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INSTITUTE OF MEDICAL SCIENCES

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READY RECKONER FOR PAEDIATRICS PRACTICAL EXAM

Module 2: DEVELOPMENT

COMPILED BY:

Dr. Jawhar E. A.
Senior Resident

EDITORS:

Dr. Riya Lukose
Associate Professor
Dr. Kalyani Pillai
Professor & HOD

DEPT. OF PAEDIATRICS
AMALA INSTITUTE OF MEDICAL SCIENCES, THRISSUR

DEVELOPMENT

Development refers to the maturation of functions and acquisition of the various skills for optimal functioning of an individual.

The sequential attainment of developmental milestones reflects maturation and myelination of the nervous system.

Over 80% of brain development occurs in the first three years of life.

Early childhood development (ECD) refers to the physical, motor, socio-emotional, cognitive and linguistic development of a young child, especially in the first three years of life. ECD determines learning outcomes in school and beyond. The first 1000 days(antenatal period + first 2 years of life) is the most critical period in a child's development.

Common Patterns/Principles of Development

1. Development is a continuous process, starting in utero and progressing until maturity.
2. Development depends on the functional maturation of the nervous system.
3. The sequence of attainment of milestones is the same in all children.
4. The development progresses in a cephalocaudal direction, and proximal to distal.
5. The attainment of certain milestones requires that relevant neonatal reflexes to disappear. (eg:- ATNR should disappear for the baby to turn over, grasp reflex should disappear for voluntary holding to occur)
6. Specific actions replace the initial disorganized mass activity.

Causes of Developmental Delay

- Antenatal Factors
- Neonatal Risk Factors
- Postnatal Factors
- Psychosocial Factors
- Protective Factors

Prenatal Factors

● Genetic factors - Chromosomal abnormalities (eg: Down Syndrome)

- Single gene disorders (eg: congenital deafness)
- Metabolic disorders (eg: Phenylketonuria)

● Maternal factors - Maternal malnutrition

- Exposure to drugs and toxins (Drugs like Phenytoin, valproate, Antithyroid drugs, anticancer drugs, radiation)
- Maternal diseases and infections (eg: PIH(uteroplacental insufficiency), Gestational diabetes mellitus, untreated hypothyroidism, IUGR(fetoplacental insufficiency- absent or reversal of diastolic flow on doppler), TORCH infections(Toxoplasmosis, Syphilis, Rubella, CMV, Herpes) Others-Zika, HIV)

● Neonatal Risk Factors

- Small for gestational age (SGA) status
- Prematurity
- Perinatal asphyxia
- Respiratory distress / need for ventilation/ oxygen support
- Severe hyperbilirubinemia requiring prolonged phototherapy or exchange transfusion
- Neonatal seizures
- Severe sepsis
- Hypoglycaemia, electrolyte abnormalities

● Post neonatal Factors

- Infant and child nutrition- Severe malnutrition Congenital hypothyroidism
- Infectious diseases-Diarrhoea, malaria, HIV, other parasitic infections
- Environmental toxins- Lead, arsenic, pesticides, mercury, polycyclic aromatic carbons
- Acquired insults to brain-Traumatic or infectious insults like meningitis, encephalitis, cerebral malaria
- Associated impairments- Sensory impairment like vision, hearing

● Psychosocial Factors

- Parenting -Suboptimal parenting such as inadequate emotional warmth
- Lack of nurturing conditions- Social and emotional deprivation and lack of adequate stimulation
- Violence and abuse- domestic and community violence, physical and sexual abuse
- Maternal depression
- Institutionalization- Institutional care eg: orphanage
- Poverty exposes the child to scarcity of opportunities, excessive stress, malnutrition, environmental toxins and concurrent infections.
- Increased screen time

● Protective Factors

- Breast feeding
- Kangaroo mother care
- Optimum nutrition
- Absence of illness
- Nurturing family
- Secure home
- Educated parents

DEVELOPMENTAL DOMAINS

DEVELOPMENTAL DOMAIN	SKILLS LEARNED BY CHILD
Gross Motor	Movements using the large muscles
Fine Motor	Movements using the hands and smaller muscles, often involving daily living skills
Language	Receptive and expressive communication, speech, and nonverbal communication
Cognitive	Reasoning, memory, and problem-solving skills
Social-emotional & behavioural	Attachment, self-regulation, and interaction with others

(Ref: Scharf RJ, Scharf GJ, Stroustrup A. Developmental milestones. Pediatrics in review. 2016 Jan 1;37(1):25-38.)

