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Autism Spectrum Disorder: The Dilemma of Untimely Recognition, Intervention and Diagnostic Scales Obtainable at Indian Sub-continent

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ABSTRACT

The increasing prevalence of Autism Spectrum Disorder makes it as considerable issue worldwide. Recent studies addresses the hot topic of Mirror Neuronal System (MNS) confers behind the ASD. However, the cause is uncertain, Indian population prone to varied prenatal and postnatal factors of the condition. Indian parents and professional still be at the initial awareness phase of the spectrum. Years of delay in identification and intervention while comparing with world standards due to various Indian socio-economic and socio-cultural factors. Less availability of screening and diagnostic tools headed to rely on culturally irrelevant and expensive international tools. Government funded research initiatives developed ISAA, INDT-ASD, CASI and AIIMS Modified INDT-ASD as culturally relevant indigenous tools and available on practice. So far, the tools have their own advantages and limitations, requires further research and progression. Owing to scarcity of trained professionals for a wide population range, home based parent-mediated therapies be the most preferred mode of therapy. However, the therapeutic options vary with people. The study aimed to ascertain the present Indian scenario, look upon the awareness about the condition, availability of screening and diagnostic facilities, the early identification and timely intervention program. In addition, the study briefly confers the biological and clinical background of ASD.

1. Introduction

Autism spectrum disorder (ASD) be the pervasive developmental disorder affecting the overall psychological growth of the person, presenting as a lifelong condition, and becomes major social stigma worldwide in prevalence rate of 1 in 59. In India, more than 3 million people affected with ASD in an average. The socio-culture of India, confirm to social laws, valued social relationships, mutual love and respect. However,

Autistic people have problem in social communication like strange, socially deviant behaviors odd to the society, isolated in nature, fail to make and maintain relationships; hence become the significant issue in the major human resource country^[32,33]. However, daily advancements in scientific studies on autism therapeutic procedures, diagnosis play a major role in the success. Even the availability of many screening and diagnostic tools internationally for ASD, those be socio-culturally irrelevant to Indian setting, many standard tools are patterned and costly, re-

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quires training and expertise to utilize. The development of user-friendly, indigenous screening and diagnostic tool will rectify the difficulties. The less awareness of autistic features among parents and professionals directed towards identification delay, even identified early, seldom lead to early intervention due to cultural beliefs and availability of few trained professionals at Indian scenario.

The article discussed briefly about Autism Spectrum Disorder and various difficulties in early identification and intervention of ASD in India. In addition, briefly evaluate the accessibility and validation of various screening and diagnostic tools in practice at India.

2. Materials and Method

An intensive literature survey conducted with various standard textbooks, monographs, and articles and indexed journals through online. The ASD features outlined and documented difficulties at recognition and intervention within India. In adding together, meticulous search for development and validation of various indigenous Indian diagnostic tools and other culturally related ASD screeners with appropriate articles. The real world survey, discussion with experts and people relating with autistic community also be the input of the study.

3. History and Prevalence

In 1943, Dr. Leo Kenner identified 11 cases of 'Autistic disturbance of affective contact' as a congenital neuro-developmental disorder, have 'congenital inability to relate with people in a natural way and unusual response to the environment'. At the same period Dr. Ronald, a pediatrician practicing in Darjeeling, India identified and describes the signs and symptoms of 'Difficult child' similar to autism^[47]. Around 1980s some psychiatrists in India got diagnosis of 'autistic children' commencing from abroad and spread awareness of the condition. By late 90s, obvious number of autism organizations begins to developing and now a day, many ASD specific intervention centers accessible in India.

According to primary epidemiological study by Victor Lotter in 1996, prevalence of 4 to 5 in 10,000, children among entire 8 to 10 years old population, afterwards 60 out of 10,000 children be autistic among 8 years old population. In 2007 an average of 1 in 800 to 1000 children were identified, WHO's study on 2013 there are 1 in 160 persons are suffered with ASD, but currently (2018) alarming increase of 1 in 50 to 60 children with ASD^[61]. Among gender ratio, boys affected more in the range of 5 to 6 boy: one girl ratio^[17]. The INCLIN's survey shows, the prevalence of 1 in 125 children of 3-6 years and 1 in

85 children of 6-9 years identified, and 0.90% in rural, 0.6% in hilly, 1.01% in urban, 0.1% in tribal, 0.61% in costal population of India^[22,35,44]. In spite the fact, vast number of population remains undiagnosed and misdiagnosed under some other conditions.

4. Etiology and Clinical Features

Even the cause still uncertain, genetic, environmental and immunological factors assumed as the reasons behind. May prenatal and postnatal causes like consanguineous marriages, aged parents, maternal malnutrition, complicated labor, premature births, low birth weight, fetal distress and neonatal asphyxia are the risk factors for ASD and other developmental disorders^[20,33]. These factors are widespread in developing country like India.

ASD frequently present as deferred speech and communication, developmental hindrance, being absorbed in personal world, deprived eye contact and remains isolated. Inappropriate non-functional use toys and objects like licking, spinning, banging, and breaking; Stereotypic motor behaviors like hand flapping, finger flickering, body rocking, spinning; lack of imitation and imaginary play etc. Sensory abnormalities include hypo/hypersensitivity to sounds, lights, touch, pain etc. The spectrum often co-occurs with intellectual deficiency, ADHD, seizures and other disorders.

According to DSM V diagnostic criteria, ASD present with at least 3 social communicative deficits and 2 restricted/ repetitive behaviors; those deficits must be identified at early developmental period with significant impairment in social occupational functioning, which are not explained by intellectual disability or global developmental delay. In addition, graded on severity level as 1, 2, 3 according to the requirement of social support^[54].

Socio-communicative deficits include, difficulties in socio-emotional reciprocity, failure in conversation and unusual communication like pronoun reversal, echolalia, reduced sharing of interests, emotions or affect and failure to initiate social interactions. Deficits in non-verbal communication like failure to make eye contact, failed to look other's face, lack of appropriate gestures and facial expression, complexities in developing, maintaining, understanding relationships, difficult social adjustments, failure to make friends, lack of peer interests and lack of imitation and imaginative play.

