniture and other stationary objects. By the ages of 28 to 54 weeks, on average, they begin navigating a room in an upright position by holding on to the furniture to keep their balance. Eventually, they are able to walk while holding on to an adult with both hands and then with only one. They usually take their first uncertain steps alone between the ages of 36 and 64 weeks and are competent walkers by the ages of 12. In toddlerhood, on each step before going on to the next one. Most infants this age climb (some very actively) and have a rudimentary ability to kick and throw a ball. By the age of three, children walk with good posture and without watching. Toddlers are usually very active physically[2].

By the age of two years, children have begun to develop a variety of gross motor skills. They can run fairly well and negotiate stairs holding on to a banister with one hand and putting both feet their feet. They can also walk backwards and run with enough control for sudden stops or changes of direction. They can hop, stand on one foot, and negotiate the rungs of a jungle gym. They can walk up stairs alternating feet but usually still walk down putting both feet on each step. Other achievements include riding a tricycle and throwing a ball, although they have trouble catching it because they hold their arms out in front of their bodies no matter what direction the ball comes from.

Preschoolers, Four-year-olds can typically balance or hop on one foot, jump forward and backward over objects, and climb and descend stairs alternating feet. They can bounce and catch balls and throw accurately. Some four-year-olds can also skip. Children this age have gained an increased degree of self-consciousness about their motor activities that leads to increased feelings of pride and success when they master a new skill. However, it can also create feelings of inadequacy when they think they have failed. This concern with success can also lead them to try daring activities beyond their abilities, so they need to be monitored especially carefully. School-age children, who are not going through the

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rapid, unsettling growth spurts of early childhood or adolescence, are quite skilled at controlling their bodies and are generally good at a wide variety of physical activities, although the ability varies according to the level of maturation and the physique of a child. Motor skills are mostly equal in boys and girls at this stage, except that boys have more forearm strength and girls have greater flexibility. Five-year-olds can skip, jump rope, catch a bounced ball, walk on their tiptoes, balance on one foot for over eight seconds, and engage in beginning acrobatics. Many can even ride a small two-wheel bicycle.[2,3]

Eight- and nine-year olds typically can ride a bicycle, swim, roller skate, ice skate, jump rope, scale fences, use a saw, hammer, and garden tools, and play a variety of sports. However, many of the sports prized by adults, often scaled down for play by children; require higher levels of distance judgment and hand-eye coordination, as well as quicker reaction times, than are reasonable for middle childhood. Games that are well suited to the motor skills of elementary school-age children include kick ball, dodge ball, and team relay races.[2,3]

In adolescence, children develop increasing coordination and motor ability. They also gain greater physical strength and prolonged endurance. Adolescents are able to develop better distance judgment and hand-eye coordination than their younger counterparts. With practice, they can master the skills necessary for adult sports.[2]

Test for gross motor development is revised as TGMD-2 which can be readily used by physical[5] therapists, kinesiologists as well as educators in physical education to assess the gross motor skills of as described before of children between age group of 3-11 yrs who are significantly behind their peer group in acquiring these skills and who should be eligible for special education in physical education. TGMD-2 assess 12 skills 6 for each sub-tests namely, A. Locomotors skills: running, galloping, hopping, leaping, horizontal jump, sliding. B. Object control skills: two-hand strike, stationary bounce, catching, kicking, overhand throw, under-hand throw. The Locomotors subtest measures the above mentioned gross motor skills that require fluid co-ordinate movements of the body as the child moves in one direction or another[4]

Run: The ability to advance steadily by springing steps so that both feet leave the ground an instant with each stride.

Gallop: The ability to perform a fast, natural three-beat gait.

Hop: The ability to hop a minimum distance on each foot.

Leap: The ability to perform all of the skills associated with leaping over an object.

Horizontal-jump: The ability to perform a horizontal-jump from a standing position.

Slide: The ability to slide in a straight line from one point to another

Object control subtests measures the gross motor skills that demonstrate efficient throwing, striking, and catching movements.

Striking a stationary ball: the ability to strike a stationary ball with a plastic bat

Stationary dribble: the ability to dribble a ball a minimum of four times with dominant hand before catching the ball with both the hands without moving feet.

Kick: the ability to kick a stationary ball with the preferred foot.

Catch: the ability to catch a plastic ball that has been tossed underhand.

Overhand Throw: the ability to throw a plastic ball at a point on a wall with preferred hand.

Underhand Roll: the ability to roll a ball between two cones with the preferred hand

The child is required to perform 2 trials of each skill and the performance of the child in each skill is seen .Where the child performs a behavioral component correctly is marked as "1" in appropriate box in correct assessment column where the child does not perform a behavior component in 2 out of 3 trials are marked as "0".There are 2 separate columns provided for each of the assessment occasions and the child's initial assessment data should appear in the first column. The test is carried out in a field based setting and according to the specific directions for each item and the equipment used in each item is commonly found in motor skills program and is listed in the directions for each item. The materials used for the test are: masking tape, chalk, traffic cones, or other marking device, 4-6 inch light weight ball, plastic bat, 8-10 inch play ground ball, 6-8 inch sponge ball, 8-10 inch plastic ball, tennis ball. The children are required to wear rubber soled canvas or school shoes to minimize the risk of falling or slipping and there by promoting safety.

TGMD-2 is a good assessment tool for assessing gross motor skills as the items of the test are easy to administer and can be easily understood and performed, in shorter time the examiner gets an overall idea of the level of acquisition of gross motor skills and get the index of performance and thereby useful in evaluating if the these children lack in performance as compared to their peer

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groups and hence necessary further referrals can be made for further interventions if at all necessary[4]. Moreover the items in the scale involve play activities which are enjoyable for the children and involve bi-manual co-ordination activities essential for normal functional activities. The components of the scale test the repertoire of the child in varying enriched, complex, sensory, perceptual environment.

There has not been enough research in the field of validation of the scale except in the western countries. Research by Kristine et al has validated the TGMD-2 scale in preschooler children in European population where they have made comparison between various scales to assess the gross motor function and TGMD-2 has been proved to be the most valid and reliable tool with high inter-rater and intra-rater reliability[5]. There has also been validation of the scale in visually impaired children by Junker et al, there has been proved concurrent validity of the scale by Wong K et al also in Flemish children also research in Portuguese children has shown TGMD-2 to have a good inter-rater and intra- rater reliability. However there has not been enough research on TGMD-2 in Indian scenario and hence much further research can be carried out.

