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Down Syndrome: An Overview

Tamanna Grewal and Dr Mukesh Kumar

Abstract

Down syndrome (DS), a genetic disorder brought on by a numerical alteration in single or multiple chromosomes affecting autosomes, sex chromosomes or both. that exhibits a variety of physical and medical features, a distinct appearance, and learning disability, has been a subject of multidisciplinary inquiry. This article presents a comprehensive review encompassing the aetiology, clinical manifestations, cognitive and behavioural features, medical implications, and societal perspectives associated with Down syndrome. By consolidating existing knowledge, this review aims to provide a valuable resource for healthcare professionals, special educators, policymakers, and the broader community to foster a more informed and supportive environment for individuals with Down syndrome.

Keywords: Down syndrome, chromosomal anomaly, and learning disability.

Tamanna Grewal - PGDRP Student, Department of Psychology, State Institute for Rehabilitation, Training & Research, Rohtak, Haryana, India

Dr Mukesh Kumar - Rehabilitation Psychologist, Department of Psychology, State Institute for Rehabilitation, Training & Research, Rohtak, Haryana, India

Introduction

Although Down syndrome was initially identified in 1866 by the English physician John Langdon Down, its connection to chromosome 21 was not proven until 1959, nearly a century later, in Paris by Dr Jerome Lejeune (Wahab, 2006).

One in 1000-1100 babies is impacted globally by down syndrome, usually referred to as trisomy 21, which is the most common chromosomal anomaly (WHO). The frequency of such occurrence in India is 2.2 per 1000 live births,

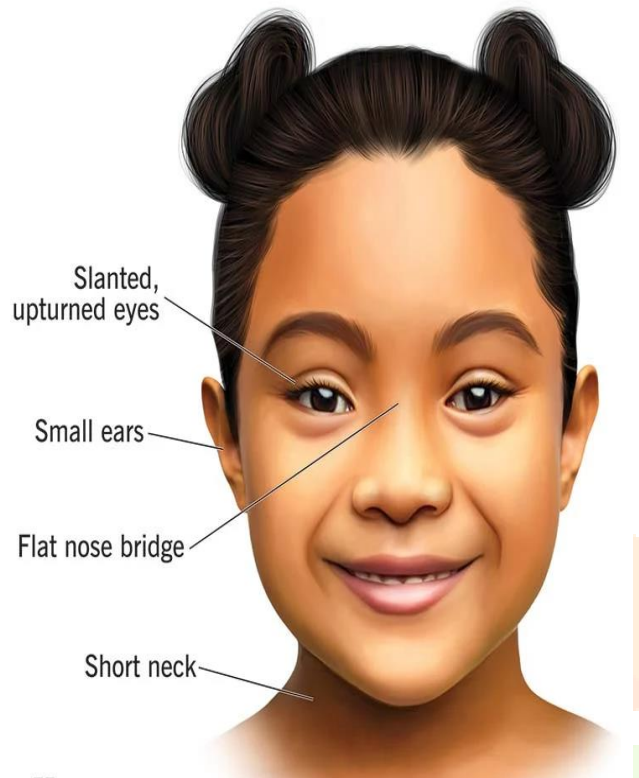
greater than the national average of 1 in 600 for all racial groups (Grouchy, 1983).

Down syndrome is a genetic disorder that occurs when a person has an extra copy of chromosome 21. Typically, humans have 46 chromosomes, including two sex chromosomes (XX or XY) and 44 autosomes. People diagnosed with Down syndrome carry a total of 47 chromosomes in each cell.

This extra genetic material leads to several physical, intellectual, medical disabilities and challenges. Various abnormalities involving respiratory, cardiovascular, endocrine,

gastrointestinal, haematological, immunological, musculoskeletal, genitourinary, and neurological systems may also accompany (Arumugam, et. al., 2016).

Down Syndrome



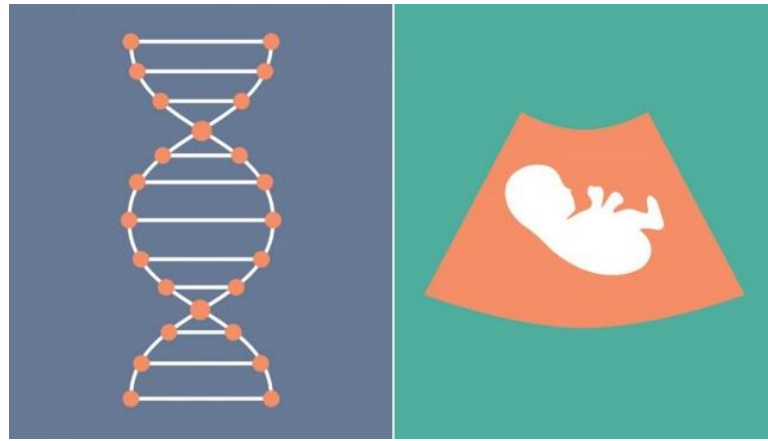
Psychologists and specialists working in the field of intellectual and developmental disabilities typically define Down syndrome in a consistent manner. While definitions may vary in their wording, they all describe the core characteristics and features of the condition. Here's a general definition of Down syndrome:

"Down syndrome is a congenital genetic disorder caused by the presence of an extra copy of chromosome 21 in a person's cells, resulting in a total of 47 chromosomes instead of the usual 46. This genetic anomaly leads to a range of physical, intellectual, and medical challenges. Common characteristics include mild to moderate intellectual disabilities, certain physical features such as a flattened face and slanting eyes, and a heightened risk of specific health issues, including congenital heart defects. With early interventions, proper care & support, and access to educational and medical research, a person with down syndrome could lead a fulfilling life.

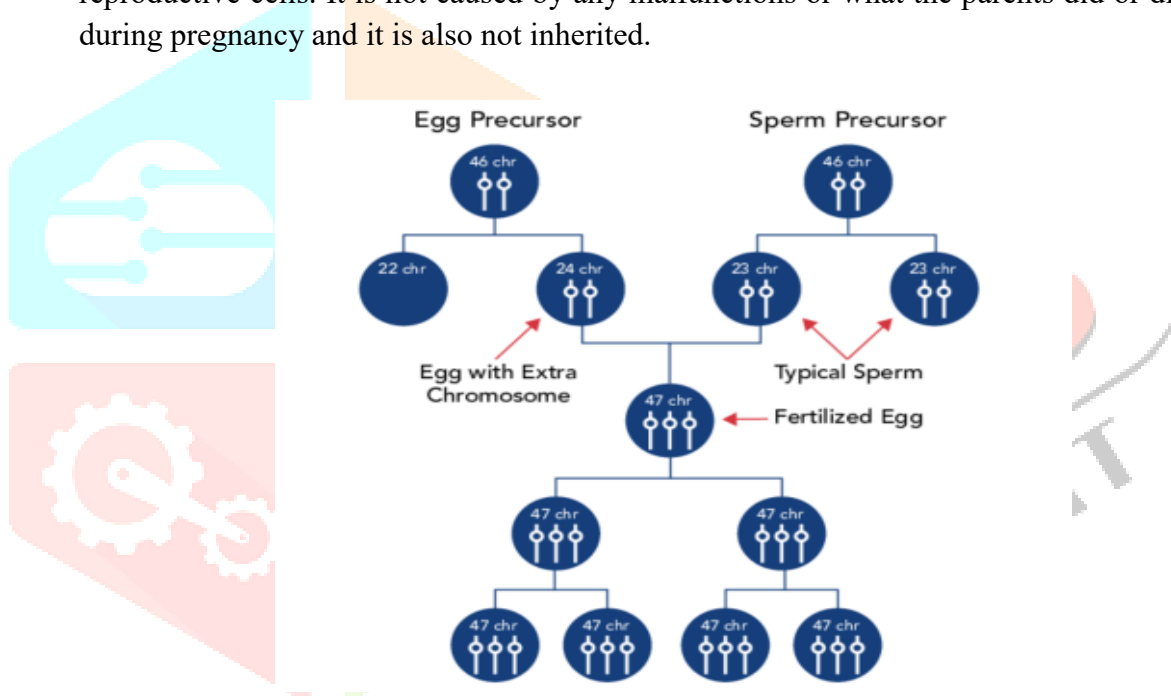
Aetiology of Down Syndrome

The cause of down syndrome is a genetic variation which is accountable for the characteristic features and challenges associated with the syndrome. The exact reason of the genetic variations leading to the syndrome is not completely understood.

1. **Genetic Cause:** Down syndrome is usually caused by the genetic mutation, primarily due to a spontaneous genetic event during the formation of the reproductive cells or early development of the embryo, leading to extra copy of chromosome 21 in the embryo.