Restricted, repetitive pattern of behaviors and interests includes, stereotyped repetitive motor mannerisms like hand flipping, finger wiggling, toe walking, lining up of toys, insistence on sameness, inflexible adherence to routines, extreme distress to small changes, highly restricted fixated interests like stares in to space, spinning fans and

wheels, looking things in unusual angles. Hypo or hyper-active responses to sensory inputs like sounds, light, texture, smells, movements and apparent indifference to pain and temperature also expressed.

5. Genetics and Neurobiology

Globally, various studies demonstrate the genetic background of ASD, more than 100 genetic and genomic changes identified. Emerging studies shows associations of genetic environmental factors with de novo (new) mutations and polymorphisms. The chromatin modification, synaptic proteins, fragile x mental retardation protein and rare de novo variations like CNV (copy number variations) play a major role in pathophysiology of ASD. The fragile x mental retardation and tuberous sclerosis are the major associated genetic conditions with ASD. Family and twin studies show 60- 90% association among blood relatives. Various population and family based studies made in India to identify the association of ASD loci on Chromosome MicroArray (CMA) including engrailed-2 (EN-2), RELN, ITGB-3, SLC6A-4, TPH2 etc. However, there is no conclusive evidence on specific genetic involvement on Indian population^[13].

Neurobiological studies show the evidence of autistic features early within initial intra uterine life itself. Infant Brain Imaging Studies (IBIS) show early signs of developmental disturbance in social part of brain with-in 3 to 6 months of age. Most of autistic child has enlarged head and brain size than typical children. The enlargement in gray and white matters of brain with reduced neuronal thickness and blocked axonal fiber development identified. The microstructure abnormality of the fibrous bundle associated with visual orientation leads to sticky visual attention and consequently reduced eye tracking. There is disproportional enlargement of frontal and temporal lobes and early overgrowth of amygdale a structure vital for emotional processing and memory. Functional MRI (fMRI) studies shows some regions of brains are hypo/hyperactive in autistic child. Hypo activity of amygdale and limbic system,(the reward system)responsible for learning, early sensory emotional processing leads to poor learning and social difficulties in autistic child. Under activity of fusiform gyrus, responsible for visual image processing leads difficulties in face recognition. The above factors together cause difficulties in person's association with socially relevant interactions.

Recent studies address the importance of mirror neuronal system (MNS) in brain's constellation, accountable for perception and implementation of the specific body movements^[29,39,58]. MNS helps the person to imitate action what he observed, and contribute to theory of mind abilities

related with learning, language abilities and understanding of action and intention of others. Mirror neurons in anterior insula and anterior cingulate cortex are accountable for emotions and empathy. MNS of posterior part of superior temporal sulcus responsible for social perception of non-verbal cues like facial expression, gestures, and eye gaze direction, understanding the intention of others. MNS of orbital prefrontal cortex and medial prefrontal cortex be dependable for understanding the value of rewards in emotional learning. MNS of inferior frontal cortex near broca's area acts as fundamental for language development and imagination. By the mirror neuronal activity, the child smiles in response to mother's smile, be the first socio-communicative pace. The site, size and quantity of mirror neurons connected with acquisition of social skills; insufficiency or the thinner layer of mirror neurons believed be the cause for autism spectrum disorder. Females have more mirror neurons than males, may fall out reasonably more number of autistic male than female.

6. Inevitable Early Identification

The child's growth in usual be the continuation of various periods of rapid changes on distinct areas of development; these are interdependent and independent in nature. The critical vulnerable periods show increased activity of certain parts of the nervous system; provide the opportunity for maximal growth and be effective on restructuring the neuronal system. Though the neurons developed fully at birth, the neural pathway development depends on environmental stimulation; because of the child's repeated exposure and experimenting with the environment, new neuronal synapses formed. Such a neural pathway interacts with genetically controlled proteins and enzymes, headed for neuronal parts of brain responsible for special functions like motorist functions, language and perceptual functions.

The early years of child's life, be crucial for the formation of bulk of neuronal synapses. At the age of 2 years, the child has twice the number of synapses as an adult, and at 5 years, the brain development completes 95% of adult brain size. However, after 10 years the brain involves actively in destroying weakly formed synapses, the under stimulated pathways guides atrophy of brain part unused. However, the developing brain has the ability to plasticity; our brain can compensate functions by forming alternative neuronal pathways. During first years of life, the child's nervous systems actively interrelate with environmental stimulation through gene induced neuronal synapses; more than 50,000 genes have capacity to reshape themselves by environmental stimulation. Hence, it is crucial to identify ASD within early years and activate

alternate neuronal pathways of brain segments related with autistic difficulties and map intervention programs to prevent disuse atrophy^[31].

Early recognition of ASD help the parents to identify and understand their child's handicaps, and gain knowledge about the course, clinical characteristics, emotional and cognitive behavioral factors influencing their course^[1,26]. The Parents can overcome the feeling of anxiety about disability of their children, discover the ways to support and manage their autistic child^[24]. Genetic counseling helps the parent's choice for next child, because 3 to 7% risk of ASD in siblings^[28]. Early identification paves to early initiation of therapy; proven IQ gains, language improvement, enhanced social and behavioral skills, and overall reduction in severity of symptoms^[18]. More evidence on early intervention at infancy and pre-school age had great impact on outcome of children and families than intervention at school age. The expenditure on early intervention happens to lesser than on later age special education, crime, welfare and other expenses^[4,8].

7. Identification Intricacy

On early years, the low prevalence and less awareness of ASD features or the condition identified with some other disorders like mental retardation, language disorder etc. The parents concern barely at verbal delay on comparing with typical developing children, around 2 years of age; never consider early because, most autistic children with normal physical and motor development^[19,20]. Several children may have good ability on reciting rhymes and memorizing things, may mask the social language deficit. Indian cultural norms intend the quiet child as well-behaved, trouble-free child and Ignores the self absorbed, secluded child as good, which may leads delayed identification. On rural and lower socio economic areas, some hyperactivity and low adherence to social norms be unconsidered. The Parents often concern about language delay, hyperactivity, temper tantrums, bizarre body movements, problem in eating, sleeping, toilet training and other medical conditions like seizures; thinking about social symptoms only after prodding^[57,59]. At educational scenario, difficulties in language use, group activity, peer relationships and hyperactivity often reported^[35].