Domains of development

1. Gross motor
2. Fine motor
3. Personal, social and general understanding
4. Language
5. Vision and hearing

GROSS MOTOR DEVELOPMENT

Motor development progresses in an orderly sequence to attain locomotion and the ability to do more complex motor tasks.

Key gross motor milestones

Age	Milestone
3-4 months	Neck holding
5 months	Roll over
6 months	Sits in tripod fashion (sitting with own support)
8 months	Sits without support
8-9 months	Crawling(abdomen on the ground)
9 months	Stands holding on (with support)
10 months	"Creeping (abdomen off the ground) ; cruising (walking holding onto furniture); Pivoting- turns around to pick an object at 10-11 months"
12 months	Creeps well; walks but falls; stands without support, bear walk
15 months	Walks alone; creeps upstairs
18 months	Runs; explores drawers
2 years	Walks up and downstairs (2 feet/step)
2 ½ years	Jumps
3 years	Rides tricycle; alternate feet going upstairs
4 years	Hops on one foot; alternate feet going downstairs
5 years	Skips

FINE MOTOR SKILL DEVELOPMENT

This domain deals with using hands and eyes for manipulation and coordinated activities.

Hand regard-The child observes his/her own hands very intently between 12 to 20 weeks. Its persistence beyond 20 weeks is abnormal.

Hand to mouth coordination-

At 6 months, as the ability to chew develops.

By 12 months, he tries to feed himself with a cup with spilling.

By 15 months, the child can pick up a cup and drink from it without much spilling.

By 18 months, he can feed himself well using a spoon.

Key fine motor milestones

Age	Milestone
4 months	Bidextrous reach (reaching out for objects with both hands)
6 months	Unidextrous reach (reaching out for objects with one hand); transfer objects
9 months	Immature pincer grasp; probes with forefinger
12 months	Mature pincer grasp, casting
15 months	Imitates scribbling; tower of 2 blocks
18 months	Scribbles; tower of 3 blocks
2 years	Tower of 6 blocks; vertical and horizontal stroke
3 years	Tower of 9 blocks; copies circle; bridge with blocks
4 years	Copies cross; gate with blocks
5 years	Copies triangle;

Drawing skills

Circle – 3 years

Cross – 4 years

Square – 4 ½ years

Triangle – 5 years

Diamond – 6 years

Cylinder – 9 years

Cube – 11 years

Block skills at various ages

15 months – Tower of 2 blocks

18 months – Tower of 3 blocks

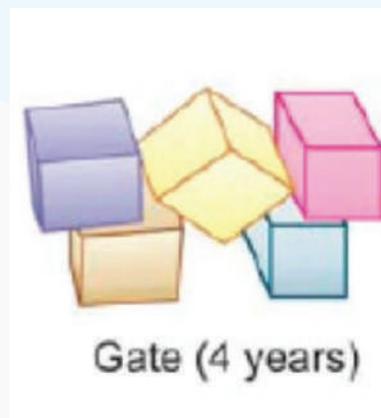
2 years – Train

2 ½ years – Train with chimney

3 years – Tower of 9 cubes; Bridge

4-5 years – Gate

5-6 years – Steps



Personal and social development

Key social and adaptive milestones

Age	Milestone
2 months	Social smile (smiles in response, looking at the face)
3 months	Recognizes mother; anticipates feeds
6 months	Recognizes strangers; stranger reaction;
8-9 months	Responds to NO
9-10 months	Waves bye-bye; peek a boo; pat a cake
12 months	Comes when called; plays simple ball game
15 months	Jargon
18 months	Copies parents in task (sweeping) - domestic mimicry
2 years	"Ask for food, drink, toilet; pulls people to show toys Parallel play"
3 years	Shares toys; knows full name and gender
4 years	Plays cooperatively in a group; goes to toilet alone; Right & Left discrimination
5 years	Helps in household tasks, dresses and undresses; morning and afternoon difference

Colour Concept

3 years- identifies 1-2 colours

5 years- identify 4 colours

Object permanence - The understanding that an object exists even if one cannot see it, is typically mastered by 9 to 12 months of age. Out of sight is not out of mind once object permanence is achieved, so a child will look for a toy that has been completely covered from view. This is one cognitive milestone that can be tested; starts by 6 months when baby starts looking for fallen toy.