Need of the study:

- TGMD-2 has not been used in India for assessment purpose and as yet there has been no scale validated in Indian standards.
- Considering the differences in the development in western and Indian children due to factors like dietary, physical, racial, and cultural[8] factor like the up-bringing of the child differs from family to family and race to race, and we have been still been using western standards for reference for assessment purpose so considering these points is the purpose of validating the scale
- To look at the percentile of achieving of a milestone in Indian Scenario and there by establishing a range of Normal Development (gross motor milestones in children) and since 3 yrs onwards up to 5 yrs period is the critical period for normal development and many set of things are happening in this period so an assessment is necessary to measure the growth of the child.
- Gross motor skill assessment gives hint of disorders like Developmental co-ordination disorder- a problem of bilateral integration and co-ordination, therefore a need to establish validity of a scale which will assess at which particular point of development the child is having a particular problem.
- Moreover components of TGMD-2 incorporates Bi-manual, co-ordination activities which are of functional significance for a growing child and also tests the repertoire of the child in varying, complex, sensory, enriched, perceptual environment.

Aims:

To test the validity and Reliability of TGMD-2 in children between age group 3-10 yrs.

Objectives:

1. To assess the quality of movement processes involved in performing gross skills
2. To assess the overall level of motor skill development in young children.
3. To identify delay or disorder in motor skill development.
4. To identify children who are significantly behind their peers in gross motor skill development
5. Context for assessment of motor development or function.
6. To develop a tool for use in diverse field based setting for assessing gross motor skills.
7. To develop a valid & reliable tool for assessing gross motor functions.

II. REVIEW OF LITERATURE:

1. **Wong Ka Yee, Allison established the construct validity of TGMD-2 in1251 Chinese children in Aug 2006[6]** TGMD-2 was administered to 1251 Chinese children. It showed that males performed better in object control skills like throw, catch, kick, dribble and in all locomotors skills and provided a database for subsequent evaluation of children's gross motor skills.
2. **Daniel Tik-Fui Fong, Agnes Wai- yin Pang in their study on Chinese children assessed the reliability and validity of TGMD-2[7].** The study was carried on Chinese children between age 6-9 yrs including 99 boys and 76 girls and the results showed that the participants were in general superior to the normative samples from the TGMD-2 manual, scoring a gross motor quotient (GMQ) of 56.8–80.9. Overall, 24% of the participants were rated as superior, 36% as above average, 47% as average, and 2% as below average. Excellent proficiency (>80% in every sub item) was observed in running, galloping, leaping, sliding, catching, and throwing skills. In comparing the results with other studies, we

found that the participants were superior to the data reported in previous studies in United States, Brazil, and Australia. This study added valuable information to the establishment of a worldwide normative reference for the comparison of future studies in other countries.

3. **A S Niemeijer, B C M Smits-Engelsman M M Schoemaker conducted a study on Neuromotor task training on children with Developmental co-ordination disorder**[9].In this study the author administered Neuromotor task training- a task oriented approach to a group of children with DCD versus no training group for 9 weeks and then assed the performance of children at the end of the session using TGMD-2 as one of the outcome measures and found significant improvement in the NTT group on TGMD-2 scale.
4. **E.H Martin, M.E Rudisill conducted a study on Motivational climate and fundamental Motor skill performance in a naturalistic physical education setting**[10]**.** The authors performed a comparative study in which they used TGMD-2 as the outcome measure to determine pre and post test scores and found that the Mastery group performed better than the Low Autonomy group.
5. **Suzanne Houen and Esther Hartman and Laura Jonker et al, established the validity of TGMD-2 in visually impaired primary school aged children**[11] **This study determines the reliability and validity of TGMD-2 in primary school aged children between ages 6-12 yrs.** The internal consistency of TGMD-2 was high and having high inter-rater and intra-rater reliability (alpha=0.71). Finally, the scores on the object control subtest of the TGMD-2 and the ball skills subtest of the Movement ABC correlated moderately to high (r = 0.45 to r = 0.80). Based on the current results, it is concluded that the TGMD-2 is an appropriate tool to assess the gross motor functions. The Reliability and validity of TGMD-2 has been established for typically developing children as well as for children with intellectual disabilities. It was however proposed that as TGMD-2 evaluates both loco motor skills and object control skills, TGMD-2 is a suitable test to assess the movement skills of primary school age children.
6. **Logan SW, Robinson LE, Getchell N performed a study on the comparison of performance of children on two outcome measures namely, TGMD-2 & MABC-2**[12] The authors compared the performance of preschool children on the TGMD-2 and the MABC-2. 32 children (M age = 4.2 yr., SD = 9) completed each test to assess whether each described motor performance similarly. Significant low to moderate Spearman's rank correlations (r2 range = .13-.40) were found between the subscales of the assessments. A related-samples Wilcoxon signed rank test was not significant between total performances on the TGMD-2 and MABC-2. From a practical standpoint, each assessment provides a similar overall description of motor competence in preschool children. However, each assessment results in scores that present different information about motor performance.
7. **Houwen, Suzanne; Visscher, Chris; Hartman, Esther; Lemmink, Koen A.P.M.**[13] **conducted a comparative study between normal children and those with visual impairments on physical activity**. The authors concluded that children with visual impairments had significantly lower object control but not locomotors skill scores than the sighted children. No significant differences were found between children with a moderate and severe visual impairment. Children with visual impairments who participated in sports had significantly higher object control skill scores than those who did not. No significant associations between motor skills and sports participation were found in the sighted children.
8. **E. Hartman and C. Fischer in their study compared the movement skills and intellectual abilities of normal children**[14]**.** It has been suggested by this study that children with disrupted higher level cognitive processing have affected gross motor deficits also This study evaluates the motor skill performance using TGMD-2 and higher level cognitive functions of children with mild and borderline intellectual disability and a significant relationship between the two, and found that there exists impaired qualitative motor skills and impaired higher cognitive functions in children with Intellectual disabilities.
9. **J. Simons and D. Daly, Theodorou F, Caron C, Simons J, Andoniadou E. in their study proved the reliability and validity of TGMD-2 in Flemish children with intellectual disability.**[15] The purpose of this study was to assess the reliability and validity of 99 Flemish children consisting of 7-10 yrs age group consisting of 67 boys and 32 girls with Intellectual disability where in they

concluded that a factor analysis supported a two factor model of the TGMD-2. A low significant age effect was also found for the object control skill but not for locomotors ability. Furthermore, a significant difference was observed between the results of the children of the United States without intellectual disability and Flemish children with mild intellectual disability.