Owing to the variability of knowledge about ASD features among medical people, nearly all hospital setting chiefly concerns the moderate or severe symptoms and ignores the few mild featured children^[62]. Practicing at the most populated country, numerous primary care physician/pediatricians often concerns medical problem primarily and identified behavioral or developmental problems later on with their busy schedule^[23,27]. The majority of parents

frequently changing their consultants make it difficult to diagnose at single visit. The tribulations of misdiagnosis, incomplete diagnosis and non-referral contribute delayed diagnosis at the medical sphere of influence^[9,10].

8. Screening and Diagnostic Implements

NHS, UK's MeASURE program identified more than 130 early ASD screening and diagnostic tools available internationally^[37]. Yet, very few available at Indian practice, like M-CHAT(R/F), CARS, ADOS, ADI-R, Indigenous Indian tools ISAA, INDT-ASD and AIIMS modified INDT-ASD etc. A number of people employ tools like VABS, DP-III, VSMS, ASQ, SRS, SCQ, SCDC, ABC etc. SCDC and SCQ available as translated version in Indian languages Hindi and Bengali^[11,48,49]. In addition, few screening and diagnostic tools available for free download like M-CHAT-R/F, ISAA, INDT-ASD, PDDST-II, ABC, ESAT, ITC, SCQ, SRS, CSBS-DP, ASD parent interview, and standard diagnostic manuals DSM-V, ICD-10 be accessible for reference. The Indian academy of pediatrics recommends the M-CHAT, SCQ and Trivandrum Autism Behavior Checklist as initial screeners; the diagnostic tools like CARS, ADOS, ADI, INDT-ASD, and ISAA for diagnosis of ASD^[12]. However, nearly all of the screening and surveillance tools depend on parental observation and responses; therefore, the legitimacy varied depends on parental understanding. The standard tool should have high sensitivity that could not miss the true positive cases and high specificity, which could avoid true negative cases. Nevertheless, the reliability, validity and measurement properties of every instrument in practice vary with each other.

8.1 Modified Checklist for Autism in Toddlers, Revised, with Follow-up M-CHAT(R/F)

The M-CHAT(R/F) be utilized as initial ASD screening implement for 16 to 30 months old children, the two stage early screening tool contains parental questionnaire and screened positive cases can be referred for further diagnostic evaluation. The tool initially developed by Robin et al.^[46] as a modified version of the CHAT^[46], named M-CHAT with inclusion of early socio communication impairments, repetitive behaviours and sensory abnormalities. Diana Robins, Deborah Fein and Marianne Barton (2014) revised as M-CHAT (R/F) with accompanying follow-up session^[45]. Available on free download and as translated version in many Indian languages like Hindi, Bengali, Kanata, and Tamil. The M-CHAT developed as parent report screener and not at all for clinician. However, the majority of the pediatricians habitually utilize with

general pediatric population, to discriminate between developmentally delayed children and child with ASD signs and symptoms. The instrument can more over used as a second stage screener, and the good number screen-positive can confidently referred for early evaluation and intervention programs. The universal screening implementation of M-CHAT(R/F) can lower the age of ASD diagnosis by 2 years compared with recent surveillance findings and increases time accessible for early intervention. It recognized 47.5% risk of autism and 95% as risk for developmental disorders. Yet, the tool could not used as a diagnostic implement, because it relies on self-report questionnaires, the possibility of under/over estimation may more depend on the individual's responses. A number of pediatricians feel it could under identify cognitive, emotional and behavioral features amongst children. In addition, the tool has some real time examples unsuitable for Indian cultural backgrounds; necessitate modifications to implement on Indian community.

8.2 The Indian Scale for Assessment of Autism (ISAA)

The ISAA developed by a team of experts associated with the national trust, ministry of social justice and empowerment, and the ministry of health and family welfare, under the government of India^[38]. The instrument developed primarily for disability certification and research purpose, be a valid and user-friendly implement for grading autistic population aged around 3 to 22 years and officially recommended ASD diagnostic tool in India. The ISAA is available on free download and as mobile application at The National Trust of India's website. Anybody can administer the tool with minimal training and proficiency within 20-30 minutes. The instrument used for multipurpose screening, grading severity, clinical diagnosis, intervention planning and monitoring purpose, being well suited for India like multicultural and multi linguistic country.

The tool developed based on CARS and has 40 items under six domains includes, social relationship and reciprocity; emotional responsiveness; speech, language and communication; behavior patterns; sensory aspects and cognitive component^[38]. The responses rated with 5-point likert scale based on increasing severity. A score of <70 indicates no autism, 70-106 (mild autism), 107-153 (moderate autism), and >153 (severe autism). The criterion validity of ISAA was significant in comparison with the CARS ($r = 0.765$, $p < 0.001$), Internal consistency and reliability (Cronbach's coefficient alpha) were significant and were comparable to CARS (Cronbach's alpha 0.932 $p < 0.001$). Each ISAA item was highly correlated with the total score, Inter-rater reliability ($r > 0.83$) as well

as test-retest reliability after three months was satisfactory in a sub-sample ($r > 0.89$). A cut off score of 70 showed high and balanced sensitivity and specificity between autism and the group without psychiatric diagnosis, as well as between autism and the MR group. Receiver Operator Curve (ROC) analysis confirmed the discriminate ability of ISAA (Area under the curve, AUC = 0.931, SE = 0.009 using the cut off score of 70). The tool originally claimed to have 94.3% of sensitivity and 92% specificity.