Parallel play - from 2-3 years, kids start to show their need for being with peers, will look and be in the proximity of other children playing and will be trying to imitate their play.

Pretend play - from 1 to 5 years, play activities can be imaginative. Eg: the child may pretend to bathe or feed a doll or attend a doll pretending to be a nurse or doctor.

Language milestones

Key language milestones

Age	Milestone
1 month	Alert to sound
3 months	Coos (musical vowel sound)
4 months	Laugh loud
6 months	Monosyllables (ba, da, pa), ah-goo sounds
9 months	Bisyllables (mama, baba, dada)
12 months	1-2 words with meaning
18 months	8-10 words vocabulary; jargon speech
2 years	2 word sentences, uses pronouns "I", "me", "you"
3 years	3 word sentences; Asks questions; knows full name and gender
4 years	Says song or poems; tells stories
5 years	Asks meaning of words

Visual development

At birth- baby can fixate and follow a moving person or dangling ring held 8-10 inches away upto a range of 45 degree

4 weeks – fix and follow an object upto 90 degree , baby can fixate on his mother as she talks

12 weeks- fix and follow an object upto 180 degree

3-4 months- child fixates intently on an object shown to him (grasping with the eye) as if the child wants to reach for the object

4 months – binocular vision

6 months- child adjusts his position to follow objects of interest

12 months – child can follow rapidly moving objects

Hearing

At birth- newborns respond to sound by startling, blinking, crying

3 to 4 months – child turns his head toward the sound

5 to 6 months- child turns the head to the side and then downwards to the sound produced below the ear level

10 months- child directly looks at the source of sound diagonally

Red flags in development

Age	Red flags for gross motor
9 months	No sitting without support
12 months	No standing with assistance
17 months	Unable to stand alone
18 months	Unable to walk alone
2 years	Unable to walk upstairs with help
4 years	Unable to jump
	Red flags for fine motor
5 months	Unable to hold a rattle
12 months	No pincer grasp
20 months	Unable to remove socks or gloves
24 months	Unable to scribble
3 years	Cannot work simple toys
5 years	Does not draw picture

	Red flags for hearing
12 months	No babbling or vocal imitaitaion
18 months	No use of single words
24 months	Single word vocabulary < /= 10 words
30 months	< 100 words no two word combination
36 months	<200 words, no telegraphic sentence
42 months	<600 words, no simple sentences
	Red flags for socioadaptive
2 months	No social smile
12 months	No pointing
3 years	No pretend play
4 years	No response to peers
5 years	Usually withdrawn and not active

(Ref: <https://pedneuroaiims.org/pdf2015/developmental-milestones-at-a-glance.pdf>)

Developmental observation card (DOC)

Developmental Observation Card is a self-explanatory, simple card that can be used by the parents. The DOC has been developed at Child Development Centre, Thiruvananthapuram. This can be used to screen for developmental delays by parents and by anganwadi workers. The large majority of developmental delays can be identified by using cut off points for 4 simple developmental milestones namely social smile, head control, sitting and standing.

Direct Observation Card

Developmental milestones	Attained age
Social smile	2 months
Holds head steady	4 months
Sits alone	8 months
Stands alone	12 months

Make sure that baby does see, hear and listen

Developmental Assessment

Developmental delay is estimated to be present in about 10% of children.

Steps

History: A well taken history will provide information regarding

- risk factors
- rate of acquisition of milestones and differentiating delay from the regression (loss of already achieved milestones)
- approximate developmental age of the child, which helps to choose the appropriate tool for evaluation.