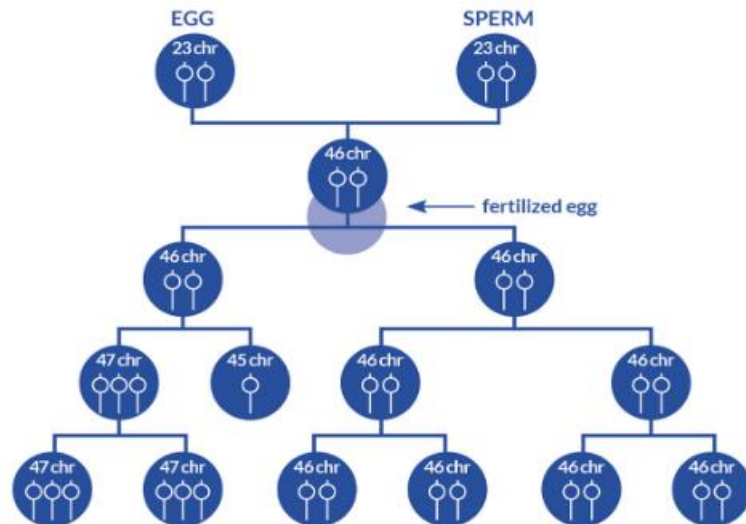


- Trisomy 21 (Nondisjunction):** Mostly, down syndrome is caused by trisomy 21 (in approximately 95% cases). Here, a person has three copies of chromosome 21 in each cell instead of two chromosomes. The anomaly is caused by random error during formation of reproductive cells. It is not caused by any malfunctions or what the parents did or didn't do during pregnancy and it is also not inherited.



- Mosaicism:** In some cases (about 1-2% of cases), a person may have a mix of cells with the typical 46 chromosomes and cells with the extra chromosome 21. This is known as mosaic Down syndrome and occurs after fertilization, during embryonic development and rapid cell division.

MOSAIC CELL DIVISION



4. **Translocation:** About 2-3% people are diagnosed with Translocation Down syndrome. In this case, part of chromosome 21 is attached to another chromosome, typically chromosome 14. While the total number of chromosomes is 46, the extra genetic material from chromosome 21 can still lead to the characteristic features and challenges of Down syndrome.

Risk Factors

Some parents have a greater risk of having a baby with Down syndrome. Risk factors include:

- **Advancing Maternal Age –**
The risk of having a baby with Down syndrome increases with maternal age, particularly after age 35 (Shetty et al., 2013). This is because as women age, the likelihood of errors in cell division during the formation of eggs (meiosis) increases, leading to an increased risk of chromosomal abnormalities.
- **Prior Child with Down Syndrome -**
Women who have previously given birth to a baby with Down syndrome have an increased risk, about 1%, of having another baby with the condition. This risk is higher in cases of translocation Down syndrome.
- **Carrying a Translocation -**
If a parent carries a balanced translocation (where a piece of chromosome 21 is attached to another chromosome), there is an increased risk of having a child with translocation Down syndrome.
- **Family History -**
In rare cases, individuals with a family history of Down syndrome or certain other chromosomal abnormalities may have an increased risk of having a baby with Down syndrome.
- **Maternal Health -**

Certain maternal health conditions, such as obesity and diabetes, have been associated with a slightly increased risk of having a baby with Down syndrome.

Symptoms of Down Syndrome

While individuals with Down syndrome vary in their characteristics and abilities, some common symptoms and features associated with the condition include:

1. Physical Characteristics

- Flattened facial profile
- Almond-shaped and slightly slanted eyes
- A tiny nose and flat nasal bridge
- Swollen tongue
- A single, deep groove (simian crease) runs across the palm of the hand
- Hypotonia, or low muscular tone
- Short stature



2. Intellectual and Developmental Delays

- Mild to moderate intellectual disabilities
- Delayed speech and language development
- Delayed motor skills, such as crawling and walking
- Slower cognitive development

3. Behavioural and Social Characteristics

- Friendly and affectionate nature
- Desire for social interaction and companionship
- Varied behavioural challenges, such as attention deficits, impulsiveness, and stubbornness

4. Health Issues

- Increased susceptibility to certain medical conditions, including:
 - Hereditary heart defects
 - Breathing problems
 - Intestinal issues
 - Issues related to hearing and vision
 - Thyroid disorders
 - Increased risk of leukaemia and other health concerns