10. **Sabah Bakhtiari, Parvaneh Shafinia, and Vahid Ziaee, conducted a study on the effect of selected exercises on school girls and the motor development was assessed using TGMD-2 as outcome measure.**[16] The authors concluded that the reliability of this scale was 0.76 for locomotion scale, 0.62 for manipulation scale and 0.71 for motor efficiency and all scales displayed acceptable reliabilities (internal consistencies) for research purposes and that motor skills development is positively associated with physical activity.
11. **Cliff D.P., Oakley A.D, Morgan P.G, Jones R.A, Steele JR, Baur L.A conducted a study on Proficiency Deficiency: Mastery of Fundamental Movement Skills and Skill Components in Overweight and Obese Children.**[17] The authors compare the mastery of 12 fundamental movement skills (FMS) and skill components between a treatment-seeking sample of overweight/obese children and a reference sample from the United States. Mastery of six locomotors and six object-control skills (24 components in each subdomain) were video-assessed by one assessor using the test of gross motor development-2 (TGMD-2). The 153 overweight/obese children (mean ± s.d. age = 8.3 ± 1.1 years, BMI z-score = 2.78 ± 0.69, 58% girls, 77% obese) were categorized into age groups (for the underhand roll and strike: 7-8 years and 9-10 years; all other FMS: 6-7 years and 8-10 years) and mastery prevalence rates were compared with representative US data (N = 876) using $\chi(2)$ analysis. For all 12 skills in all age groups, the prevalence of mastery was lower among overweight/obese children compared with the reference sample (all $P < 0.05$). This was consistent for 18 locomotors and up to 21 object-control skill components (all $P < 0.05$). Differences were largest for the run, slide, hop, dribble, and kick. Specific movement patterns that could be targeted for improvement include positioning of the body and feet, the control or release of an object at an optimal position, and better use of the arms to maintain effective force production during the performance of FMS. Physical activity programs designed for overweight and obese children may need to address deficiencies in FMS proficiency to foster the movement capabilities required for participation in health-enhancing physical activity.
12. **Cepika L. in their study established the validity of TGMD-2 in Flemish and American children**[18]. This study concluded that TGMD-2 can be used to identify children who significantly lack behind their peer group in development and that racial differences do have to be considered in development and thus Flemish children scored less as compared to American children in the scores of TGMD-2
13. **Kerri L. Stapples, Grieg Ried performed a comparative study in children with ASD and normal children.**[19] **Fundamental movement skills of 25 children with autism spectrum disorders (ASD) (ages 9–12 years) were compared to three typically developing groups using the Test of Gross Motor Development (TGMD-2).** The group matched on chronological age performed significantly better on the TGMD-2. Another comparison group matched on movement skill demonstrated children with ASD perform similarly to children approximately half their age. Comparisons to a third group matched on mental age equivalence revealed the movement skills of children with ASD are more impaired than would be expected given their cognitive level. Collectively, these results suggest the movement skills of children with ASD reflect deficits in addition to delays.
14. **Meek, G.A. did a comparative study between physical fitness and gross motor skills in visually impaired children**[20]. This experiment employed simple exercises to ascertain whether 49 children (ages 9-16) with partial or complete blindness had lesser levels of physical fitness than 24 fully sighted controls. Results found low rates of fitness among both groups, but considerably lower among students with visual impairments.
15. **Marques established a relationship between BMI and gross motor skills.**[21] This study aimed to verify relationship between performance in gross motor tasks using TGMD-2 and Body Mass Index in 4-6 year old children
16. **Leila Ojai studied the relationship between Physical activity, Motor ability, and Anthropometric variables in 6 year old**

Estonian children[22]. This study showed that motor ability does not depend on the amount of physical activity and Anthropometric measurements.

III. MATERIAL & METHODOLOGY:

Study design:

A descriptive study to establish Reliability and Validity of TGMD-2 scale in Indian scenario in Urban setting including typically developing school going children from 3 schools namely toddlers between age group. 3-5 yrs and primary school going children between 6-10 yrs

Materials: (Fig. no. 1)
Following materials were used for the administration of TGMD-2:
8-10 inch playground ball
4 inch plastic ball
Foot ball
Measuring tape
Batting tee
Plastic bat
2 smaller size plastic cones
4-5 inch bigger plastic bag
White chalks for marking

Sampling:
Normative sample of 300 typically developing children from three schools in urban area

Population:
300 School going children between age 3-10 years of age.

Inclusion criteria:
Typically developing school going children between age 3-10 yrs.

Exclusion criteria:
- Any problem which could lead to delay in development for example pre or post birth trauma
- Orthopedic impairments like Calcium deficiency
- Medical problems like Asthma
- Visual or Hearing impairments
- Behavioral / Developmental disorder like ADHD.

Methodology:
Administration of the TGMD-2 test was done on school children [n=300] of three different schools, St. Xavier's Boys school which included toddlers between age group of 3-5 yrs, and also from Vidyanidhi school Balkunj section which also included both girls and boys of toddler age group, St. Louis convent school from where primary school age girls were chosen for the study. The students were divided into age groups as
3.0-3.5,
4.0-4.5,
5.0-5.5,
6.0-6.5,
7.0-7.5,
8.0-8.5,
9.0-9.5 and 10.

A Written consent was taken prior from the Head Mistress of the school, and a letter giving the summary of the entire procedure was submitted to the head-mistress. Written consent from the parents of the children mentioning the entire procedure that would be done with the child was explained along with the entire duration of the study. Finally the TGMD-2 was administered to each kid during their Physical training period after taking their hand-foot preference and the age of the child. The PT teacher was also included in the study along with the class-teacher of the students. The entire procedure, the scale as well as the scoring of the scale was explained to both the teachers. The PT teacher was also requested to administer the scale, the time required to administer the scale to each student was between 15-20 minutes. Each kid was initially assessed singly with each skill demonstrated to the kid then later with time as the skill to administer the scale was mastered two students were administered the scale together with each kid given two trials to perform a skill and the behavior of the kid in each skill was observed to the behavior points in the scale for that particular skill.. Testing conditions were arranged prior to the test to help minimize administration time and distractions like, all the materials required to administer the test were kept ready, the safety of students was also considered like wearing rubber-soled shoes or run barefoot, and administering the scale on the school ground during testing to minimize the chance of slipping and falling, thus promoting safety and maximum effort in performing the locomotors skills .After demonstrating the skill to each kid they were given two trials to perform the skill with consistent praises on performing each skill appropriately to their age without prompting. Each skill when administered was closely observed for each of the behavior component of the skill and was scored appropriately likewise for skill like running which consisted of 4 behavior component if the child performed a behavior component then he/she was marked as "1" and if the child did not perform a behavior component then he/she was appropriately marked as "0".Then by doing this the total score of

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each skill for e.g. run was calculated and then the 'raw score' of locomotors sub-test was calculated and similarly that of object control sub-test was calculated, the standard deviation, mean and the percentiles were also calculated.

