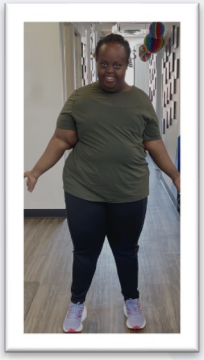
On Your Feet!
Feet, Foot Support, and Walking for Individuals with Down Syndrome




Dr. Sarah Mann, PT, DPT, MBA, NSCA-CPT

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Dr. Sarah Mann, PT, DPT

BA 1999

MBA 2002

DPT (Doctor of Physical Therapy) 2012

Dr. Jennifer Spiric, PT, DPT

BA Integrative Physiology 2008

DPT Doctor of Physical Therapy 2012

Mann Method Therapy Network

Amaryllis Therapy Network

Kids in Motion Spiric Therapies, LLC

GiGi's Playhouse™ Down Syndrome Achievement Centers educate. inspire. believe.

Rocky Mountain Down Syndrome Association

Talking Together, Inc. Family-Centered Early Intervention

UNLV Physical Therapy CARE-lab Where Science Meets Practice

TheraTogs therapy you wear

Jordan Pittman, CPOA, BHK

UBC OKANAGAN

Human Kinetics and Psychology

Mann Method PT and Fitness, PLLC

NATIONAL SPORTS CENTER FOR THE DISABLED

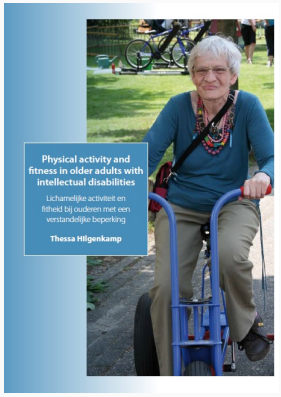
AMERICAN BOARD FOR CERTIFICATION
ORTHOTICS · PROSTHETICS · PEDORTHICS

Certified Orthotic Assistant
Certified Prosthetic Assistant

Special Olympics Colorado

Dr. Thessa Hilgenkamp, PhD

- University of Nevada, Las Vegas
  - Cardiovascular Research and Exercise (CARE) Lab
- 15 years of research with individuals with ID and with DS
- Loves to run and dance



NIH *Eunice Kennedy Shriver* National Institute of Child Health and Human Development
Health research throughout the lifespan

UNLV PHYSICAL THERAPY
CARE-lab
WHERE SCIENCE MEETS PRACTICE

THE UNIVERSITY OF ILLINOIS AT CHICAGO

Erasmus MC
Universitair Medisch Centrum Rotterdam

MARIE CURIE ACTIONS

Radboudumc
university medical center

SEVENTH FRAMEWORK PROGRAMME

INTEGRATIVE PHYSIOLOGY LABORATORY

Hannah Baker

Helen McClain

Mann Method Affiliations/Disclosures

Mann Method Therapy Network

Mann Method PT and Fitness, PLLC

Consultant

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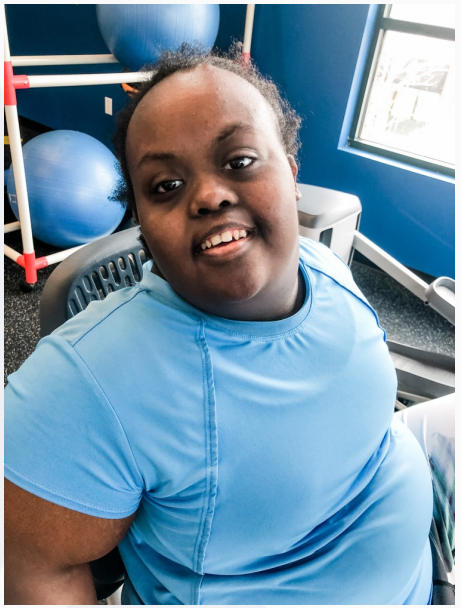
ROCKY MOUNTAIN DOWN SYNDROME ASSOCIATION

UNLV PHYSICAL THERAPY CARE-lab WHERE SCIENCE MEETS PRACTICE

Happy Feet

Our Plan Today:

- Overview of anatomy and physiology
- Overview of common musculoskeletal issues
- Foot posture
- Walking patterns
- Ideas to share with your providers
- Insurance questions

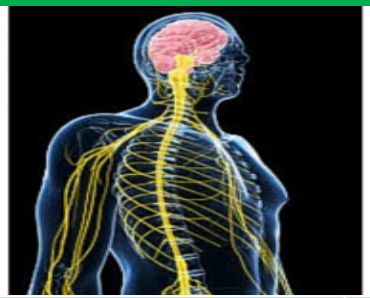


Today, we are going to be talking about feet. But first, let's talk about how people with Down syndrome are built!

People with Down syndrome have a **UNIQUE PHYSIOLOGY!** Before we get started, we need to **u**nderstand the unique physical, mental, and motor characteristics of people with Down syndrome. When it comes to muscles and bones, people with Down syndrome have:

- Flexible ligaments
- Flexible joints
- Lower resting muscle tone
- Flat feet

Teen and Adult Systems Review


Cardiovascular	Neuromuscular	Endocrine	Sleep	Central nervous system
Lower Maximal Heart Rate - 100% of population	**Joint Hypermobility** - 100% of population	**Hypothyroid** - Congenital 1% - 40% prevalence by adulthood	**Obstructive Sleep Apnea** - 50-80% of population	**Alzheimer's Disease** - Higher incidence, earlier onset - Studies on exercise helping people with AD
Pulmonary Hypertension - 38% - 90% CHD and Ds vs. 40% CHD without Ds	**Spondylosis or degenerative change of the cervical spine** - 33–64% of population	**Early Menarche/ Puberty**		**Seizures** - 1-13% of population
Decreased Endurance	**Ligamentous Laxity** - 100% of population	**Early Menopause**		**Depression** - 30% of population
Valve Dysfunction (Prolapse, insufficiency, regurgitation) - Mitral valve 36% - Tricuspid valve 10% - Aortic 8%	**Atlantoaxial Instability** - 2-20% of people with Ds - 1-2% symptomatic			**Hypotonia** - 100% of population
Cardiac Malformation (PDA, VSD, ASD) - 50% of population	**Scoliosis** - 50% of population			

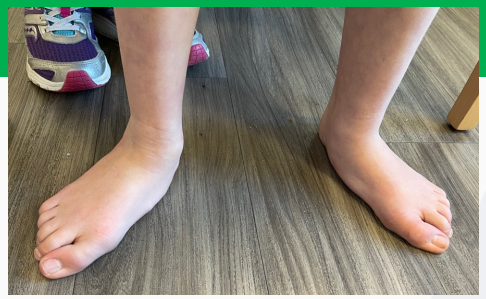
Teen and Adult Systems Review Musculoskeletal