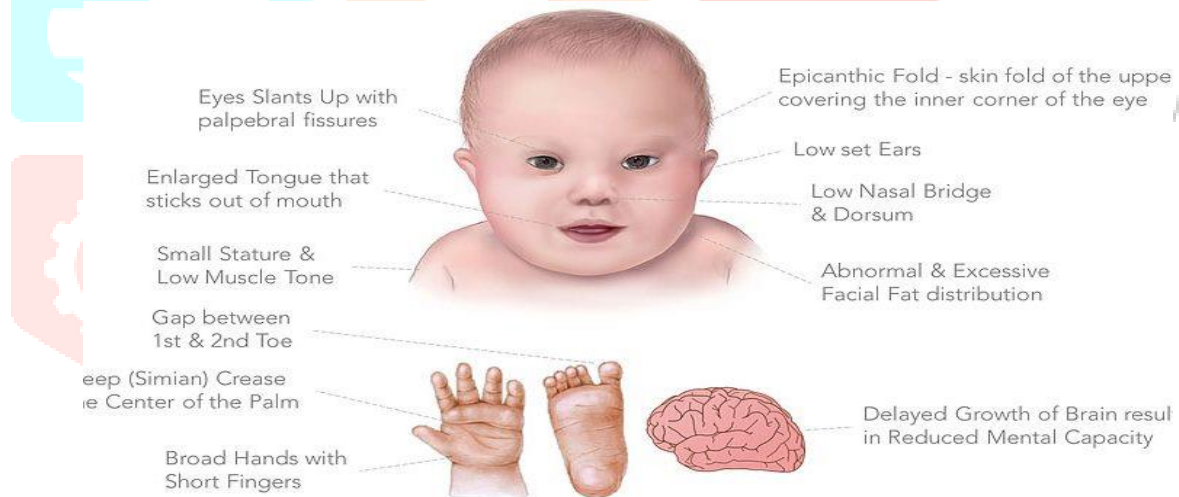


5. Speech and Communication

- Delayed speech and language development
- Articulation and pronunciation difficulties

6. Cognitive Abilities

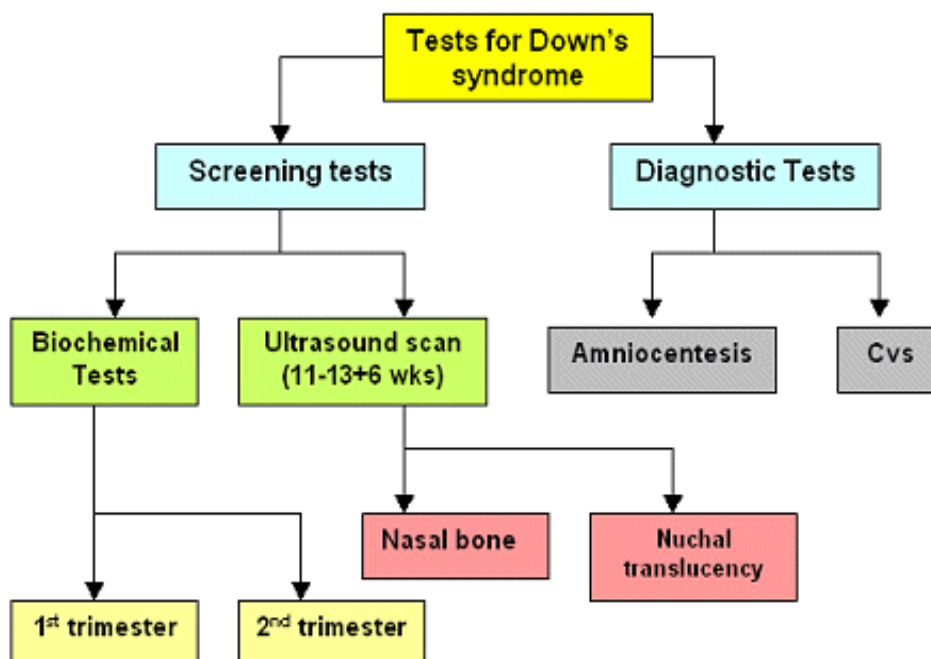
- Varied cognitive abilities, with some individuals having a better capacity for learning and problem-solving than others



Body System	Comorbidity
General features	<ul style="list-style-type: none"> • Obesity¹
Head and neck (ie, airway)	<ul style="list-style-type: none"> • Upper- and lower-airway abnormalities² • Hypotonia² • Atlantoaxial instability or atlanto-occipital instability^{1,2} • Laryngomalacia (ie, floppy larynx)³ • Tracheomalacia (ie, soft or collapsing airway)¹ • Subglottic stenosis, congenital or acquired from repeated or prolonged intubation¹ • Eyes <ul style="list-style-type: none"> ◦ Slated palpebral fissures with epicanthal folds,⁴ strabismus,⁵ nystagmus,⁵ congenital cataracts⁵ ◦ Vision impaired⁵ • Stenosis, exaggerated curvature of the external auditory canal, hearing loss, chronic otitis media⁶
Respiratory	<ul style="list-style-type: none"> • Pneumonia and respiratory infections^{1,7} • Obstructive sleep apnea^{1,7} • Upper-airway obstruction^{1,7}
Cardiovascular	<ul style="list-style-type: none"> • Congenital heart disease¹ • Complete atrial-ventricular canal⁸ • Ventricular septal defect⁸ • Atrial septal defect⁸ • Childhood leukemia⁹
Nervous	<ul style="list-style-type: none"> • All experience some degree of cognitive impairment¹ • Seizure disorders (adults)¹ • Alzheimer disease or dementia (early onset)¹
Psychiatric	<ul style="list-style-type: none"> • High risk for autism and attention deficit disorders⁷ • Hyperactivity and conduct disorder¹⁰ • Depressive disorder (older adults)¹⁰
Gastrointestinal	<ul style="list-style-type: none"> • Duodenal obstruction,⁴ atresia,⁴ webbing¹¹ • Gastroesophageal reflux disease¹¹ • Hirschsprung disease⁴ • Tracheoesophageal fistula or atresia⁴ • Celiac disease¹¹
Musculoskeletal	<ul style="list-style-type: none"> • Hip dysplasia¹ • Osteoporosis¹²
Endocrine	<ul style="list-style-type: none"> • Hypothyroidism¹ • Type 1 diabetes mellitus¹
Immune	<ul style="list-style-type: none"> • Abnormal immune function²