According to Mukherjee, et al. study on 2-9 years old children^[38], some of the test items are unsuitable for younger children. Some items shows overlapping content, ambiguous phrasing, and some features are normal variation of developing children considered as deviant. On construct validity, Pearson correlation coefficient(r) was acceptable in only social and emotional domains and had sub-optimal value for other domains. Test-retest and inter-rater reliability was 0.93-0.99 and 0.99. The level of agreement with CARS was low. On scatter diagram plotted between ISAA and CARS total scores showed maximum clustering around 70-80 scores of ISAA. The study shows 93.3% sensitivity, 97.4% specificity of ISAA scores with good reliability and validity among age cut-off of 4.5-year children. Yet, the diagnostic accuracy of ASD among 2-9 years old children limited up to 40% only and categorization of severity was unsatisfactory, have evidence of poor agreement with CARS and absence of clustering around ISAA scores of >153. In common, positive symptoms (overt behaviours) easily identified and negative symptoms (absence of pro-social behaviours) often ignored. Hence, the both could be included in the tool like ISAA developed for wide range of applicability, because it probably leads to the suboptimal construct validity. Hence, it requires further analysis and evaluation and may not possible to use ISAA for assessing the severity of autism between 2 - 9 years old children^[5,41].

8.3 INDT-ASD (INCLIN Diagnostic Tool for Autism Spectrum Disorder)

INDT-ASD is the indigenous Indian instrument developed by the INCLIN (International Clinical Epidemiology Network) trust international with the team of experts in INCLIN-NDD Project^[22,60]. The tool based on DSM- IV TR, it can diagnose and differentiate pervasive developmental disorders like Autism, Asperger's syndrome, Rett's syndrome, Childhood disintegrative disorder, Pervasive developmental disorder - not otherwise specified. The tool has two sections; section A contains 29 parental questions and corresponding behavioral observations of the interviewer with three response options yes/no/unsure or not applicable. The tool has three sub categories in-

cludes social interaction, social communication, restrictive and repetitive behaviours, each category has four items. Each item contains various descriptive questions related to the caption. Section B scored responses of section A and Six out of 12 items diagnose ASD. It will take 45 – 60 minutes to administer and score the responses in an average.

On Juneja, et al. study on 2-9 years children^[22], The INDT-ASD's diagnostic accuracy being good [AUC=0.97 (0.93, 0.99), $P < 0.001$], and have Sensitivity 98%, specificity 95%, PPV (positive predictive value) 91%, NPV (negative predictive value) 99%. The Cronbach's alpha coefficients for internal consistency (0.96) being high indicates the symptoms cluster of INDT-ASD were homogenous and good agreement with DSM-TR. The instrument has high convergent validity with CARS ($r = 0.73$, $p = 0.001$), and divergent validity with SBIS (standford-binet intelligence scale) showed moderate negative correlation ($r = -0.37$, $p = 0.004$). The results show the CARS and INDT-ASD theoretically related with each other; SBIS was theoretically different in its IQ measures. The study conducted at the tertiary care hospitals, could not represent the general population, so a community-based study is required. In addition, the instrument validated for 2-9 years old children may not capture less than two years old. The implement developed based on DSM- IV TR and could not cover the sensory symptoms, impairment of daily functional activities and early onset of symptoms. Hence, necessitate upgrading with DSM-V. However, the tool differential diagnoses ASD with other conditions like ID (intellectual deficiency) it could not grade the severity of autism.

8.4 The AIIMS Modified INDT-ASD Diagnostic Evaluation for ASD

The AIIMS Modified INDT-ASD was the new tool developed by Sheffali Gulati et al. at All India Institutes of Medical Sciences (AIIMS) beside with INCLIN group^[52]. The team used pool of items from CARS (Childhood Autism Rating Scale), M-CHAT (Modified Checklist for Autism in Toddlers), and ABCL (Autism Behaviour Checklist) through modified Delphi technique; and developed as the upgraded version of INDT-ASD as per DSM-V specifications. The instrument has two sections (Section A and Section B). Section A has 28 questions to address seven items. Of which three items in the domain of social communication and interactions and four items in the domain of restricted repetitive pattern of behaviors and activity. In this modified form, the items to define sensory symptoms moreover included. Each items validated with responses yes/no/unsure by assessor/interviewer and behavioral ob-

servations of the clinician; Section B analyze the score of Section A. In addition, Section B has two mandatory items of 'onset at early developmental period' and 'impairment in daily functioning' - a prerequisite for the diagnosis of ASD. The tool could not require expertise and training to administer; will take 25 to 30 minutes to administer and get results. The AIIMS Modified INDT-ASD validated with 225 children (age group 1 to 14 years) presented in International Conference on Autism & Neurodevelopment Disorders, and claimed the psychometric properties of Sensitivity: 97.4% [90.9% to 99.3%] Specificity: 89.5 % [80.6% to 94.6%] Positive Predictive Value: 90.2% [81.9% to 94.9%] Negative Predictive Value: 97.1 % [90.2% to 99.2%] Diagnostic accuracy: 93.4% [88.3% to 96.4%]. Hence, it considered as a valid tool to get the DSM V based ASD diagnosis. The tool developed as user friendly and existing in various Indian languages like Hindi, Malayalam, Kanata, and English etc. offered as a mobile application too. Therefore, be the suitable implement for socio-culturally varied country like India. Yet, the tool could not assess the severity of ASD, and ignoring the few autistic features present in the notably abnormal children and labeling them as non-ASD. Here is the necessity of further research and upgrading of the instrument.

8.5 CARS2 (Childhood Autism Rating Scale 2)

The Childhood Autism Rating Scale (CARS)^[7,50] has available in use since 1971, developed by Eric Schopler, Robert Reichler and Barbara Rothen Renner. The CARS be the observation based rating scale, applicable for children 2 years and above, rates the child's abilities and behavioral characteristics against the typically developing child. The early tool (CARS) allows observations and ratings by the trained diagnosticians only. Subsequent edition on 1988 allowed a wide variety of trained professionals to use reliably. The second edition CARS 2 has added new features and data analysis^[37]. It contains two versions CARS2-ST (Standard Form), CARS2-HF (High Functioning) and CARS2-QPC (Questionnaire for Parents and Caregivers). The tool was same as CARS, the 15 items scale with 4 response categories normal, mild, moderate and severe and 3 intermediate responses as 1, 1.5, 2, 2.5, 3, 3.5, and 4. Of which, rating 1 for age appropriately normal child, 2 for mildly abnormal, 3 for moderately abnormal and 4 for severely abnormal autistic child. The cumulative Scores range from 15 to 60 for the 15 items. The scale classify the severity of ASD features for the individuals based on total raw scores into, minimal-to- no symptoms of ASD, mild-to- moderate symptoms of ASD, and severe symptoms of ASD depends on total scores obtained. The total raw scores can convert into T-scores

and corresponding percentile rank. It indicates the level of correspondence with individuals of ASD.