Examination:

- Physical growth and head circumference
- Dysmorphic features (mongloid/antimongloid slant of eyes, epicanthal fold, low set ears, ear tags, cleft lip/palate, poly/syndactyly, abnormal palmar creases)
- Neurocutaneous markers (café au lait macules, ash leaf macules, shagreen patch, neurofibromas)
- stigmata of intrauterine infections
- Signs of hypothyroidism
- Vision and hearing
- Neurological status including the presence of primitive reflexes

Developmental quotient (DQ) = $\frac{\text{Developmental age} \times 100}{\text{Chronological age}}$

DQ below 70% is taken as the delay that warrants detailed evaluation.

Corrected developmental age (CDA): Chronological age (CA) – No. of weeks or months premature
Usually no further correction will be made after 24 months of corrected post-natal age.

Eg: Baby M was born at 32 weeks gestation

He was 8 weeks premature (40 weeks - 32 weeks = 8 weeks = 2 months)

Baby M is seen at 12 weeks post natal age (Chronological Age)

Corrected age (CA) = Chronological age (CH) - No of weeks premature
= 12 weeks - 8 weeks
= 4 weeks

Global Developmental Delay

GDD is defined as a significant delay in two or more of the following developmental domains: gross/fine motor, speech/ language, cognition, social/personal, and activities of daily living. Significant delay is defined as performance being two or more standard deviations lower than the mean, on age appropriate, standardized norm-referenced testing.

GDD indicates that the child should have cognitive dysfunction. After 5 years of age when an IQ assessment can be done, it can be termed as intellectual disability.

Eg:- Down syndrome, Fragile X syndrome, Phenyl ketonuria, Angelman syndrome, Prader Willi syndrome, Brain malformations, TORCH infections, Birth trauma, severe asphyxia, Quadriplegic cerebral palsy,

Characterization of atypical development

Atypical development	Definition
Delay	Significantly delayed attainment of milestones or skills in one or more domains, but in an expected sequence, compared to that of typically developing children
Deviation	"Attainment of developmental skills in a given domain that is out of sequence, for example, when an infant rolls from supine to prone before prone to supine. Eg:- In Cerebral palsy, due to hypertonia, the baby turns prone before head control. In autism spectrum disorder, child may repeat rhymes but is not able to communicate typically."
Dissociation	"Attainment of developmental skills at significantly different rates between two or more domains of development. For example, when there is delayed motor development relative to other domains in cerebral palsy. Isolated speech delay- could be expressive/receptive or combined speech delay; autism spectrum disorder Isolated gross motor delay- rickets, diplegic/hemiplegic CP, myopathies, muscular dystrophies, spinal muscular atrophy, benign congenital hypotonia"
Regression	"Loss of previously acquired developmental milestones or skills or failure to acquire new skills. Eg:- indicative of progressive neurological illnesses- neurometabolic illnesses, aminoacidopathies, urea cycle disorders, glycogen storage disorders, lipid storage disorders, mucopolysaccharidoses."

(Ref: Patel DR. Principles of developmental diagnosis. In: Greydanus DE, Feinberg A, Patel DR, et al. editors. Pediatric Diagnostic Examination. New York: McGraw Hill Medical, 2006:629-44.)

Treatable or preventable causes of intellectual disability/GDD

- Hypothyroidism
- Vitamin B12 deficiency
- Phenylketonuria
- Cong rubella infection

Cerebral Palsy

Cerebral palsy describes a group of permanent disorders of movement & posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in developing fetal or infant brain (Rosenbaum and Bax)

Early markers of CP

- Persistent fisting after 2 months of age
- Persistent ATNR, Moro's reflex
- Persistent tone abnormalities
- Paucity of movement
- Excessive or disorganised movement
- Hyperextension of head and neck
- Feeding difficulties/swallowing
- Delayed social smile
- Stereotypical behaviour

Classification of CP

● Physiological classification (Based on Muscle tone):-

Spastic type or CP Muscle stiffness:- Often the head position triggers abnormal positioning. Stiffness increases when the child is excited or upset.

Dyskinetic type or CP with involuntary & Uncontrolled movements. Can be **Choreoathetoid type** or **Dystonic type**. Most have normal intelligence, but if muscles needed for speech are affected then it may be hard for them to communicate their thoughts.

Ataxic type or CP with disturbed sense of balance & perception. Will have difficulty beginning to sit & stand.

Mixed type of Cerebral Palsy

Based on topography:-

Hemiplegic:- Spastic Hemiplegic most closely related to Perinatal stroke.