Diagnosis of Down Syndrome

Diagnosing Down syndrome typically involves a combination of prenatal and postnatal assessments. Here are the main approaches:



1. Prenatal Screening:

- **First-Trimester Combined Screening:**

This typically involves a combination of a blood test to measure levels of certain proteins and hormones in the mother's blood and an ultrasound to measure the thickness of the back of the baby's neck (nuchal translucency). Abnormal results may indicate an increased risk of Down syndrome.

- **Second-Trimester Quadruple Screen:**

This includes a blood test called the quadruple screen or quad screen, which measures levels of certain proteins in the mother's blood. Abnormal results may indicate an increased risk of Down syndrome.

2. Prenatal Diagnostic Tests:

- **Chorionic Villus Sampling (CVS):**

CVS involves taking a small sample of tissue from the placenta for genetic testing. This can be done as early as 10-12 weeks of pregnancy and provides a definitive diagnosis of Down syndrome.

- **Amniocentesis:**

It involves collecting a sample of the amniotic fluid surrounding the foetus for genetic testing. It is typically performed between 15 and 20 weeks of pregnancy and can also provide a definitive diagnosis.

3. Postnatal Diagnosis:

- **Physical Examination:**

Babies with Down syndrome often have characteristic physical features that may prompt further evaluation.

- **Karyotype Analysis (Chromosomal Analysis):**

A blood sample is taken to analyse the baby's chromosomes. A karyotype reveals whether there is an extra copy of chromosome 21, confirming the diagnosis of Down syndrome.

- **Fluorescence in Situ Hybridization (FISH):**

This technique can provide a quicker confirmation of Down syndrome by looking specifically at the number of chromosome 21 copies.

4. Cell - Free Foetal DNA analysis (NIPT):

- The test for cell-free foetal DNA looks for foetal DNA that is present in the mother's blood. This test is typically advised in response to risk identified by one of the earlier tests, or for women who are at a higher risk of giving birth to a child who has Down syndrome. After ten weeks of gestation, the mother's blood can be checked throughout pregnancy.

- Compared to previous Down syndrome screening techniques, this test seems to be far more specific. To find out if your baby truly has Down syndrome, a more intrusive diagnostic test could be performed if the results of this screening test point to a high risk of the condition.

Effects of Down Syndrome on Family and Friends

The impact of Down syndrome on parents and the family of affected children can be significant and multifaceted. It's important to note that while there are challenges related to the upbringing of a child with Down syndrome, there are also many positive and enriching experiences. Here are some of the effects and considerations:

1. Emotional and Psychological Impact:

- **Initial Shock and Grief:** The diagnosis of Down syndrome can initially be overwhelming and might lead the parents to have feelings of guilt, grief and loss as they will have to accept and adjust their expectations and imaginations related to their child.
- **Unconditional Love:** Over time, many parents come to experience a profound sense of love and attachment to their child with Down syndrome. These children often bring immense joy, love, and unique perspectives into their families.



2. Financial and Practical Considerations:

- **Medical Expenses:** Children with Down syndrome may require regular medical check-ups, therapies, and, in some cases, surgeries. These can lead to increased medical expenses.
- **Educational and Therapeutic Services:** Parents may need to invest in early intervention services, special education programs, and therapies, which can be costly.
- **Time Commitment:** Raising a child with Down syndrome often requires extra time and effort for caregiving, therapy appointments, and support.

3. Impact on Siblings:

- Siblings of children with Down syndrome may have a unique experience. They may feel a mix of love and responsibility for their sibling, as well as occasional jealousy or resentment due to the extra attention the child with Down syndrome may require. However, many siblings also develop strong bonds and a deep sense of empathy.

4. Advocacy and Awareness:

- Parents of children with Down syndrome often become advocates for their child's needs, working to ensure access to appropriate medical care, education, and community services. This advocacy role can be both rewarding and demanding, requiring ongoing education and collaboration with healthcare providers and educational professionals.