The CARS-ST contains same items and clinical cut-off as of old CARS, which indent to use for less than 6 years old children or 6 years and above children with IQ score less than 79 and having impairment in communication. The diagnosis of severity in CARS2-ST depends on total raw scores 15-29.5 as minimal to no ASD (15-27.5 for age 13+), 30- 36.5 as mild to moderate symptoms of ASD (28-34.5 for ages 13+), and the score more than 37 as severe symptoms of ASD (35 and above for ages 13+).

The CARS2-HF developed to identify High Functioning Autistic individuals (HFA) and Asperger's disorder. Used to assess individuals with IQ 80 and higher, or children aged six and above with good verbal skills and fluent communication. The 15 categories in CARS has modified in CARS2-HF to provide information to the clinicians about the socio communicative deficits, behavioral excesses, and cognitive sensory deficits in HFA and Asperger's disorder. The CARS2-HF rated similar to CARS2-ST, based on behavioral observations, and comparison with typical developing child of same age. Scoring also similar to CARS2-ST for 15 categories, but severity group scores differs with CARS2-ST, the score range 15-27.5 for mild ASD, the scores 28-33.5 for mild to moderate ASD and severe category scored 34 and higher.

The CARS2 contains CARS2-QPC in addition, to rate parent's/caregiver's responses. The Questionnaire for Parents or caregivers is an un-scored form, designed to accompany CARS2-ST and CARS2-HF. It gives information relevant to each 15 categories, helps the professional to understand the overall strengths and weaknesses of the individual on evaluation. Moreover, the newer tool is easier to use than older version. In addition, it differentiates ASD with other conditions like intellectual deficiency.

The test review on CARS2 by schopler et al. claims, the reliability of internal consistency of CARS2 with the original CARS shows 93% for CARS2-ST, 96% for CARS2-HF. The item correlations ranged from 0.43 to 0.81 on CARS-ST and from 0.53 to 0.88 on the CARS-HF. The validity of internal structure for both CARS2-ST and CARS2-HF, the items rating correlation is moderately high, ranging from 0.42 to 0.77 for CARS2-ST and 0.40 to 0.79 for CARS-HF; the CARS2-ST has 88% sensitivity and 86% specificity, the CARS2-HF has 81% sensitivity and 87% specificity. The content validity of both forms consistent with five core criteria of diagnostic systems^[56].

On Russell et.al study on the diagnostic accuracy, reliability and validity of CARS among Indian children with ASD^[50], shows the psychometric properties acceptable with Indian population as that of western and other

non-western population. The study on children and adolescences suspected with ASD in tertiary care and teaching hospital at south India shows, the CARS threshold score of greater than 33 considered as an ideal cut-off score for diagnosis of ASD among Indian population. The first ever validation of CARS against ICD-10 shows the high concordance rate (82.52%; Cohen's kappa=0.40, P=0.001) in classifying autism. The AUC 0.81 (P= 0.001) for ROC curve shows the overall diagnostic accuracy of CARS was high. A score of > or =33 (sensitivity = 81.4%, specificity = 78.6%; area under the curve = 81%) suggests good psychometrics for the diagnostic use of CARS on Indian populations. The inter-rater reliability (ICC=0.74) and test-retest reliability (ICC=0.81) for CARS were good. In addition, the tool have the adequate face and content validity, demonstrated good internal consistency (Cronbach's alpha=0.79) and item-total correlation. There was moderate convergent validity with Binet-Kamat Test of Intelligence or Gessell's Developmental Schedule (r=0.42; P=0.01), divergent validity (r=-0.18; P=0.4) with ADD-H Comprehensive Teacher Rating Scale. The tool have high concordance rate with the reference standard, ICD-10 diagnosis (82.52%; Cohen's kappa=0.40, P=0.001) of ASD. A 5-factor items loading structure on factor analysis explained 65.34% of variance. However, the items total correlation that determines the role of each 15 items in entire test shows the items activity level and intellectual functioning were ineffective in contributing the total score. These items could also measure the intellectual deficiency (95%) and Attention deficit and Hyperactive Disorder (53%), the two more highly prevalent co-morbid conditions with ASD among Indian population. It suggests the hypothesis to exclude these items to improve the construct validity of the CARS. This hypothesis needs further research and testing.

8.6 PAAS (Pictorial Autism Assessment Scale)

Pictorial autism assessment tool (PASS) was the culturally adopted tool developed by Perera H et al. (2016) of Sri Lanka^[42], the neighboring country have similar socio-cultural settings like India. The screening tool developed with 21 items as that of M-CHAT, having pictorial representation of the each items with photographs. The items explained in local languages Tamil and Sinhala with yes/no responses. While comparing with text only tools, it has good accurate response with parents, being user friendly and can administer within 15- 20 minutes. The study on the tool claims, 88.8% sensitivity, 93.3% specificity, and 95.2% positive predictive value and 84% negative predictive value^[43]. Though the screening tool has its own advantages of including visual aid to understand the concept

of the items, the tool tested to assess 18-48 months old children and could not test for its usability on the children above 48 months of age. Hence, show the limited applicability at particular age group.

8.7 CASI (Chandigarh Autism Screening Instrument)

Chandigarh Autism Screening Instrument (CASI) developed by Dr. Priti Arun and the team of professionals at department of psychiatry, Government Medical College and Hospital, Chandigarh, India [2]. The 37 items screening tool with north Indian regional language Hindi, developed as a parental screening questionnaire with dichotomous yes/no responses. The tool constructed based on DSM IV TR, and validated against M-CHAT and ABC (Autism Behavior Checklist). Developed to assess 1 and half to 10 year old children. It takes 15-20 minutes to administer. The tool has 89.16% sensitivity and 89.13% specificity, positive predictive value 67.89% and negative predictive value 96.96%. The screener has the advantage of user friendly and native language tool, being self-explanatory, can administer by anyone without training. However, the tool needs to upgrade for DSM-V diagnostic criteria. Further evaluation needed with testing on larger community settings and has to translate in various other Indian languages.