Fig. no. 1

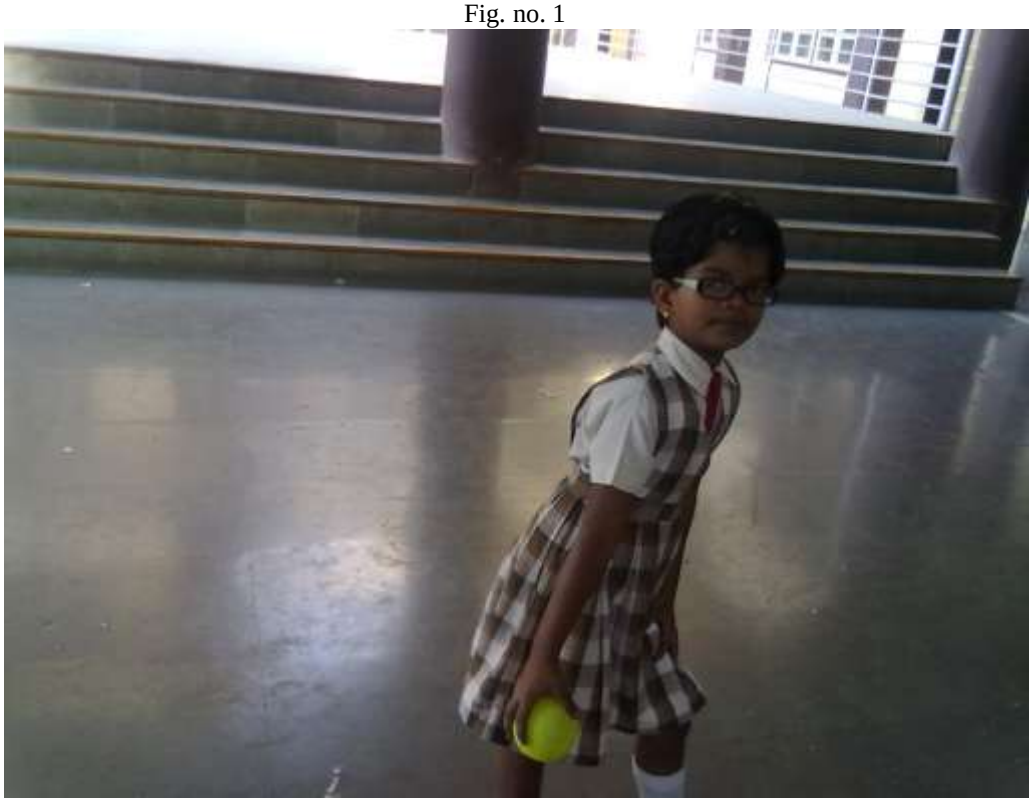

Fig. no.2

Fig.no.3

Fig. no. 4

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Fig. no. 5

IV. RESULTS:

Table no. 1a (difficulty level by Gender & Age)

Mean Difficulty Level in % for Locomotor Skills

Mean

Gender	Age Group	Difficulty Level Run	Difficulty Level Gallop	Difficulty Level Hop	Difficulty Level Leap	Difficulty Level Horizontal Jump	Difficulty Level Slide
Male	3 - 3.5	8.9286	20.5357	57.1429	15.4762	5.3571	26.7857
	4 - 4.5	.5952	4.7619	35.2381	11.1111	4.1667	13.6905
	4 - 4.5	.0000	11.4583	30.0000	3.4722	7.8125	12.5000
	6 - 6.5	.0000	4.6875	26.2500	2.0833	9.3750	3.1250
	7 - 7.5	.0000	.0000	20.0000	.0000	25.0000	.0000
	8 - 8.5	.0000	.0000	20.0000	.0000	12.5000	.0000
	9 - 9.5	.0000	.0000	20.0000	3.3333	2.5000	.0000
	10 - 10.5	.0000	.0000	20.0000	.0000	.0000	.0000
	Total	1.7188	8.7500	34.1250	7.0833	6.0938	12.3438
Female	3 - 3.5	1.5625	19.5313	70.0000	22.9167	6.2500	25.0000
	4 - 4.5	3.0000	3.0000	40.0000	17.3333	11.5000	10.0000
	4 - 4.5	.0000	.0000	22.6667	5.5556	1.6667	.0000
	6 - 6.5	1.6304	5.9783	23.4783	1.4493	6.5217	2.7174
	7 - 7.5	.8929	.4464	22.8571	2.3810	10.7143	4.9107
	8 - 8.5	.0000	1.2195	20.0000	.0000	2.4390	.0000
	9 - 9.5	.0000	2.9070	18.3721	.7752	.5814	4.3605

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	10 - 10.5	.0000	.0000	17.9310	.5747	2.5862	.0000
	Total	.7386	3.2386	26.2273	4.6970	4.8295	4.7159
Total	3 - 3.5	5.0000	20.0000	64.0000	19.4444	5.8333	25.8333
	4 - 4.5	1.9022	3.8043	37.8261	14.4928	8.1522	11.6848
	4 - 4.5	.0000	7.0513	27.1795	4.2735	5.4487	7.6923
	6 - 6.5	1.2097	5.6452	24.1935	1.6129	7.2581	2.8226
	7 - 7.5	.8621	.4310	22.7586	2.2989	11.2069	4.7414
	8 - 8.5	.0000	1.1628	20.0000	.0000	2.9070	.0000
	9 - 9.5	.0000	2.6042	18.5417	1.0417	.7813	3.9062
	10 - 10.5	.0000	.0000	18.2353	.4902	2.2059	.0000
	Total	1.0000	4.7083	28.3333	5.3333	5.1667	6.7500