Physiological Impact	Literature	Implications for PT
Ligamentous Laxity	Caird, Wills, Dormans, 2006; Concolino et al., 2006; Foley & Killeen, 2019; Merrick et al., 2000	Increased range of motion at all joints; Decreased joint stability; Tendency for excessive pronation during standing and walking
Pes Planus	Concolino et al., 2006; Foley & Killeen, 2019; Perotti et al., 2018	Supportive footwear recommendations; Orthotics and arch support; Increased risk for hallux valgus, bunions, great toe abduction, decreased gait speed, decreased step length, fatigue with walking/standing
Scoliosis	Foley & Killeen, 2019; Milbrandt & Johnston, 2005	Asymmetrical weakness; Asymmetrical posture; Asymmetrical scapular strength and stability; Asymmetrical gait; Possible leg length discrepancy
Osteoporosis	Angelopoulou et al., 2000; Capone et al., 2018; Center et al., 1998; Turner & Robling, 2003	Increase risk of fracture; Multifactorial interventions focused on physical activity; Sunlight exposure and vitamin D

Common Musculoskeletal Conditions

Primary Concern	People with DS	General Population	Patients at MMTN
Atlantoaxial Instability	10-20% (1-2% symptomatic) (El-Khouri 2014)	Rare – idiopathic or injury 11% in population with RA (Lacy 2023)	2/350 0.6%
Scoliosis	11% (Abousamra 2017)	2-3% (AANS 2024) 0.5-5% (Konieczny 2012)	50%
Hip Instability/Dysplasia	1-7% (Maranho 2018)	1.4% (Tao 2023)	50%
Knee (Patellar) Instability	1.5% (Foley 2019)	3% of all knee injuries (Wolfe 2023)	30%
Pes Planus	91% (Foley 2019)	23% (Banwell 2014)	95%
Hypotonia	100%	0.5% (Straathof 2020 – 9/1100 babies with global hypotonia)	100%
Ligamentous Laxity	100%	18-30% (Sobhani-Eraghi 2020)	100%

Foot Changes



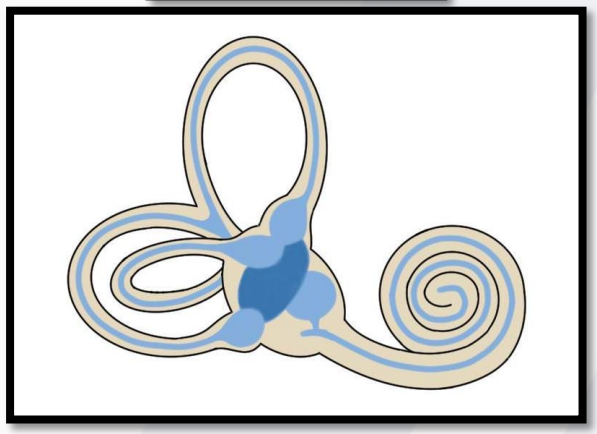
Primary Concern	People with DS	General Population
Flat Feet (Pes Planus)	91%	26%
Hallux Valgus	55%	23-36%
Metatarsal Adductus	15%	unknown
***Foot PAIN!	62%	17-30%

(Bull 2011, Bull 2020, Bennet 1982, Fernhall 2001; Fithian 2004, Foley 2019, Perotti 2018, Hendry 2018, Pita-Fernandez 2018, Hilgenkamp 2021; Concolino et al., 2006; Foley & Killeen, 2019; Perotti et al., 2018)

Common Musculoskeletal Diagnoses Your Provider Needs to Know

- Foot
  - Pes planus
  - External rotation
  - Forefoot abduction
  - Great toe external rotation and flexion (hallux valgus)
  - Great toe abduction
  - Calcaneal valgus
- Ankle
  - Plantarflexion
  - Eversion
  - Limited dorsiflexion
- Gastroc/Soleus complex (Calf muscles)
  - Muscle shortness/tightness
  - Plantarflexion contracture
- Knees
  - Genu valgum
  - Genu recurvatum
  - Increased Q-angle
  - Hamstring tightness
- Hips
  - Increased external rotation
  - Increased Q angle
  - Increased hip abduction
  - Limited range of motion into internal rotation
  - Limited range of motion into adduction/neutral
  - Possible increase in retroverted hip position
  - Decreased hip extension
- Pelvis
  - Anterior pelvic tilt
  - Short/tight hip flexors

Common Sensory Integration Impairments

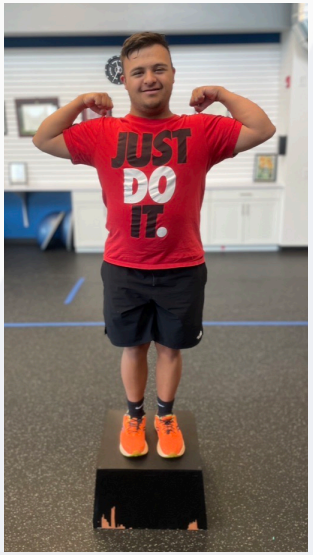


- Visual
  - Increased prevalence of visual impairment – up to 80% of people with Ds
  - Increased prevalence of nystagmus and strabismus
- Hearing/Vestibular
  - Increased prevalence of hearing impairment – 50-75% of people with Ds
  - Sensorineural hearing loss impacts to cranial nerve VIII (vestibulocochlear) which impacts vestibular function and balance
  - Documented differences of inner ear anatomy/shape may impact vestibular function and balance
- Proprioception
  - Decreased feedback from proprioceptive sensors in muscles/tendons/joints due to low muscle tone and ligamentous laxity – 100% of people with Ds

Key Points to Remember!

People with Down syndrome have:

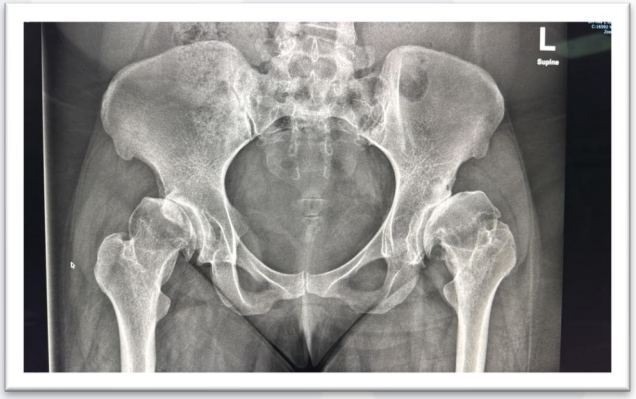
- Flexible Ligaments
- Flexible Joints
- Hypotonia - Lower Resting Muscle Tone
- Flat Footed Posture
- Hearing Impairment
- Visual Impairment
- Balance Impairment