As discussed, the majority of screening and diagnostic tools available internationally may not be suitable for Indian socio-cultural situations, many implements are patterned and costly, difficult to adopt in different socio-economic status of India [55]. Numerous instruments need training and expertise to use, and here, the smaller amount of trained personals to work on various rural and urban settings of India. The available above-mentioned indigenous Indian tools and others have their own advantages and limitations, requires further research and development in the field [6].

9. Intervention obscurities

At Indian scenario, many practical difficulties including delayed identification and difficult parental acceptance, hesitation to start therapy and less number of trained personals to provide therapy especially at rural and remote areas. Even though, wide increase in awareness; more number of cases remains undiagnosed and devoid of the required crucial intervention [8,51]. Early appropriate screening and initiation of intervention can improve outcomes in these children [16,53]. Yet, the mean age of first consultation in children with ASD 32.5 months and intervention initiated at 52.75 months [34]. The limited

availability of ASD specific governmental organizations, less availability of standardized therapeutic methods for intervention, the cost of private intervention programs become more burden to the parents of middle and lower socioeconomic group [3,21].

Though the international insistence of various ABA (Applied Behaviour Analysis) based therapies as standard [30], the applicability restricted due various socioeconomic, educational, cultural and healthcare standards in India. Hence, parent mediated, home based therapies are the most suitable mode of therapy in Indian setting due to the scarcity of professionally trained persons; be economically advantageous, available in practice early before the insistence in modern literatures, provide intervention at naturalistic setting at the convenient time [40,44]. The available few governmental organizations can train parents on periodical basis to act as a co-therapist. Individualized therapy plan according to child and family centered needs are to be developed; and the professional can monitor the outcome on regular basis. However, mother being the primary care-taker, busy with all her household chaos and profession cannot contribute the therapy. Raising a child with disability leads a tremendous stress on parents and family. On the other hand, the joint family system in India can act as a great support to the suffering child, and facilitate therapy in good manner through grant parents, brothers, sisters, cousins etc. Yet it is not possible in low socio economic families, whom themselves lack basic education, or suffer from autism like traits, depression, anxiety and other psychiatric disorders, [14,15]. However, it is essential to incorporate multi-centric evidence based practices and research on comprehensive method to improve the available interventions. Until now, there is no proven evidence of cure for ASD, various pharmacotherapies in practice for behavioral difficulties and co-morbidities. In addition, India being the land of Yoga and Ayurveda, various AYUSH based therapies are available as optional. Yet, the scientific proving and research on various therapeutic practices are essentially progressing in India.

10. Conclusion

Autism Spectrum Disorder remains as life-long condition, early intervention can improve the symptoms and aids independent living with educational and vocational achievements [25]. At Indian sub-continent, varied socio-cultural, economic, healthcare and literacy ranges contribute the factor deciding untimely identification, diagnosis and management. It requires generating immense awareness and association among parents and professionals. Policymaking necessitates added training and educational programs for professionals and people handling autistic children. Pro-

spective research imposes on cultural, language specific, indigenous screening and diagnostic instruments with rationalized implementation for Indian gamut of population. The advancement of varied cultural specific behavioral and environmental modified intervention program necessitates the betterment of Indian autistic community.

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References

- [1] Allen-Meares, P., MacDonald, M., & McGee, K..Autism Spectrum Disorder Updates–Relevant Information for Early Interventionists to Consider. *Frontiers in public health*, 2016, 4: 236.
- [2] Arun, P., &Chavan, B. S..Development of a screening instrument for autism spectrum disorder: Chandigarh Autism Screening Instrument. *The Indian journal of medical research*, 2018, 147(4): 369.
- [3] Barua, M., Kaushik, J. S., & Gulati, S.. Legal provisions, educational services and health care across the lifespan for autism spectrum disorders in India. *The Indian Journal of Pediatrics*, 2017, 84(1): 76-82.
- [4] Bhargava, A.. School Education of Children with Special Needs in India with a Perspective on the Initiatives for Children with Autism, 2017.
- [5] Chakraborty, S., Thomas, P., Bhatia, T., Nimgaonkar, V. L., & Deshpande, S. N..Assessment of severity of autism using the Indian scale for assessment of autism. *Indian journal of psychological medicine*, 2015, 37(2): 169.
- [6] Charman, T., & Gotham, K.. Measurement Issues: Screening and diagnostic instruments for autism spectrum disorders–lessons from research and practise. *Child and adolescent mental health*, 2013, 18(1): 52-63.
- [7] Chlebowski, C., Green, J. A., Barton, M. L., & Fein, D.. Using the childhood autism rating scale to diagnose autism spectrum disorders. *Journal of autism and developmental disorders*, 2010, 40(7): 787-799.
- [8] Corsello, C. M..Early intervention in autism. *Infants & Young Children*, 2005, 18(2): 74-85.
- [9] Daley, T. C.. From symptom recognition to diagnosis: children with autism in urban India. *Social science & medicine*, 2004, 58(7): 1323-1335.
- [10] Daley, T. C., &Sigman, M. D.. Diagnostic conceptualization of autism among Indian psychiatrists, psychologists, and pediatricians. *Journal of Autism and Developmental disorders*, 2002, 32(1): 13-23.
- [11] Dalwai, S. H., Modak, D. K., Bondre, A. P., &Gajria, D.. Analysis of tools for diagnosing autism spectrum disorder in the Indian context. *Acad J Ped Neonatol*, 2016, 1: 555-62.
- [12] Dalwai, S., Ahmed, S., Udani, V., Mundkur, N., Kamath, S. S., & Nair, M. K. C.. Consensus statement of the Indian academy of pediatrics on evaluation and management of autism spectrum disorder. *Indian pediatrics*, 2017, 54(5): 385-393.
- [13] Deepthi, V., &Vineetha, S.. Study On Early Detection Of Autism Using Genetic And Kinematic Biomarker. In *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, 2018, 396(1):012034.
- [14] Desai, M. U., Divan, G., Wertz, F. J., & Patel, V..The discovery of autism: Indian parents’ experiences of caring for their child with an autism spectrum disorder. *Transcultural psychiatry*, 2012, 49(3-4): 613-637.
- [15] Divan, G., Vajaratkar, V., Desai, M. U., Strik-Lievers, L., & Patel, V.. Challenges, Coping Strategies, and Unmet Needs of Families with a Child with Autism Spectrum Disorder in Goa, India. *Autism Research*, 2012, 5(3): 190-200.
- [16] Eapen, Valsamma. Early identification of autism spectrum disorder: Do we need a paradigm shift? 2016: 718-720.
- [17] Elsabbagh, M., Divan, G., Koh, Y. J., Kim, Y. S., Kauchali, S., Marcín, C., &Yasamy, M. T..Global prevalence of autism and other pervasive developmental disorders. *Autism research*, 2012, 5(3): 160-179.
- [18] Fernell, E., Eriksson, M. A., &Gillberg, C..Early diagnosis of autism and impact on prognosis: a narrative review. *Clinical epidemiology*, 2013, 5: 33.
- [19] Guthrie, W., Swineford, L. B., Nottke, C., &Wetherby, A. M..Early diagnosis of autism spectrum disorder: stability and change in clinical diagnosis and symptom presentation. *Journal of Child Psychology and Psychiatry*, 2013, 54(5): 582-590.
- [20] Hossain, M. D., Ahmed, H. U., Uddin, M. J., Chowdhury, W. A., Iqbal, M. S., Kabir, R. I.,& Hossain, S. W.. Autism Spectrum disorders (ASD) in South Asia: a systematic review. *BMC psychiatry*, 2017, 17(1): 281.
- [21] Jain, R., Juneja, M., &Sairam, S.. Children with developmental disabilities in India: age of initial concern and referral for rehabilitation services, and reasons for delay in referral. *Journal of child neurology*, 2013, 28(4): 455-460.
- [22] Juneja, M., Mishra, D., Russell, P. S., Gulati, S., Deshmukh, V., Tudu, P., & Durkin, M.. INCLEN diagnostic tool for autism spectrum disorder (IN-DT-ASD): Development and validation. *Indian pedi-*