Mean Difficulty Levels in % for Object Control

Mean

Gender	Age Group	Difficulty Level Ball Striking	Difficulty Level Stationary Dribble	Difficulty Level Catch	Difficulty Level Kick	Difficulty Level Over-hand Throw	Difficulty Level Under-hand Throw
Male	3 - 3.5	46.4286	51.7857	32.1429	15.1786	43.7500	39.2857
	4 - 4.5	37.6190	49.4048	23.8095	7.7381	35.7143	26.1905
	4 - 4.5	27.5000	38.5417	14.5833	9.8958	34.3750	18.2292
	6 - 6.5	23.7500	25.0000	8.3333	.0000	18.7500	4.6875
	7 - 7.5	40.0000	25.0000	.0000	.0000	25.0000	.0000
	8 - 8.5	20.0000	12.5000	.0000	.0000	25.0000	.0000
	9 - 9.5	2.0000	2.5000	.0000	.0000	2.5000	5.0000
	10 - 10.5	.0000	.0000	.0000	.0000	.0000	.0000
	Total	29.7500	36.8750	17.0833	7.6563	30.3125	20.0000
Female	3 - 3.5	48.1250	56.2500	31.2500	8.5938	47.6563	42.1875
	4 - 4.5	37.2000	46.0000	26.6667	8.0000	35.0000	34.0000
	4 - 4.5	29.3333	42.5000	11.1111	5.0000	30.8333	17.5000
	6 - 6.5	31.3043	29.3478	8.6957	4.3478	30.4348	19.0217
	7 - 7.5	23.5714	15.6250	7.7381	2.6786	25.8929	4.4643
	8 - 8.5	23.1707	8.2317	.0000	2.7439	23.7805	7.0122
	9 - 9.5	13.4884	1.7442	1.5504	1.7442	8.7209	5.8140
	10 - 10.5	6.5517	1.2931	.5747	.4310	1.2931	.8621
	Total	23.8182	19.3182	8.3333	3.5795	22.3295	13.2386
Total	3 - 3.5	47.3333	54.1667	31.6667	11.6667	45.8333	40.8333
	4 - 4.5	37.3913	47.5543	25.3623	7.8804	35.3261	30.4348
	4 - 4.5	28.2051	40.0641	13.2479	8.0128	33.0128	17.9487
	6 - 6.5	29.3548	28.2258	8.6022	3.2258	27.4194	15.3226
	7 - 7.5	24.1379	15.9483	7.4713	2.5862	25.8621	4.3103
	8 - 8.5	23.0233	8.4302	.0000	2.6163	23.8372	6.6860
	9 - 9.5	12.2917	1.8229	1.3889	1.5625	8.0729	5.7292
	10 - 10.5	5.5882	1.1029	.4902	.3676	1.1029	.7353
	Total	25.4000	24.0000	10.6667	4.6667	24.4583	15.0417

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As shown in Table no.1 a and b the Difficulty level according to the age for the locomotors sub-test the skill for example running is difficult for the child between age of 3-4 years of age and as we see downward as the age group increases the level of difficulty for the skill decreases as the skill gets mastered with maturation and growth. Considering among the locomotors skills, hopping appears to be most difficult then followed by sliding, galloping, leaping, running and horizontal jump being least difficult. There is evidence from the literature on Neuromaturation and neurodevelopment[23] suggesting the locomotors strategy adopted by young children during acquisition of Bipedal gait, it was hypothesized that non-dimensional scaling would account for physical growth and that when two gait parameters, like step length and step frequency are scaled non-dimensionally account for increase in infants physical size. Same is the case with object control sub-test. Thus while considering a skill like stationary dribble is the most difficult then followed by striking a stationary ball, overhand throw, underhand throw, catching a ball and kicking being the least difficult.

Table no 1b (Difficulty level by Gender)

Boys
Loco Motor

	N	Mean Difficulty Level in %
Difficulty Level Hop	80	34.1250
Difficulty Level Slide	80	12.3438
Difficulty Level Gallop	80	8.7500
Difficulty Level Leap	80	7.0833
Difficulty Level Horizontal Jump	80	6.0938
Difficulty Level Run	80	1.7188

Object Control

	N	Mean Difficulty Level in %
Difficulty Level Stationary Dribble	80	36.8750
Difficulty Level Over-hand Throw	80	30.3125
Difficulty Level Ball Striking	80	29.7500
Difficulty Level Under-hand Throw	80	20.0000
Difficulty Level Catch	80	17.0833
Difficulty Level Kick	80	7.6563

Girls
Loco Motor

	N	Mean Difficulty Level in %
Difficulty Level Hop	220	26.2273
Difficulty Level Horizontal Jump	220	4.8295
Difficulty Level Slide	220	4.7159
Difficulty Level Leap	220	4.6970
Difficulty Level Gallop	220	3.2386
Difficulty Level Run	220	.7386

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Object Control

	N	Mean Difficulty Level in %
Difficulty Level Ball Striking	220	23.8182
Difficulty Level Over-hand Throw	220	22.3295
Difficulty Level Stationary Dribble	220	19.3182
Difficulty Level Under-hand Throw	220	13.2386
Difficulty Level Catch	220	8.3333
Difficulty Level Kick	220	3.5795

Considering the difficulty level according to gender, it can be seen that in the Locomotors subtest the skill hopping (is most difficult in girls as compared to boys) then followed by sliding, galloping, leaping, running and horizontal jump is the least difficult. Also the difficulty level is more in girls as compared to boys thus suggesting that some gender differences do exists among acquisition of gross motor skills in the two genders.

Considering correlation of tasks with age, which was analyzed using Pearson coefficient, as seen in Table no. 2 a &b it is seen that among the Locomotors subtests almost all the skills like hopping, galloping, sliding, leaping, show a highly significant value(p=0.000) and skills like running show significance of p=0.001 and horizontal jump show significance of p=0.002 indicating that hopping & running shows good correlation with age as compared to horizontal jump which shows poor correlation with age .In case of object control subtest all the skill with especially striking a stationary ball shows greater correlation with age with(p=0.000) which is highly significant.

Table no.2a **Correlation of task with age(Locomotor skills)**

		Age
Run	Pearson Correlation	.184(**)
	Sig. (1-tailed)	.001
	N	300
Gallop	Pearson Correlation	.307(**)
	Sig. (1-tailed)	.000
	N	300
Hop	Pearson Correlation	.598(**)
	Sig. (1-tailed)	.000
	N	300
Leap	Pearson Correlation	.423(**)
	Sig. (1-tailed)	.000
	N	300
Horizontal Jump	Pearson Correlation	.162(**)
	Sig. (1-tailed)	.002
	N	300
Slide	Pearson Correlation	.381(**)
	Sig. (1-tailed)	.000
	N	300
Total Loco-Motor Skill	Pearson Correlation	.599(**)
	Sig. (1-tailed)	.000
	N	300

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Table no. 2 b

Object Control

		Age
Ball Striking	Pearson Correlation	.697(**)
	Sig. (1-tailed)	.000
	N	300
Stationary Dribble	Pearson Correlation	.815(**)
	Sig. (1-tailed)	.000
	N	300
Catch	Pearson Correlation	.632(**)
	Sig. (1-tailed)	.000
	N	300
Kick	Pearson Correlation	.307(**)
	Sig. (1-tailed)	.000
	N	300
Over-hand Throw	Pearson Correlation	.688(**)
	Sig. (1-tailed)	.000
	N	300
Under-hand Throw	Pearson Correlation	.619(**)
	Sig. (1-tailed)	.000
	N	300
Total Object Control	Pearson Correlation	.889(**)
	Sig. (1-tailed)	.000
	N	300