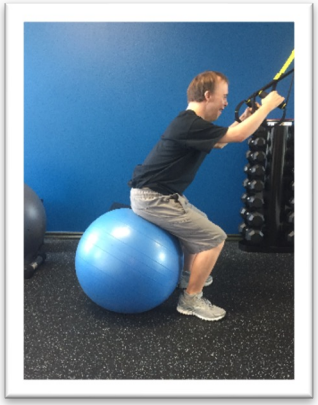


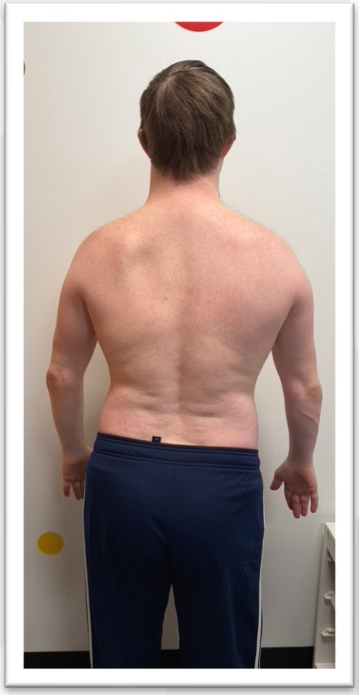
What you should do

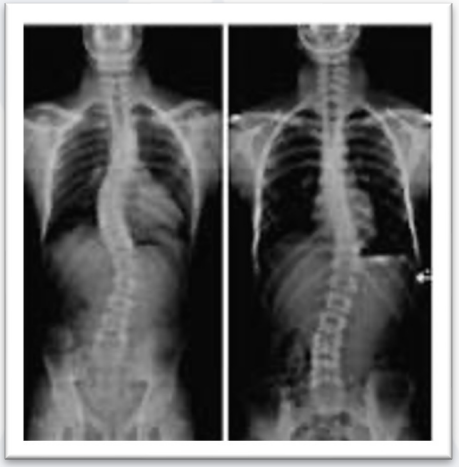
Dr. Sarah's recommendations - Annually:

- Hip x-rays
- Scoliosis x-rays
- Bone Density scan
- Foot support
- Good shoes
- BASELINE measurements are SO HELPFUL!