5. Support Network:

- Building a strong support network is crucial for families having child diagnosed with Down syndrome. This network may include other parents of children with Down syndrome, support groups, and healthcare professionals who specialize in developmental disorders.



6. Legal and Financial Planning:

- Parents often need to consider long-term planning for their child with Down syndrome, including guardianship, financial security, and estate planning.

7. Celebrating Achievements:

- Families often celebrate the accomplishments and milestones of their child with Down syndrome, cherishing their unique qualities and the positive impact they bring to their lives.

8. Inclusion and Community:

- Families may work to ensure their child is included in school, social, and community activities, fostering a sense of belonging and acceptance.

Effect of down syndrome on children

Down syndrome is a genetic condition that can have a wide range of effects on children's physical, intellectual, and emotional development. It's necessary to understand that the disorder impact each individual differently, and not all children with Down syndrome will experience the same challenges or have the same abilities. Here are some common effects of Down syndrome on children:

1. Developmental Delays:

- Children with Down syndrome typically experience delays in reaching developmental milestones such as sitting up, crawling, walking, and talking. Early intervention services, including physical therapy, occupational therapy, and speech therapy, can help address these delays and support optimal development.

2. Intellectual Disability:

- Most children with Down syndrome have some degree of intellectual disability, ranging from mild to moderate. This may affect learning, problem-solving, and academic achievement. However, with appropriate educational support and accommodations, children with Down syndrome can make progress and reach their full potential.

2. Speech and Language Challenges:

- Children with Down syndrome may experience delays in speech and language development due to factors such as low muscle tone, hearing loss, and cognitive differences. Speech therapy can help improve communication skills and facilitate social interaction.



3. Health Concerns:

- Children with Down syndrome is at increased risk of certain health conditions, including congenital heart defects, respiratory infections, gastrointestinal issues, and thyroid disorders. Regular medical check-ups, monitoring, and timely intervention are important for managing these health concerns and promoting overall well-being.

4. Physical Characteristics:

- Physical characteristics such as a flat face, a tiny nose, and low muscle tone can be present in children with Down syndrome. Although they can be utilized in the diagnostic procedure, these characteristics do not necessarily reflect their skills.



5. Delayed Milestones:

- When it comes to reaching developmental milestones like walking and talking, children with Down syndrome usually develop later than children of their age. Speech and occupational therapy are two early intervention treatments that can help with these difficulties.

6. Social and Emotional Development:

- Children with Down syndrome may face social and emotional challenges, such as difficulty in making friends and understanding social cues. Social skills training and support can be beneficial.

7. Supportive Services:

- The unique requirements of children with Down syndrome are frequently addressed by early intervention services, which include physical therapy, occupational therapy, speech therapy, and special education programs. With the aid of these services, kids can realize their greatest potential.



8. Inclusive Education:

- Many children with Down syndrome benefit from inclusive education settings, where they learn alongside their typically developing peers. Inclusive education promotes social interaction and academic growth.

9. Positive Traits and Strengths:

- Children with Down syndrome often exhibit positive traits and strengths, including kindness, empathy, resilience, and a joyful disposition. These qualities contribute to their unique personalities and enrich the lives of those around them.

10. Impact on Family Dynamics:

- Raising a child with Down syndrome can have a significant impact on family dynamics, including emotional, financial, and practical considerations. Families may experience challenges as well as opportunities for growth, resilience, and connection.

Management and Services for Down Syndrome

Management for Down syndrome involves a comprehensive, multidisciplinary approach aimed at addressing the various medical, developmental, and social needs of individuals with the condition. Here are key components of management for Down syndrome:



1. Medical Management:

- Regular medical check-ups and monitoring are important for managing health issues commonly associated with Down syndrome, such as congenital heart defects, respiratory infections, gastrointestinal problems, thyroid disorders, and vision/hearing impairments. Treatment and interventions are tailored to the individual's specific needs.

2. Early Intervention Services:

- Early intervention programs provide Early intervention services provide support to infants and young children with Down syndrome to address developmental delays and promote optimal development. These programs may include physical therapy, occupational therapy, speech therapy, and developmental interventions tailored to the individual's needs.



3. Educational and Employment Support:

- Children with Down syndrome benefit from inclusive educational environments that provide appropriate accommodations and support to promote learning and academic achievement. Individualized Education Plans (IEPs) or 504 plans may be developed to address the child's unique educational needs.
- Programs that focus on vocational training and employment support can help individuals with Down syndrome become active and contributing members of the workforce. Supported employment opportunities may be available.

5. Behavioural and Social Support:

- The aim of behaviour therapy is to find responses to both acceptable and non-acceptable resources. Behavioural interventions can help manage challenging behaviours and support the development of appropriate social skills. Social skills training and opportunities for social interactions are essential for building relationships and community integration.
- A psychologist can help a child deal with emotions and build coping and interpersonal skills.
- Parents may also benefit from guidance on how to help a child with Down syndrome manage day-to-day challenges and reach his or her full potential.