- atrics, 2014, 51(5): 359-365.
- [23] Juneja, M., Mukherjee, S. B., & Sharma, S.. A descriptive hospital based study of children with autism. *Indian pediatrics*, 2005, 42(5): 453.
- [24] Kandasamy, P.. Early intervention of Autism Spectrum Disorder: translating research into practice. *Indian Journal of Mental Health and Neurosciences*, 2018, 1(1): 1-7.
- [25] Karanth, P., & Chandhok, T. S.. Impact of early intervention on children with autism spectrum disorders as measured by inclusion and retention in mainstream schools. *The Indian Journal of Pediatrics*, 2013, 80(11): 911-919.
- [26] Koegel, L. K., Koegel, R. L., Ashbaugh, K., & Bradshaw, J.. The importance of early identification and intervention for children with or at risk for autism spectrum disorders. *International journal of speech-language pathology*, 2014, 16(1): 50-56.
- [27] Krishnamurthy, V.. A clinical experience of autism in India. *Journal of Developmental & Behavioral Pediatrics*, 2008, 29(4): 331-333.
- [28] Kumar, A., Juneja, M., & Mishra, D.. Prevalence of autism Spectrum disorders in siblings of Indian children with autism Spectrum disorders. *Journal of child neurology*, 2016, 31(7): 873-878.
- [29] Le Bel, R. M., Pineda, J. A., & Sharma, A.. Motor-auditory-visual integration: the role of the human mirror neuron system in communication and communication disorders. *Journal of communication disorders*, 2009, 42(4): 299-304.
- [30] Lindgren, S., & Doobay, A.. Evidence-based interventions for autism spectrum disorders. The University of Iowa, Iowa, 2011.
- [31] Malhi, P., & Singhi, P.. A retrospective study of toddlers with autism spectrum disorder: Clinical and developmental profile. *Annals of Indian Academy of Neurology*, 2014, 17(1): 25.
- [32] Malhotra, S., & Vikas, A.. Pervasive developmental disorders: Indian scene. *Journal of Indian Association for child and adolescent mental health*, 2005, 1(5).
- [33] Mamidala, M. P., Polinedi, A., PTV, P. K., Rajesh, N., Vallamkonda, O. R., Udani, V., ... & Rajesh, V.. Prenatal, perinatal and neonatal risk factors of Autism Spectrum Disorder: a comprehensive epidemiological assessment from India. *Research in developmental disabilities*, 2013, 34(9): 3004-3013.
- [34] Manohar, H., Kandasamy, P., Chandrasekaran, V., & Rajkumar, R. P.. Early diagnosis and intervention for autism spectrum disorder: Need for pediatrician-child psychiatrist liaison. *Indian Journal of Psychological Medicine*, 2019, 41(1): 87.
- [35] Monica Juneja and Smitha Sairam, Autism Spectrum Disorder - An Indian Perspective, book chapter, SMGroup.
- [36] McConachie, H., Parr, J. R., Glod, M., Hanratty, J., Livingstone, N., Oono, I. P., & Garland, D.. Systematic review of tools to measure outcomes for young children with autism spectrum disorder, 2015.
- [37] Moulton, E., Bradbury, K., Barton, M., & Fein, D.. Factor analysis of the childhood autism rating scale in a sample of two year olds with an autism spectrum disorder. *Journal of autism and developmental disorders*, 2016: 1-14.
- [38] Mukherjee, S. B., Malhotra, M. K., Aneja, S., Chakraborty, S., & Deshpande, S.. Diagnostic accuracy of Indian Scale for Assessment of Autism (ISAA) in children aged 2-9 years. *Indian pediatrics*, 2015, 52(3): 212-216.
- [39] Oberman, L. M., Pineda, J. A., & Ramachandran, V. S.. The human mirror neuron system: a link between action observation and social skills. *Social cognitive and affective neuroscience*, 2007, 2(1): 62-66.
- [40] Parsons, D., Cordier, R., Vaz, S., & Lee, H. C.. Parent-mediated intervention training delivered remotely for children with autism spectrum disorder living outside of urban areas: Systematic review. *Journal of medical Internet research*, 2017: 19(8).
- [41] Patra, S., & Arun, P.. Use of Indian scale for assessment of autism in child guidance clinic: An experience. *Indian journal of psychological medicine*, 2011, 33(2), 217.
- [42] Perera, H., Jeewandara, K. C., Seneviratne, S., & Gamage, C.. Culturally adapted pictorial screening tool for autism spectrum disorder: a new approach. *World journal of clinical pediatrics*, 2017, 6(1): 45.
- [43] Rahman, A., Divan, G., Hamdani, S. U., Vajaratkar, V., Taylor, C., Leadbitter, K., & Patel, V.. Effectiveness of the parent-mediated intervention for children with autism spectrum disorder in south Asia in India and Pakistan (PASS): a randomised controlled trial. *The Lancet Psychiatry*, 2016, 3(2): 128-136.
- [44] Raina, S. K., Chander, V., Bhardwaj, A. K., Kumar, D., Sharma, S., Kashyap, V., & Bhardwaj, A.. Prevalence of autism spectrum disorder among rural, urban, and tribal children (1-10 Years of Age). *Journal of neurosciences in rural practice*, 2017, 8(3): 368.
- [45] Robins, D. L., Casagrande, K., Barton, M., Chen, C. M. A., Dumont-Mathieu, T., & Fein, D.. Validation of the modified checklist for autism in toddlers, revised with follow-up (M-CHAT-R/F). *Pediatrics*, 2014, 133(1): 37-45.
- [46] Robins, D. L., Fein, D., Barton, M. L., & Green, J. A.. The Modified Checklist for Autism in Toddlers: an initial study investigating the early detection of au-