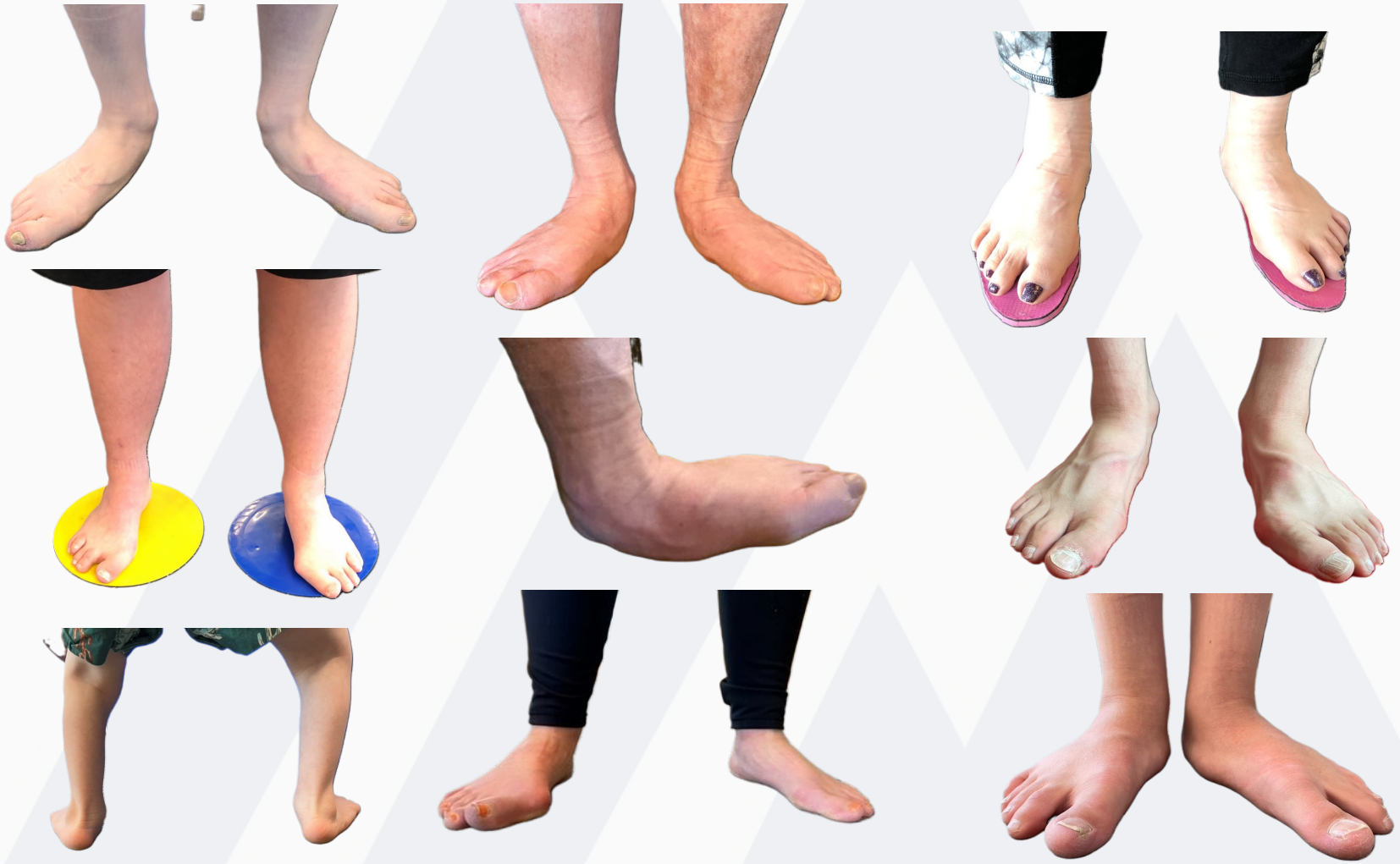




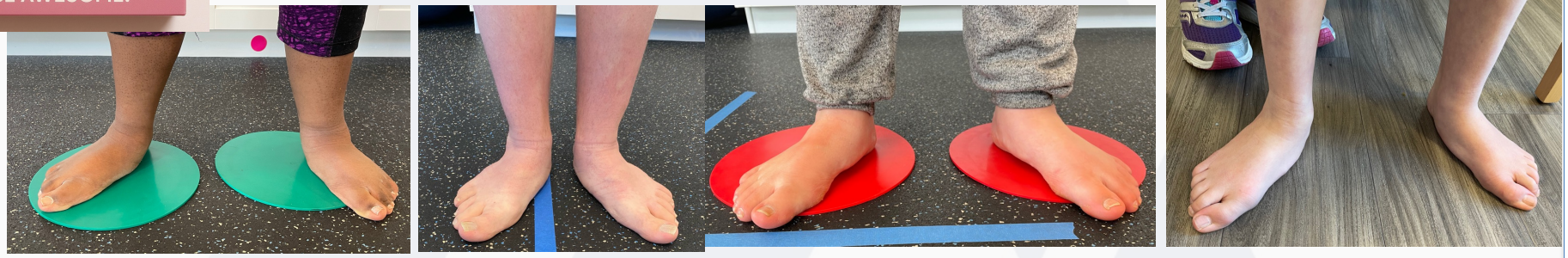


Comprehensive Systems Review

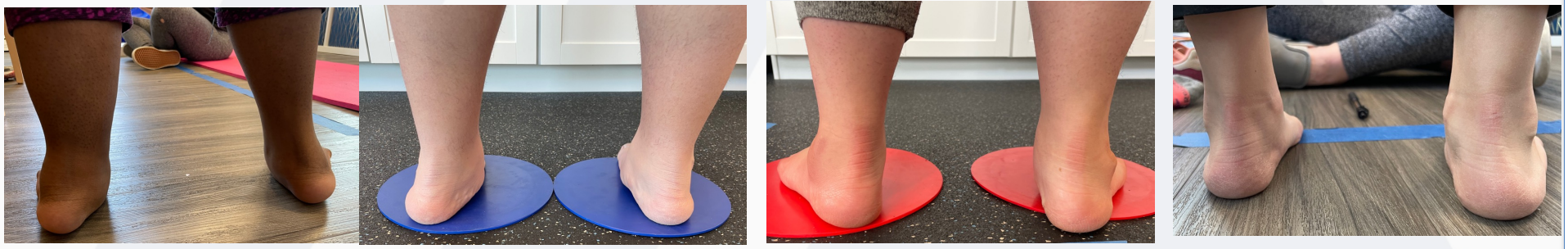
Let’s Talk Feet



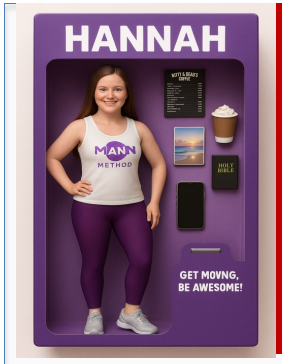
Now, let's talk feet! These are Common Feet Features for people with Down syndrome



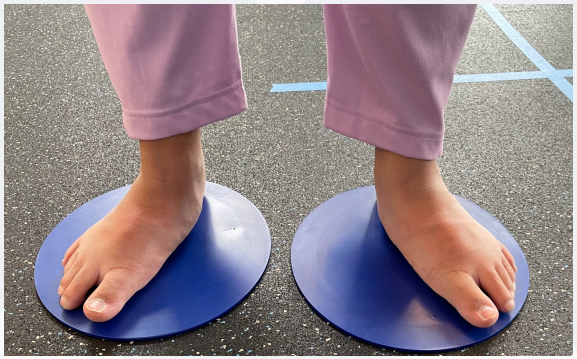
91% of people with Down syndrome have flat feet (due to ligamentous laxity)

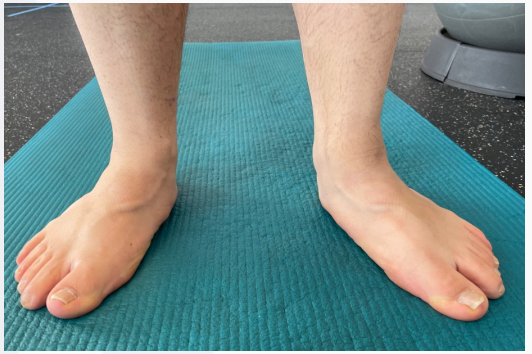


It is also very common for us to have increased heel tilt (calcaneal valgus)

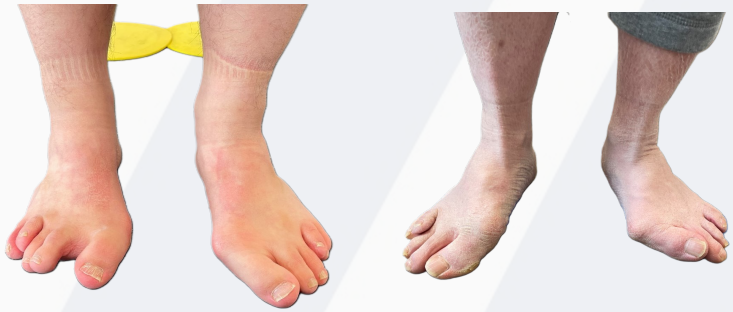


Here are some more Common Feet Features for people with Down syndrome

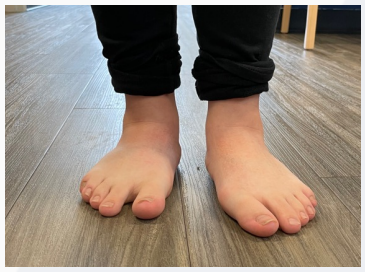




People with Down syndrome may have a wide base of support or increased foot turn out – that is an increased foot progression angle!

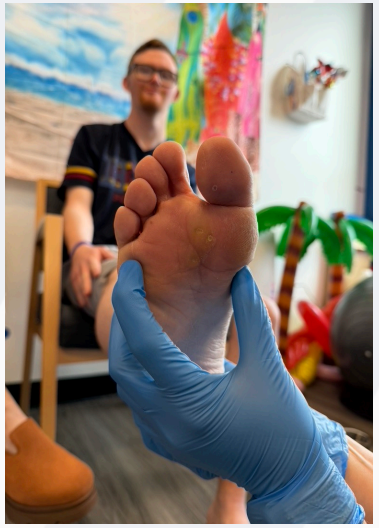


They may also have changes in their toes with something called bunions (Hallux valgus)



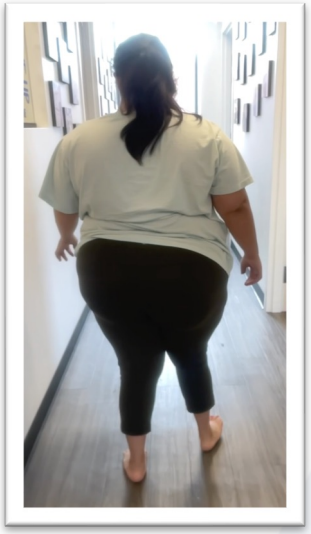
Or they may have great toe abduction (flip flop toe)

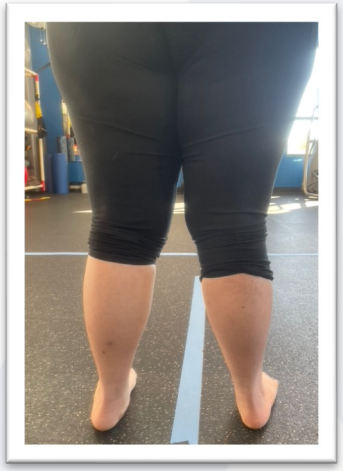
What do feet tell us?