6. Nutritional Support:

- Individuals with Down syndrome may have specific nutritional needs. A balanced and nutritious diet, along with appropriate supplements, if necessary, can support overall health and development.

7. Support for Families:

- Providing support, education, and resources to parents and families is crucial for navigating the challenges and uncertainties associated with raising a child with Down syndrome. Support groups, counselling, and access to community resources can help families cope and thrive.

8. Ongoing Monitoring and Adjustment:

- Treatment plans should be flexible and adaptable which should consider the changing and developing needs of the children with down syndrome. Regular assessments and adjustments to the intervention plan are essential.



9. Speech and Language Therapy:

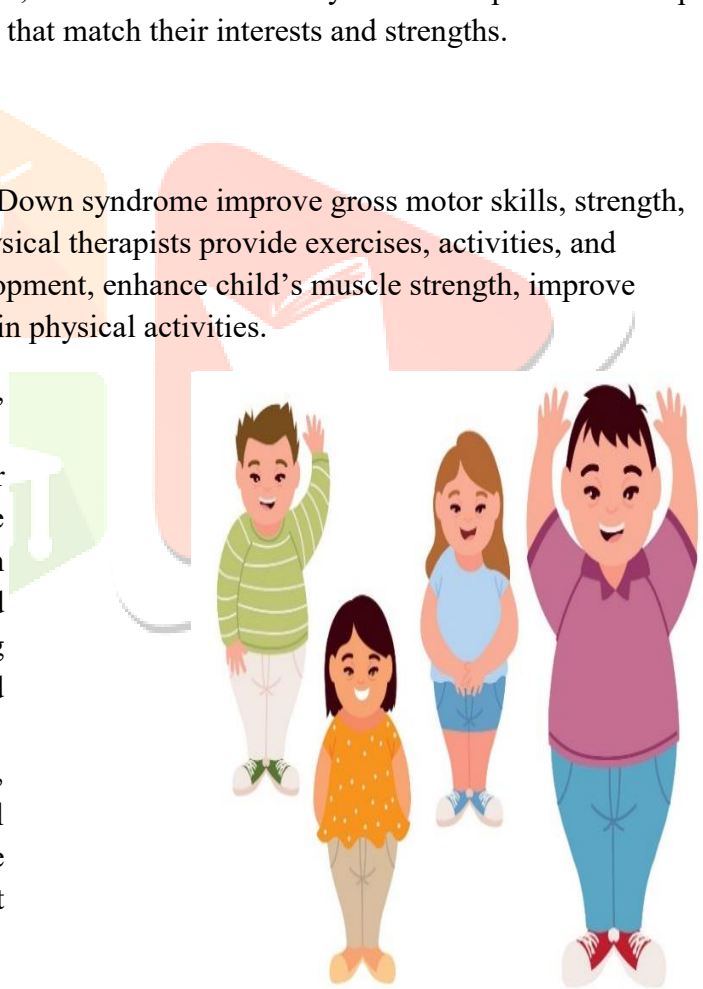
- Speech therapy helps individuals with Down syndrome improve communication skills (such as imitating sounds), including speech articulation, language comprehension, expressive language, and social communication. Speech therapists work with individuals to develop effective communication strategies and promote independence.
 - o A child receiving speech-language therapy can be assisted in using non-verbal communication methods, such as drawings and sign language, while they are learning to speak.
 - o Conversational skills, pronunciation, word learning and retention, and comprehension - the ability to grasp what is read - are among the areas in which the therapist may provide assistance.

9. Occupational therapy:

- Occupational therapy focuses on developing skills and strategies to improve independence in daily activities, fine motor skills, sensory processing, and self-care skills (like eating, getting dressed, writing). Occupational therapists work with individuals to enhance their ability to participate in activities at home, school, and in the community. The therapist could help teenagers identify jobs, careers, or skills that match their interests and strengths.

10. Physical therapy:

- Physical therapy helps individuals with Down syndrome improve gross motor skills, strength, balance, coordination, and mobility. Physical therapists provide exercises, activities, and interventions to promote physical development, enhance child's muscle strength, improve body posture, balance and participation in physical activities.
 - o Therapist assist the child to roll over, crawl, and reach.
 - o Therapist help child compensate for physical challenges, like low muscle tone, in ways that avoid long-term problems. For example, assisting child to establish an efficient walking pattern, rather than one that might lead to foot pain.
 - o If PT is started before at younger age, before 1 year of age, it has additional positive effect on child's gross, fine and overall motor development (Arslan, et.al., 2020).