Analyzing discriminating power which implies the degree to which an item differentiates correctly among test takers in the behavior that the test is designed to measure. Anastasi & Urbina (1997).[5] The item discrimination index is the correlation coefficient that represents a relationship between a particular item and other items on the test, this was again analyzed using Pearson correlation. Ebel(1972), Pyrczak(1973), Anastasi & Urbina(1997)[5].Thus as shown in Fig. no. 3,all the skills in Locomotors and Object control subtests show high significance with p=0.000. Item difficulty(i.e. the % of students who pass the test) is determined to identify the items that are too easy or too difficult and to arrange items in an easy-to-difficult order. Anastasi & Urbina(1997)

Table No.3 DISCRIMINATING POWER
Loco-motor Skills

		Total Loco-Motor Skill
Run	Pearson Correlation	.568(**)
	Sig. (1-tailed)	.000
	N	80
Gallop	Pearson Correlation	.627(**)
	Sig. (1-tailed)	.000
	N	80
Hop	Pearson Correlation	.713(**)
	Sig. (1-tailed)	.000

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	N	80
Leap	Pearson Correlation	.591(**)
	Sig. (1-tailed)	.000
	N	80
Horizontal Jump	Pearson Correlation	.450(**)
	Sig. (1-tailed)	.000
	N	80
Slide	Pearson Correlation	.747(**)
	Sig. (1-tailed)	.000
	N	80

Object Control

		Total Object Control
Ball Striking	Pearson Correlation	.817(**)
	Sig. (1-tailed)	.000
	N	80
Stationary Dribble	Pearson Correlation	.837(**)
	Sig. (1-tailed)	.000
	N	80
Catch	Pearson Correlation	.462(**)
	Sig. (1-tailed)	.000
	N	80
Kick	Pearson Correlation	.489(**)
	Sig. (1-tailed)	.000
	N	80
Over-hand Throw	Pearson Correlation	.764(**)
	Sig. (1-tailed)	.000
	N	80
Under-hand Throw	Pearson Correlation	.708(**)
	Sig. (1-tailed)	.000
	N	80

Thus discrimination power and the item difficulty statistics of TGMD-2 suggest that all the items in the scale can be considered as "good" items i.e. they satisfied the item difficulty and item discrimination criteria.[5]

Factor Analysis was done using KMO & Bartlett's test as shown in Table no. 4, Table no. 4 a & Table no.4 b and relates to the degree to which the underlying traits of a test can be identified and the extent to which these traits reflect the model on which the test is based. Thus to investigate the validity of the TGMD-2 to either the Locomotors or object control subtest, Exploratory factor analysis can be done which includes the Kaiser-Guttmann method of extracting factors with Eigen values greater than 1 criterion.[5]

Table no.4 **Factor analysis(Locomotors Skills)**

KMO and Bartlett's Test (A)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.697
Bartlett's Test of	Approx. Chi-Square	301.935

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Sphericity	df	15
	Sig.	.000

Rotated Factor Matrix (a)

	Factor	
	1	2
Run	.086	.628
Gallop	.203	.585
Hop	.974	.226
Leap	.514	.195
Horizontal Jump	.097	.175
Slide	.346	.477

Extraction Method: Maximum Likelihood.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 3 iterations**.**

Eigen values (for Locomotors skill)

Factor	Initial Eigen values
	Total
1	2.373
2	1.033

Exploratory validity test (which includes the Kaiser- Guttman method of extracting with Eigen values greater than 1 criterion the first factor had Eigen value=2.373 &1.033 for locomotors skills and 3.127 and 1.080 for object control subtest) measures two factors, Rotated factor matrix[5] thus considering a Locomotors skill, running which tests two factors i.e. stamina and balance and hopping,(for hopping balance being more important factor in comparison to stamina) leaping, sliding tests stamina and co-ordination while horizontal jump and galloping tests co-ordination and stamina being common factor in all skills . Likewise there are two Rotator factor matrixes for object control subtest, for a skill striking a stationary ball there are two factors, co-ordination & strength, for stationary dribble both co-ordination and intrinsic plus extrinsic strength of upper extremity muscles is important, kicking which requires co-ordination, balance(strength in bilateral hip abductors for single limb support period during the skill) and in catching which requires upper extremity strength and co-ordination thus we see that here strength is a factor common in all skills almost. The Table no. 4 c and d explains that when running correlated with Galloping, hopping, horizontal jump, sliding show highly significant value(p=0.000) in comparison to horizontal jump correlated to running, galloping, hopping, sliding, leaping which show moderate significance(p=0.002). Likewise in case of Object control subtest, stationary dribble correlated to striking a stationary ball, overhand throw, underhand roll, kicking show high significance as compared to kicking correlated to other object control skills which show moderate significance which is shown by KMO & Bartlett's test.

KMO and Bartlett's Test (B)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.804
Bartlett's Test of Sphericity	Approx. Chi-Square	624.070
	df	15
	Sig.	.000

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Rotated Factor Matrix (a)

	Factor	
	1	2
Ball Striking	.612	.417
Stationary Dribble	.575	.576
Catch	.058	.926
Kick	.564	-.047
Over-hand Throw	.783	.236
Under-hand Throw	.537	.332

Extraction Method: Maximum Likelihood.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 3 iterations

Eigen Values for object control skills

Factor	Initial Eigen values
	Total
1	3.127
2	1.080

Confirmatory Factor Analysis was performed to test the goodness-of-fit of the TGMD-2 skill assignment to the Object Control and Locomotors subtests which includes chi square, degrees of freedom (df), Wheaton, Muthen, Alwin and Summer's(1977) and the goodness-of-fit index. Tucker & Lewis (1973) Index of fit (TLI). The general rule is that smaller values indicate a better fitt Lewis's (1herefore chi square/df should be between 2 & 5. The goodness of fit and chi square is shown in Table no. 5

Table no. 5 **Goodness-of-fit Test**

Chi-Square	Df	Sig.
.458	4	.977

Goodness of fit for object control subtest

Goodness-of-fit Test

Chi-Square	Df	Sig.
7.515	4	.111

Goodness of the fit for Locomotors subtest

Reliability refers to the consistency with which any measuring instrument or a test estimates various attributes of something. With regard to psychometric measurement tests that have adequate reliability will measure "true" that is they will yield more or less the same scores across periods of time and across different examiners. The internal consistency reliability of the items on TGMD-2 was investigated using Cronbach's coefficient alpha(1951) is shown in Table no. 6

Table no. 6

Reliability – Loco-motor Skills

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.649	**.679**	6

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Thus for Locomotors skills
Cronbach's alpha = 0.679
Split half =0.741
(spearman Brown co-efficient)

Split half =0.728
(Guttman's co-efficient)

Reliability – Object Control Skills
Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.813	.807	6

Thus for object control subtest is
Cronbach's alpha= 0.807
Spearman Brown = 0.786
Coefficient
Guttmann's = 0.775
Coefficient

Thus not all but one of the coefficients is 0.80 and rest is above 0.70 which indicates that TGMD-2 is a reliable test and the results can be used with confidence.