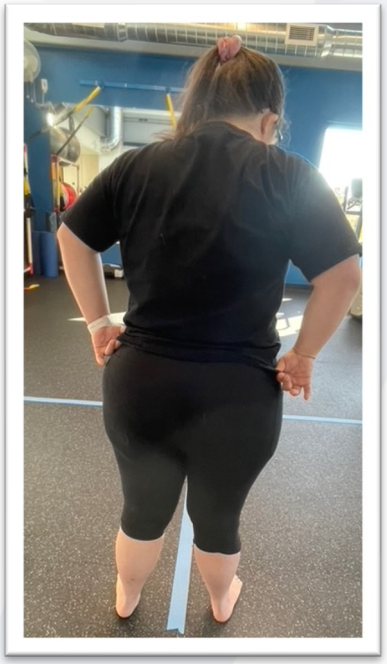


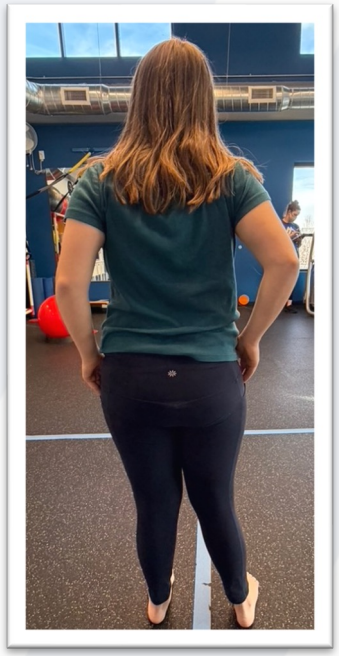
- Pressure points
- How the foot is working while walking
- Overuse patterns
- Callusing points
- Muscle compensations
- Pain?
- Do the feet need support?

Why does it matter if feet are flat?









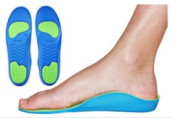
- **Knees:** Flat feet ➡ genu valgum (knees in) ➡ higher stress on the medial knee ➡ increased risk of lateral patellar dislocation
- **Hips:** Flat feet ➡ genu valgum (knees in) ➡ compensation with hip external rotation ➡ contribute to hip impairments
- **Back:** Flat feet ➡ genu valgum ➡ hip external rotation ➡ increased anterior pelvic tilt ➡ increased lumbar extension to increase stability ➡ increased pressure and pain on the low back ➡ poor posture ➡ fatigue in standing ➡ challenges with balance
- **CFOs** (and to some extent off the shelf inserts) - can immediately ameliorate the flat footed mechanics and lead to dramatic biomechanical improvements up the chain. It is not a cosmetic improvement, but rather a foot up improvement in **musculoskeletal biomechanics**

So - what do we do? Shoe To-Do List

This is our off-the shelf shoe and orthotics list with options we have had good success with for a wide variety of patients!

Individuals with Down syndrome often present with increased:

Pes planus	Great toe abduction	Excessive navicular drop
Forefoot abduction	Calcaneal valgus	Gastrocnemius/Soleus muscle tightness
Great toe external rotation and flexion (hallux valgus)	Midfoot arch collapse	Limited ankle dorsiflexion

INSERTS: Orthotics support options, full length support			
Superfeet 	About $50 www.superfeet.com Green or Blue inserts	KidSole Teen Neon 	About $25 www.kidsole.com Neon Fix Premium
Sole Inserts 	About $50, www.yoursole.com Performance Medium with cork	Custom Orthotic Inserts 	Sometimes covered by insurance (Medicaid) Ask your PCP/PT

SHOES: Supportive athletic footwear with arch support and flexible toe box				
Toddler Compatible with Orthotics Size 4-10 Medium, Wide, Extra Wide	**Saucony Baby Ride** 	Kids: $30-$60 www.saucony.com	**Saucony Liteform** 	Kids: $30-$60 www.saucony.com
Kids Size 10.5-2.5 Medium Wide Kids size 3+. Transition to women's size 5	**Saucony Cohesion or Excursion** 	Kids: $30-$60 www.saucony.com	**Saucony Velocer** 	Kids: $30-$60 www.saucony.com
Teen and Adult Women's size 5 and up. B width (medium) D width (wide)	**Brooks Adrenaline** 	$85- $130 (year model does not matter!) www.brooksrunning.com	**Saucony Triumph** 	$75-$160 (year model does not matter!) www.saucony.com (Adult, wider foot)

Get Good Shoes – TODAY!

- **Brooks Adrenaline**

(adult size 5+, narrower foot)

- **Saucony Triumph**

(adult size 5+, wider foot)

- **Saucony Cohesion**

(kids size 10-5)

- **Saucony Baby Ride Jr.**

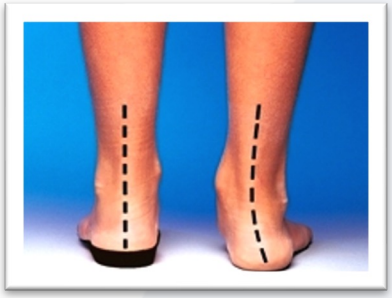
(little kid foot size 4-10)

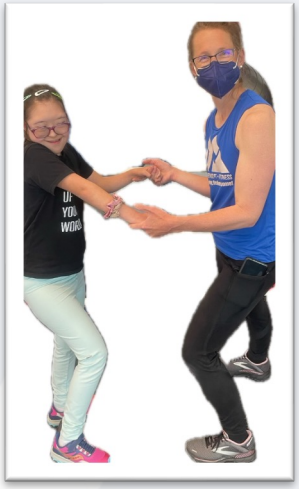
Under Review: **Footwear Science**
Better gait quality and speed were observed in adults with down syndrome when wearing supportive shoes
Bailey Gosse, Kimberly Nguyen, Zoe Zelensky, Sarah Mann, Kai Yu Ho, Thessa Hilgenkamp

Benefits of inserts and orthotics

- Provides direct support to the arch and heel
- The arch should have support all the way to the "first met head"
- Improves alignment for foot, ankle, knees, and hips
- Can relieve pain
- Improves "mechanics" for walking
- Can reduce progression of poor foot patterns
- Provides improved support for movement

Benefits of good shoes and orthotics

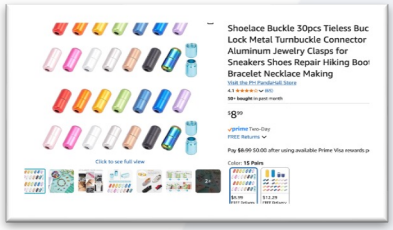


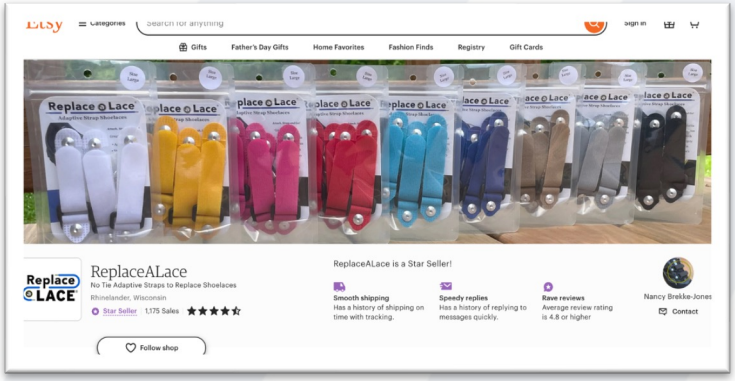


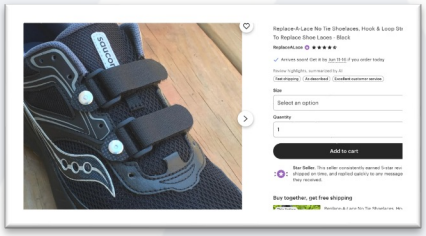
- Improves foot position
- Improves ankle, knee, hip position
- Decreases propensity for hallux valgus, great toe abduction
- Improves foot comfort
- May decrease pain with walking, running or jumping
- **Improves participation in activity!!**

Under Review: **Footwear Science**
Better gait quality and speed were observed in adults with down syndrome when wearing supportive shoes
Bailey Gosse, Kimberly Nguyen, Zoe Zelensky, Sarah Mann, Kai Yu Ho, Thessa Hilgenkamp

But what if we don't like laces?