Conclusion

It is crucial for one to understand that each person with Down syndrome is different, and there can be significant differences in the level of their physical and intellectual difficulties. All things taken into account; Down syndrome is a genetic disorder that impacts many facets of a person's life. However, people with Down syndrome can have happy and fulfilling lives if they receive the right care, receive early

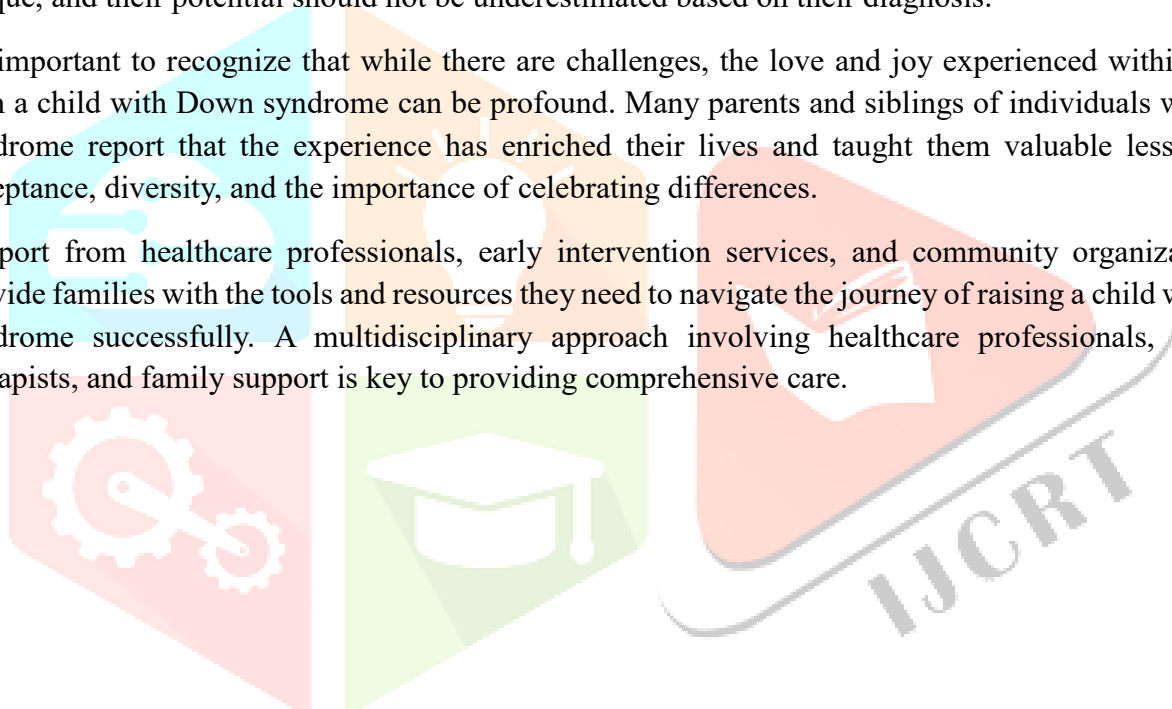
intervention, and live in inclusive communities and educational settings. Each person may only have a small number of anomalies, which change with age and in terms of severity (Shetty et al., 2013). With the correct assistance and inclusion, many people with Down syndrome lead fulfilling lives, are employed, and are highly involved in their communities.

Down syndrome could occur in any race, caste, religion, creed and it is not preventable. The extent to which the symptoms and characteristics are present can vary widely among individuals with Down syndrome. Prenatal testing can help identify the condition during pregnancy, allowing parents to prepare for the potential challenges and seek appropriate medical and educational support. Prenatal screening tests indicate an increased risk, and a diagnosis is only confirmed through diagnostic tests like CVS or amniocentesis. Decisions about prenatal testing should be made after careful consideration and consultation with a healthcare provider or genetic counsellor, as they can carry some risk of complications, including miscarriage. A postnatal diagnosis can be made soon after birth based on physical characteristics and confirmed through genetic testing.

Furthermore, individuals with Down syndrome have their unique personalities, strengths, and abilities, and it's important to approach each person as an individual with their own potential and needs. Each child is unique, and their potential should not be underestimated based on their diagnosis.

It's important to recognize that while there are challenges, the love and joy experienced within families with a child with Down syndrome can be profound. Many parents and siblings of individuals with Down syndrome report that the experience has enriched their lives and taught them valuable lessons about acceptance, diversity, and the importance of celebrating differences.

Support from healthcare professionals, early intervention services, and community organizations can provide families with the tools and resources they need to navigate the journey of raising a child with Down syndrome successfully. A multidisciplinary approach involving healthcare professionals, educators, therapists, and family support is key to providing comprehensive care.



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