Researchers have already established the Reliability and Validity of TGMD-2 scale in normative sample as subjects and considering the level of difficulty and discrimination index the items in TGMD-2 are identified as "good" items also the overall Reliability of TGMD-2 sub-test have coefficient alphas above.85 and .91 as explained in TGMD-2 manual. Also TGMD-2 has been validated in Flemish children with intellectual disability and also in primary school aged children with visual impairments and wherein TGMD-2 has shown to have high alpha= 0.71-0.72, and interrater and intrarater, test-retest reliability between 0.82 and 0.95.

V. DISCUSSION:

There has been no such reference scale used in Indian standards and we have been always relating the Normal development and Acquisition of motor skills to the western standards.

Presently for the assessment purposes of gross motor skills, physiotherapist in India use scales for reference based on Western norms in spite of differences in the development in western and Indian children due to factors like dietary ,physical, racial, and cultural[8] factor like the up-bringing of the child which differs from family to family and race to race so there was a need to form a scale which can be used by Physiotherapist in India to assess, study the normal development, look at the repertoire of achievement of motor skills, and the percentile of achieving of a milestones in Indian children which could be accomplished by evaluation of the Validity and Reliability of TGMD-2 in Indian scenario in Indian children since presently there has been no such reference scale used in Indian standards. It is clearly evident from the cross-cultural research[8] that differences in the acquisition of Motor Skills do occur in Indian and Western children owing to factors like, nutrition, sanitation, socio-economic strata, availability of healthcare facilities, social beliefs and traditions in upbringing of the child as well as the literacy rate among the parent, compared to Western children who are much privileged.

It has been suggested by Geber & Dean[8] that, despite dramatic differences in childrearing, climate, and so on, healthy children in every culture acquire basic motor functions such as reaching, sitting, and walking. Equifinality—different means to common outcomes—must reflect, at least in part, the fact that every culture places a premium on manual, postural, and locomotors skills that are foundational to human survival.[8] Since 3 yrs onwards up to 5 yrs period is the sensitive period for normal development and many set of things are happening in this period so an assessment is necessary to measure the growth of the child.

Test for gross motor development is revised as TGMD-2 which can be readily used by physical[5] therapists, kinesiologists as well as educators in physical education to assess the gross motor skills of as described before of children between age group of 3-11 yrs who are

significantly behind their peer group in acquiring these skills and who should be eligible for special education in physical education. More over the TGMD-2 scale Bi-manual, co-ordination activities which are of functional significance for a growing child and also tests the repertoire of the child in varying, complex, sensory, enriched, perceptual environment and the components of the scale include regular play activities which are enjoyable for the school going children of this age group.

Results of the Locomotors skills like **running** show that it is the highly scored skill among children of all age group, running being the next mode of locomotion attained after walking, since it is a flight phase of that distinguishes the two and appears by 2 r of age. The next highly scored skill was **galloping** since it is acquired after running by 4 yrs of age, but in the Indian population of toddlers it was seen that Gallop was still not fully matured in all children of 4 yrs age in Comparison to Western children in whom it is seen that about 43% 4yr olds gallop, In India the maximum age of achievement of gallop was at 5 yrs of age and by 6.5 yrs the skill being fully mastered. Galloping requires that the child produce asymmetrical gait with unusual timing and a differentiation of force production in each limb and has additional balance requirements. **Hopping** was found to be the most difficult, almost not yet evolved in 3 yr olds and most of 4 yr olds or if at all emergent with great difficulty, as compared to western children that 33% of 4 yr olds could hop, in India it is seen that by 6.5 yrs children could accomplish skillful galloping and hopping. Hopping emerges after running and galloping as it requires balancing the body's weight on one limb and requires additional force to lift the body off the ground after landing. From the scoring sheet of TGMD-2 of the various skills it has been seen that as the age advances, as the child matures more refined and matured behavior in the child is seen indication Neuro-maturation. There is evidence from the literature on Neuromaturation and neurodevelopment[23] suggesting the locomotors strategy adopted by young children during acquisition of Bipedal gait, it was hypothesized that non-dimensional scaling would account for physical growth and that when two gait parameters, like step length and step frequency are scaled non-dimensionally account for increase in infants physical size. The results obtained from the study- the difficulty level of the skill which is seen to decrease as the age increases indicates that an early age the child undergoes rapid neuromaturation which is right from the pre natal period up to 8 years of life which can be called as the sensitive period of development. The difference in motor skill acquisition of a 3 yr old child up to that of a 10 yr old child can be seen from the table no. 1 on level of difficulty. There is also an article supporting this point which states that the first third of infancy is a period of exuberant learning when young infants form associations rapidly, on a single occasion, between simultaneously occurring events thus rapid learning and thus observable changes in the behavior can be seen during the age of 3-5 years; [24] and along with age differences gender differences also exist. If we consider for example hopping which is having highest difficulty level of all the Locomotors skills, indicates that that it requires Balance which is the important factor for the acquisition of this skill and also good hip abductor strength for balancing the body on single limb support is not yet matured in 3 year olds as compared to 5 year old who has a pretty good control during single limb support for a brief period in this skill. Similar would be the case with **striking a stationary ball** which requires eye-hand, eye-foot co-ordination as well as dissociation of trunk pelvis and trunk- girdle ensuring proper hip-shoulder rotation and appropriate transfer of body wt. to the opposite lower extremity also for sufficient manipulation of the object requires efficient reaching and grasping for which hand and foot dominance has to be established, and it is seen from the data that in many of the 3 year olds the hand foot dominance is not clearly evident as compared to 4 and 5 year old again suggesting for the ongoing process of Neuro-maturation. Object control like striking a stationary ball, stationary dribble, catch, overhand throw and under hand throw which involves a lot of manipulator skill especially striking a stationary ball and stationary dribble requiring co-ordinate movement of fingers as well as good extrinsic and intrinsic muscle strength is yet to mature in 3 year old as compared to 5 year old and in 6 yr old as compared to 8 yr old and in 8 yr old as compared to 10 yr old the acquisition of these skill imply that there has to be a good anticipatory in grasping, lifting and manipulating objects. In a study by Pare & Dugas it was noted that children younger than 2 yrs of age did not increase grip and load forces in parallel but used sequential force activation with grip force increases occurring prior to load forces increases, they also showed that anticipatory control develops gradually with large changes occurring between 1-4 yrs and more gradual changes occurring from 4-11 yrs with adult levels being reached at about 11 yrs. Forsberg and colleagues showed that younger children used a high grip-to-load-force ratio in trials with non slippery objects this showed their