- tism and pervasive developmental disorders. *Journal of autism and developmental disorders*, 2001, 31(2): 131-144.
- [47] Ronald, A.. Problem children problem parents. *Indian Journal of Pediatrics*, 1944, 11(1): 20-29.
- [48] Rudra, A., Banerjee, S., Singhal, N., Barua, M., Mukerji, S., & Chakrabarti, B.. Translation and Usability of Autism Screening and Diagnostic Tools for Autism Spectrum Conditions in India. *Autism Research*, 2014, 7(5): 598-607.
- [49] Rudra, A., Belmonte, M. K., Soni, P. K., Banerjee, S., Mukerji, S., & Chakrabarti, B.. Prevalence of autism spectrum disorder and autistic symptoms in a school-based cohort of children in Kolkata, India. *Autism Research*, 2017, 10(10): 1597-1605.
- [50] Russell, P. S., Daniel, A., Russell, S., Mammen, P., Abel, J. S., Raj, L. E., ...& Thomas, N.. Diagnostic accuracy, reliability and validity of Childhood Autism Rating Scale in India. *World Journal of Pediatrics*, 2010, 6(2): 141-147.
- [51] Samms-Vaughan, M. E.. The status of early identification and early intervention in autism spectrum disorders in lower-and middle-income countries. *International Journal of Speech-Language Pathology*, 2014, 16(1): 30-35.
- [52] Sheffali Gulati, Jaya Shankar Kaushik, Biswaroop-Chakrabarty, Lokesh Saini, Savita Sapra, NK Arora, RM Pandey, Rajesh Sagar, VK Paul, Shobha Sharma, "AIIMS Modified INDT-ASD Tool for Autism Spectrum Disorder", The National Trust for the welfare of Persons with Autism, Cerebral Palsy, Mental retardation and Multiple Disabilities, Dept of Empowerment of Persons with Disabilities (Divyangjan), Ministry of Social Justice & Empowerment, Govt. of India.
- [53] Suma, K., Adamson, L. B., Bakeman, R., Robins, D. L., & Abrams, D. N.. After early autism diagnosis: Changes in intervention and parent-child interaction. *Journal of autism and developmental disorders*, 2016, 46(8): 2720-2733.
- [54] Taheri, A., Perry, A., & Factor, D. C.. BRIEF REPORT: A Further Examination of the DSM.5 Autism Spectrum Disorder Criteria in Practice. *Journal on Developmental Disabilities*, 2014, 20(1): 116.
- [55] Varma, A., & Iskandar, J. W.. Challenges in diagnosis of autism and the struggle of using western screening tools in different cultures. *Psychiatrist's perspective. Indian pediatrics*, 2014, 51(5): 356.
- [56] Vaughan, C. A.. Test review: E. Schopler, ME Van Bourgondien, GJ Wellman, & SR Love childhood autism rating scale. Los Angeles, CA: Western Psychological Services, 2010. *Journal of Psychoeducational Assessment*, 2011, 29(5): 489-493.
- [57] Venkatesan, S.. A Growing Trend in Pseudo-Diagnosis: A Field Study on Children Frequently Mistaken for Autism in India. *Psychological Studies*, 2015, 60(1): 91-100.
- [58] Vivanti, G., & Rogers, S. J.. Autism and the mirror neuron system: insights from learning and teaching. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 2014, 369(1644): 20130184.
- [59] Volkmar, F. R., Chawarska, K., & Klin, A.. Autism spectrum disorders in infants and toddlers: An introduction. *Autism spectrum disorders in infants and toddlers: Diagnosis, assessment, and treatment*, 2008: 1-22.
- [60] Wong, C. M., & Singhal, S.. INDT-ASD: An autism diagnosis tool for Indian children. *Indian Pediatrics*, 2014, 51: 355-6.
- [61] World Health Organization.. *Autism spectrum disorders & other developmental disorders: From raising awareness to building capacity*. Geneva: WHO Document Production Services, 2013.
- [62] waigenbaum, L., Bauman, M. L., Choueiri, R., Fein, D., Kasari, C., Pierce, K., & McPartland, J. C.. Early identification and interventions for autism spectrum disorder: executive summary. *Pediatrics*, 2015, 136(Supplement 1): S1-S9.