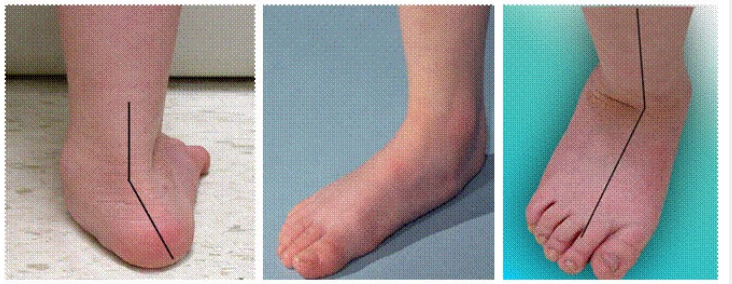






- There are so many options to turn tie shoes into slip-ons!
- Lock laces – very snug, require a little more adjustment
- Stretchy laces with a lock tie – often more successful
- Velcro adapters – velcro option, but velcro does wear out

Pediatric Flat Feet



Three Biomechanical Components of pronation
- Calcaneal Valgus
- Midfoot eversion/collapse
- Forefoot abduction combined with varus and dorsiflexion

Orthotic support options

- SMAFO
- Sure Step SMOs
- Custom insoles
- Cascade DAFO Chipmunks
- KidSole inserts (older elementary)

Benefits of foot support

- Controls heel position
- Stable platform for balance
- Flexible support for muscle development and physical activity
- Decreases hallux valgus, great toe abduction
- Improves proprioceptive and body awareness
- Improves participation in activity

Photos credit Sure Step Website
http://www.surestep.net

Does Insurance Cover Orthotics?

Depends on your insurance!

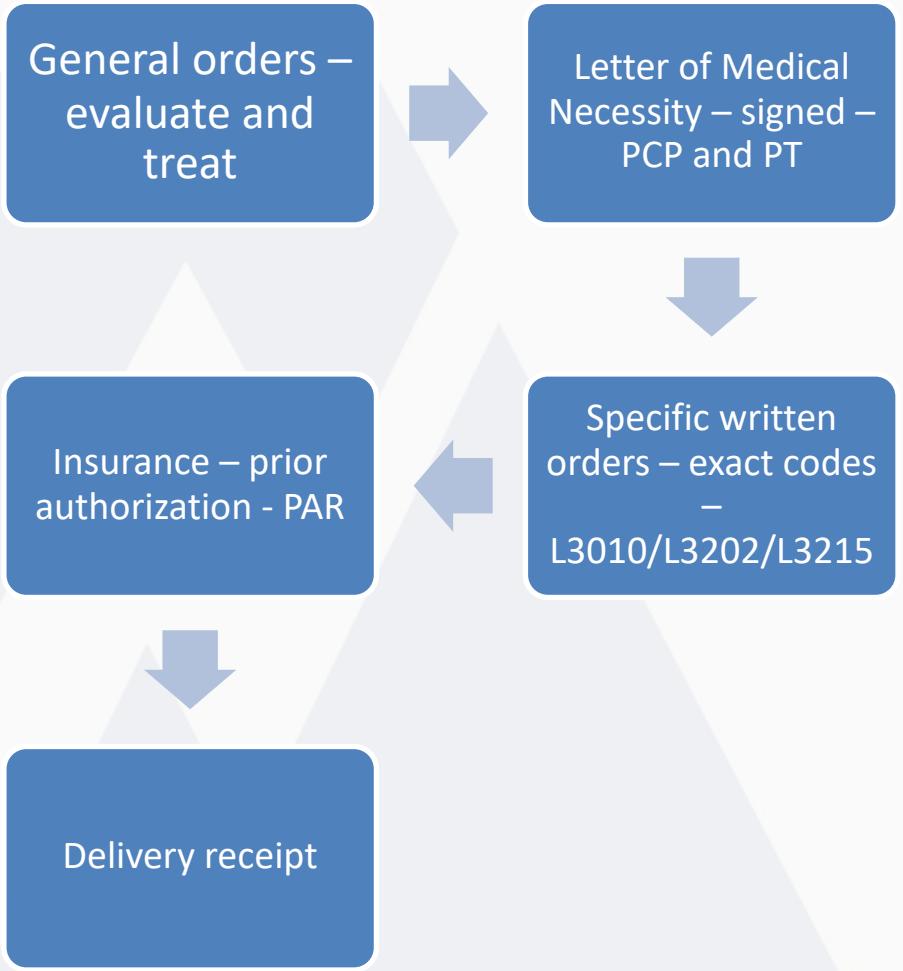
And your willingness to jump through the right hoops

- BCBS – partial coverage, some plans
- UHC – partial coverage, some plans
- Cigna, Aetna, Humana – not usually
- Medicaid – usually yes, state specific
- Medicare – yes depending on the type of orthotic
- Tricare – usually yes

Does Insurance Cover Orthotics?

What do you need?

- General orders from your PCP or Pediatrician (evaluate for foot support)
- Specific written orders from your PCP or Pediatrician (specific codes requested)
- Letter of medical necessity (LMN) from your PT signed by both your PT and PCP
- Prior Authorization – from your insurance before orthotics and shoes are delivered
- Face to face notes for SMOs (F2F)



Does Insurance Cover Orthotics?