use of large safety margins against slips indicating a immature capacity to adapt to frictional condition. The safety margin decreased during 5 yrs of life along with a lower variability in grip force and better adaptation to the current condition. There were clear developmental changes in precision of force tracking up to 4 yrs of age, there was tendency to overshoot the target force by jumping and waiting which was also seen in many of the toddlers during the object control skills in contrast the bigger age group children overshot the target only when there was a slow target force decrease. This suggest that there is a developmental strategy change for the adaptation of grip forces from a feed-forward to feed-back toward parallel and integrated feed-back and feed-forward processing, with a critical transition period being at 5-6 yrs of age. In 9-10 yr olds all the skills right from Locomotors skills and all the object control skills right from striking a stationary ball to under hand roll are more or less of adult-like character . Thus from this it is clear that TGMD-2 is a good tool to assess the quality of movement processes involved in performing gross skills and assess the overall level of motor skill development in young children. ShumwayCook, Woollcott (1987) etal.[25]

The achievement of the above mentioned gross motor milestones differs to a small extent from those of western children, in an attention to normative comparisons to the children in Uganda where the infants stood upright at 7 months, walked at 10 months and ran at 14 months[8], which may be probably due to in western world formal training to stimulate motor development often takes place outside the home (e.g., in swim, and gym classes) In general, cultural factors that augment practice and enrich or intensify stimulation can accelerate developmental timing; contextual factors that restrict practice and reduce stimulation can delay onset ages.[8]Western children By age 5, begin to spend time away from their mothers, and by 8 to 10 years of age, climbing 7.6-meter high trees, chopping branches with machetes, and using sharp knives.[8]

From the results obtained from TGMD-2 scale having reliability for both locomotors and object control subtest between 0.70 to 0.81, it can be concluded that TGMD-2 can be used as a Context for assessment of motor development or function and thereby assess the prognostic tool after administration of a particular mode of treatment. This point is also supported from article in which they had administered Neuro-motor task training for children with DCD and wherein TGMD-2 was used as assessment tool for judgment of effectiveness of a particular intervention. There was yet another study in Iran wherein the physical activity was correlated to motor skills for which TGMD-2 was used as a outcome measure for judging the performance of school girls in physical activity and also that TGMD-2 is a valid & reliable tool for assessing gross motor functions.

The strength of the study was the effectiveness of TGMD-2 scale by formulating more precise, observable behavior definitions of the movement skill characteristics to be observed, testers had clearer behavior cues to assist them in 'what to look for in children's performance . The skills tested in TGMD-2 were involving those of play activities which incorporate Bi-manual, co-ordination activities which are of functional significance for a growing child and also tests the repertoire of the child in varying, complex, sensory, enriched, perceptual environment and the skills being easy to demonstrate and comprehended by these children and also the performance of a particular student in a skill would be easily rated according to the behavior points of the skill even by teachers and administrators in physical education assessing the progress in the level of physical performance of the child. These concrete cues have aided the Assessor in processing numerous movement skill characteristics which contributed to high reliability and validity.

The population of participants in the study involved Normative sample of typically developing diverse school going children from 3 schools which made it easy for the assessor to observe for the transition in the acquisition and the refinement in the behaviors observed in the skills with Maturation and Growth. Moreover it also gave a way for establishing racial, physical and socio-cultural differences among acquisition of motor skills in various children, like some children performed better in one skill as compared to the other skill comparing to his peer. It was a multi-centered study.

Environmental distractions even though the study was carried in a field based setting, in an open environment(school playground) had no affect on reliability of the test, this suggests that the ongoing distractions in the testing environment did not affect the reliability of the assessment of children's performances.

The overall outcomes on TGMD-2 scale indicate that the protocol is appropriate for use in large-scale research to asses children's gross motor skill performance and provides a viable alternative to existing instruments for use in epidemiological, population-based studies that would involve large no. of children, thus study could be a stepping

stone for further research in the field of gross motor development in Indian scenario.

TGMD-2 may also be a valuable assessment instrument for providing important information about child's gross motor skill needs, for making appropriate referrals for services to enhance children's motor skill development, and for recommending well-targeted and individualized motor skill development interventions where appropriate.

The limitations of the study were small sample size of 300 students and the duration of the study being short, duration a sample size as large as 1000 students could not be carried out covering population from various cities and rural areas, of diverse culture in India itself giving a wide range of variation seen in each child.

VI. CONCLUSION:

Research on motor development has proven rich and informative for understanding the development of perceptual-motor control, and for illuminating some of the general issues that challenge developmental scientists.

The primary goal of the TGMD-2 scale was to study the quality of movement skills and to thereby detect any deficiencies in the attainment of movement skills in growing children. TGMD-2 scale has a good reliability (alpha=.679 foe locomotors subtest and alpha=.80 for object control subtest, with spearman's coefficient= .741 for locomotors subtest and .786 for object control subtest), and the magnitude of these coefficients suggest that TGMD-2 possesses little test error and that users can have confidence in their results. It can be also concluded that TGMD-2 is valid measure of gross motor ability and examiners with good **correlation of the task with age** p=0.001 for locomotors subtest and p=0.000 for locomotors subtest, with **discriminatory power** also highly significant with the **high Goodness of fit index.** Thus TGMD-2 can be used in diverse field based setting for assessing gross motor skills.

Implications for further Research:

The study can be a stepping stone in to further Research in the field of Normal Development involving a larger sample size from a covering more remote places. It is also a multi-centered study which can be a basis for exploring the linkage between physical fitness, the attainment of gross motor skills in growing children since the motor skills development is related to physical activity, strategies that increase physical activity in childhood may be an important target to promote increased physical activity and health in youth. These findings can be implicated in elementary school physical education programs. Moreover, Normal Development provides a fascinating area for cross-cultural Research exploring the diverse cultures and their influence on the acquisition of motor skills in growing children.

Abbreviations:

TGMD-2= Test Of Gross Motor Development, 2nd edition
Yrs= years
CNS= Central nervous system
GMQ=Gross motor quotient
DCD=Developmental co-ordination disorder
NTT=Neuro-motor task training
MABC=Movement assessment battery
M=Mean
SD=Standard deviation
FMS=Fundamental movement skills
$\chi(2)/df$=degrees of freedom
ASD=Autism spectrum disorder
PT=Physical training
TLI= Tucker & Lewis index of fit

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