Diplegic:- Mostly seen in premature with Periventricular leukomalacia. Intelligence & language skills are usually normal.

Quadriplegic:- Most severe form. Mostly seen in Hypoxic-Ischemic encephalopathy in term babies. Associated with Intellectual Disability.

Monoplegic

Aetiology of CP

Prenatal	perinatal	postnatal
Intrauterine infections (TORCH)	Prematurity	Meningitis/ encephalitis
Maternal illnesses- PIH,GDM, c/c illnesses, malnutrition, anemia	"Birth asphyxia Intrauterine growth retardation"	Head trauma, accidents
Teratogens- radiation, drugs, smoking, alcohol, anticonvulsants etc	Hyperbilirubinemia(Kernicterus)	Pediatric stroke
Chorioamnionitis	Intraventricular/intracranial bleed	Psychosocial deprivation
	Metabolic complications- hypoglycemia	Familial causes
	Neonatal seizures, sepsis	

Development screening tests

Screening is a brief assessment procedure designed to identify children requiring detailed assessment.

Eg: Trivandrum development screening chart (TDSC)- 0 to 6 years

Language Evaluation Screening Test (LEST)- 0-6 years

Denver 2 or Denver development screening test(DDST-II)-0 to 6 years

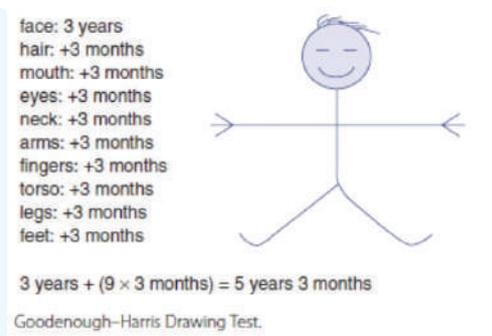
M-CHAT-R – for screening of autism in 16-30 months

Trivandrum Autism Behavior checklist (TABC) 2-6 years for autism spectrum disorders screening

Ages and stages questionnaire (ASQ-3)

Goodenough–Harris drawing test

The child is asked to draw the best person they can draw. The starting point is a circle for the face at 3 years of age. An additional point is then given for each item drawn, with each point being worth an extra 3 months.



Definitive Tests

These tests are required once screening tests or clinical assessment is abnormal. They accurately define impairments. For example, it gives domain-wise scores for verbal, motor, personal and social skills domains.

Eg: Bayley scale of infant development ☒

- Wechsler intelligence scale for children ☒
- Stanford-Binet intelligence scales for children, 5th edition
- Vineland adaptive behaviour scale
- Developmental assessment scale of Indian children (DASII) - Indian scale

Red flags for autism spectrum disorders

- Avoids or does not keep eye contact
- Does not respond to name by 9 months of age
- Does not show facial expressions like happy, sad, angry, and surprised by 9 months of age
- Does not play simple interactive games like pat-a-cake by 12 months of age
- Uses few or no gestures by 12 months of age (for example, does not wave goodbye)
- Does not share interests with others by 15 months of age (for example, shows you an object that they like)
- Does not point to show you something interesting by 18 months of age
- Does not notice when others are hurt or upset by 24 months of age
- Does not notice other children and join them in play by 36 months of age
- Does not pretend to be something else, like a teacher or superhero, during play by 48 months of age
- Does not sing, dance, or act for you by 60 months of age

Screening tools for ASD

Concern 9

MCHAT R(Modified checklist for autism in toddlers

TABC (Trivandrum Autism Behavioral Checklist)

Neurodevelopmental disorders

ASD, ADHD, Learning disability, Global developmental delay/intellectual disability, Seizure disorder, Neuromuscular disorders, Visual impairment, hearing impairment

Frequently asked viva questions:-

Definition of global developmental delay

List 5 causes for global developmental delay

What is developmental quotient?

Name few causes for isolated motor delay?

Name few causes for speech delay in a child?

What are few treatable or preventable causes for intellectual disability

Definition of cerebral palsy

Aetiological factors of cerebral palsy

What is developmental dissociation with examples

What is developmental deviation with examples

What is developmental regression with examples

Name few developmental screening tests

Name few neurodevelopmental disorders

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