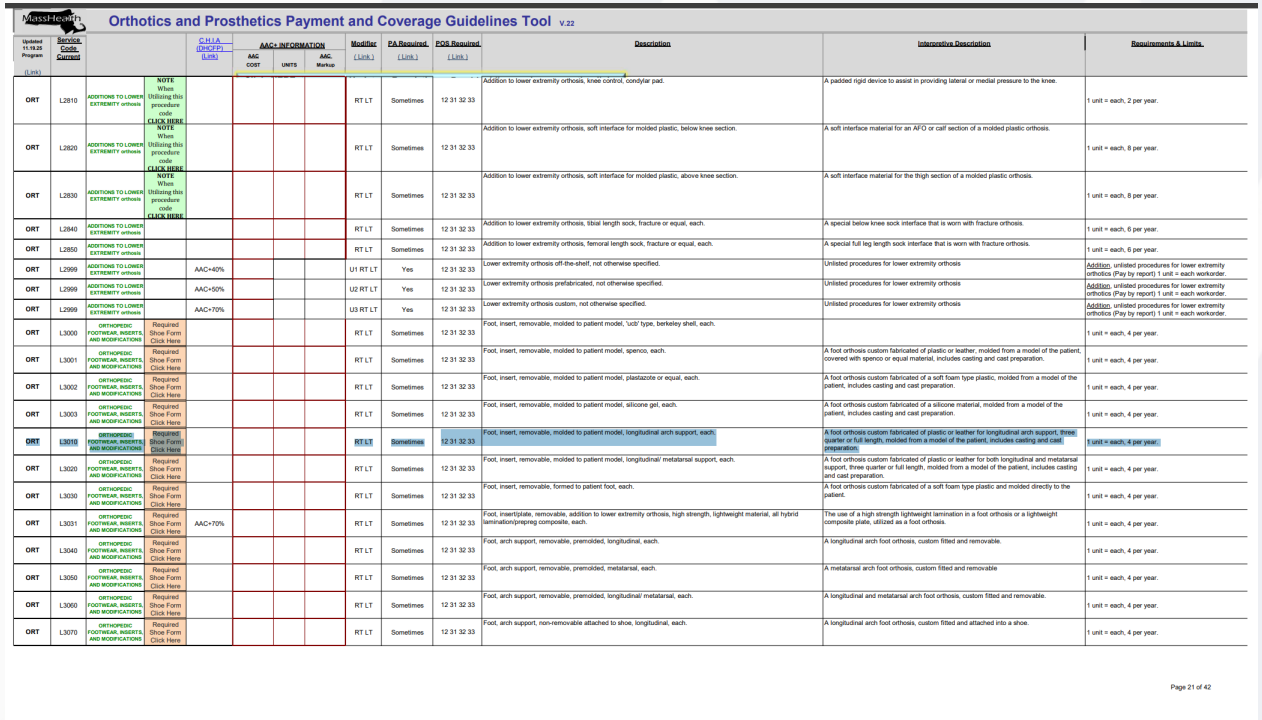
What codes do you bill?

- **L3010:** Foot, insert, removable, molded to patient model, longitudinal arch support
- **L3215:** Orthopedic footwear, ladies shoe, oxford
- **L3219:** Orthopedic footwear, mens shoe, oxford
- **L3202:** Orthopedic shoe, oxford with supinator or pronator, child
- **L1907:** Ankle orthosis, supramalleolar with straps, with or without interface/pads, custom fabricated
- **L2275:** Addition to lower extremity, varus/valgus correction, plastic modification, padded/lined
- **L2280:** Addition to lower extremity, molded inner boot
- **L3310:** Lift, elevation, heel and sole, neoprene, per inch

Does Insurance Cover Orthotics?

Look it up with Massachusetts Medicaid – MassHealth

https://www.mass.gov/doc/masshealth-ort-and-prt-payment-and-coverage-guideline-tool-v22-0/download



Orthotics and Prosthetics Payment and Coverage Guidelines Tool v.22

Updated 11.19.25 Program (Link)	Service Code Current			CHIA (DHCFP) (Link)	AAC+ INFORMATION AAC COST	AAC+ INFORMATION UNITS	AAC+ INFORMATION AAC Markup	Modifier (Link)	PA Required (Link)	POS Required (Link)	Description	Interpretive Description	Requirements & Limits
ORT	L2810	ADDITIONS TO LOWER EXTREMITY orthosis	NOTE When Utilizing this procedure code CLICK HERE					RT LT	Sometimes	12 31 32 33	Addition to lower extremity orthosis, knee control, condylar pad.	A padded rigid device to assist in providing lateral or medial pressure to the knee.	1 unit = each, 2 per year.
ORT	L2820	ADDITIONS TO LOWER EXTREMITY orthosis	NOTE When Utilizing this procedure code CLICK HERE					RT LT	Sometimes	12 31 32 33	Addition to lower extremity orthosis, soft interface for molded plastic, below knee section.	A soft interface material for an AFO or calf section of a molded plastic orthosis.	1 unit = each, 8 per year.
ORT	L2830	ADDITIONS TO LOWER EXTREMITY orthosis	NOTE When Utilizing this procedure code CLICK HERE					RT LT	Sometimes	12 31 32 33	Addition to lower extremity orthosis, soft interface for molded plastic, above knee section.	A soft interface material for the thigh section of a molded plastic orthosis.	1 unit = each, 8 per year.
ORT	L2840	ADDITIONS TO LOWER EXTREMITY orthosis						RT LT	Sometimes	12 31 32 33	Addition to lower extremity orthosis, tibial length sock, fracture or equal, each.	A special below knee sock interface that is worn with fracture orthosis.	1 unit = each, 6 per year.
ORT	L2850	ADDITIONS TO LOWER EXTREMITY orthosis						RT LT	Sometimes	12 31 32 33	Addition to lower extremity orthosis, femoral length sock, fracture or equal, each.	A special full leg length sock interface that is worn with fracture orthosis.	1 unit = each, 6 per year.
ORT	L2999	ADDITIONS TO LOWER EXTREMITY orthosis		AAC+40%				U1 RT LT	Yes	12 31 32 33	Lower extremity orthosis off-the-shelf, not otherwise specified.	Unlisted procedures for lower extremity orthosis	Addition, unlisted procedures for lower extremity orthotics (Pay by report) 1 unit = each workorder.
ORT	L2999	ADDITIONS TO LOWER EXTREMITY orthosis		AAC+50%				U2 RT LT	Yes	12 31 32 33	Lower extremity orthosis prefabricated, not otherwise specified.	Unlisted procedures for lower extremity orthosis	Addition, unlisted procedures for lower extremity orthotics (Pay by report) 1 unit = each workorder.
ORT	L2999	ADDITIONS TO LOWER EXTREMITY orthosis		AAC+70%				U3 RT LT	Yes	12 31 32 33	Lower extremity orthosis custom, not otherwise specified.	Unlisted procedures for lower extremity orthosis	Addition, unlisted procedures for lower extremity orthotics (Pay by report) 1 unit = each workorder.
ORT	L3000	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, insert, removable, molded to patient model, "cub" type, berkeley shell, each.		1 unit = each, 4 per year.
ORT	L3001	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, insert, removable, molded to patient model, spenco, each.	A foot orthosis custom fabricated of plastic or leather, molded from a model of the patient, covered with spenco or equal material, includes casting and cast preparation.	1 unit = each, 4 per year.
ORT	L3002	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, insert, removable, molded to patient model, plastazote or equal, each.	A foot orthosis custom fabricated of a soft foam type plastic, molded from a model of the patient, includes casting and cast preparation.	1 unit = each, 4 per year.
ORT	L3003	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, insert, removable, molded to patient model, silicone gel, each.	A foot orthosis custom fabricated of a silicone material, molded from a model of the patient, includes casting and cast preparation.	1 unit = each, 4 per year.
ORT	L3010	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, insert, removable, molded to patient model, longitudinal arch support, each.	A foot orthosis custom fabricated of plastic or leather for longitudinal arch support, three quarter or full length, molded from a model of the patient, includes casting and cast preparation.	1 unit = each, 4 per year.
ORT	L3020	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, insert, removable, molded to patient model, longitudinal/ metatarsal support, each.	A foot orthosis custom fabricated of plastic or leather for both longitudinal and metatarsal support, three quarter or full length, molded from a model of the patient, includes casting and cast preparation.	1 unit = each, 4 per year.
ORT	L3030	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, insert/plate, removable, formed to patient foot, each.	A foot orthosis custom fabricated of a soft foam type plastic and molded directly to the patient.	1 unit = each, 4 per year.
ORT	L3031	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here	AAC+70%				RT LT	Sometimes	12 31 32 33	Foot, insert/plate, removable, addition to lower extremity orthosis, high strength, lightweight material, all hybrid lamination/prepreg composite, each.	The use of a high strength lightweight lamination in a foot orthosis or a lightweight composite plate, utilized as a foot orthosis.	1 unit = each, 4 per year.
ORT	L3040	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, arch support, removable, premolded, longitudinal, each.	A longitudinal arch foot orthosis, custom fitted and removable.	1 unit = each, 4 per year.
ORT	L3050	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, arch support, removable, premolded, metatarsal, each.	A metatarsal arch foot orthosis, custom fitted and removable	1 unit = each, 4 per year.
ORT	L3060	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, arch support, removable, premolded, longitudinal/ metatarsal, each.	A longitudinal and metatarsal arch foot orthosis, custom fitted and removable.	1 unit = each, 4 per year.
ORT	L3070	ORTHOPEDIC FOOTWEAR, INSERTS, AND MODIFICATIONS	Required Shoe Form Click Here					RT LT	Sometimes	12 31 32 33	Foot, arch support, non-removable attached to shoe, longitudinal, each.	A longitudinal arch foot orthosis, custom fitted and attached into a shoe.	1 unit = each, 4 per year.

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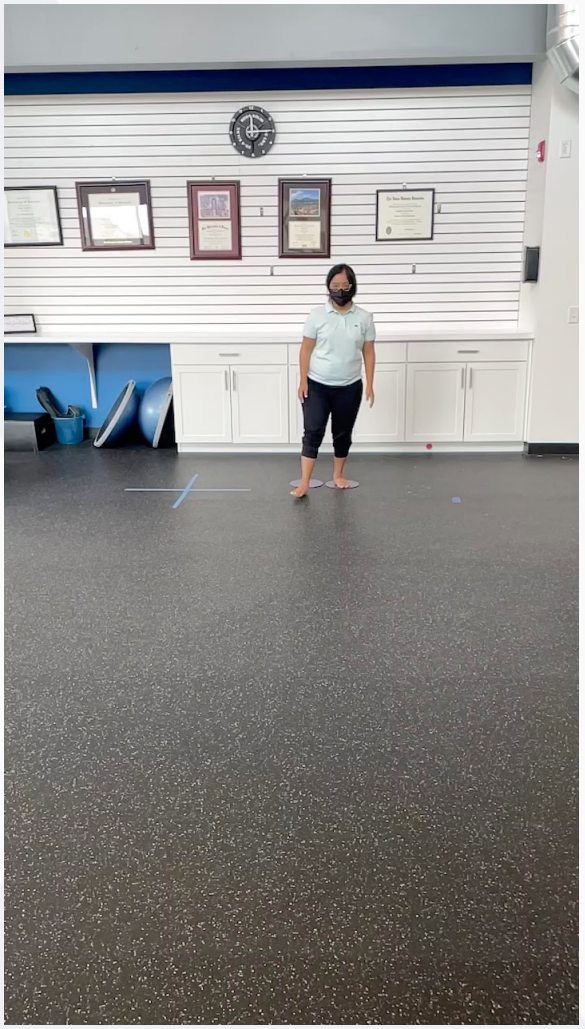
Let's Talk Walking

Walking affects so much!

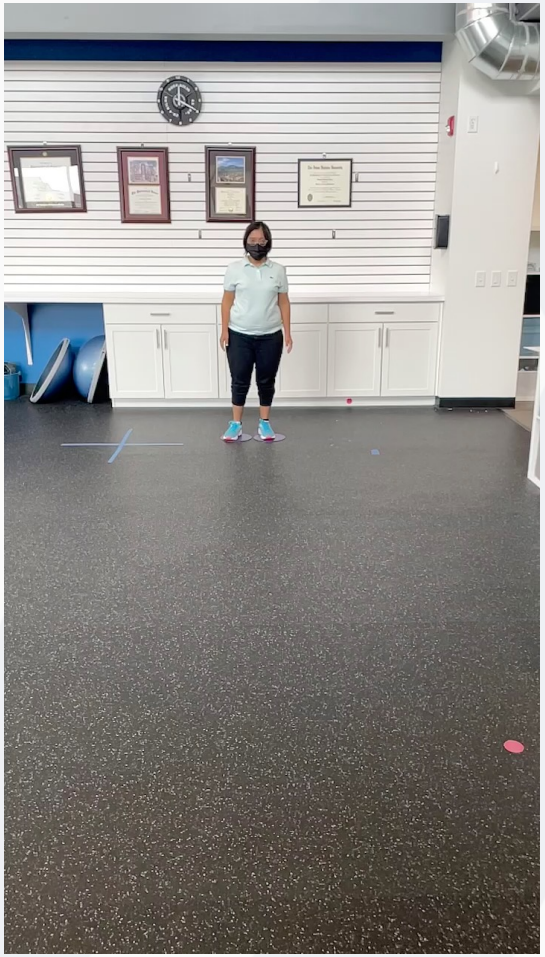
- Participation:
  - Speed
  - Work
  - Community
  - Home
- Physical fitness:
  - Activity
  - Endurance
  - Efficiency
  - How you feel!

Common Gait Features

- Wide base of support
- Slower speed
- Decreased hip extension
- Increased weightbearing on inside of foot
- Increased use of toes
- Decreased knee stability
- Increased foot turn out
- Increased hip turn out
- Limited weight shift

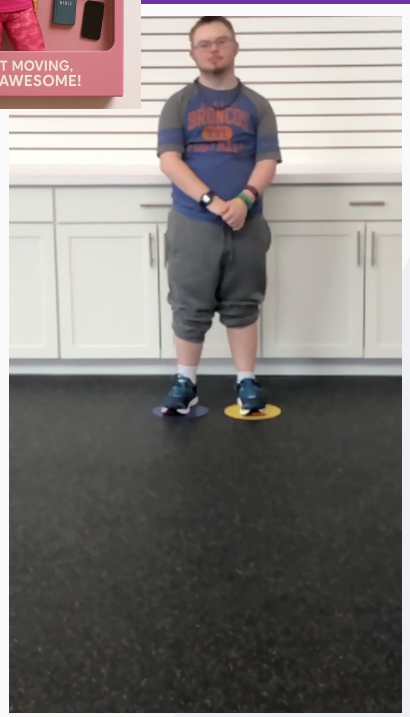


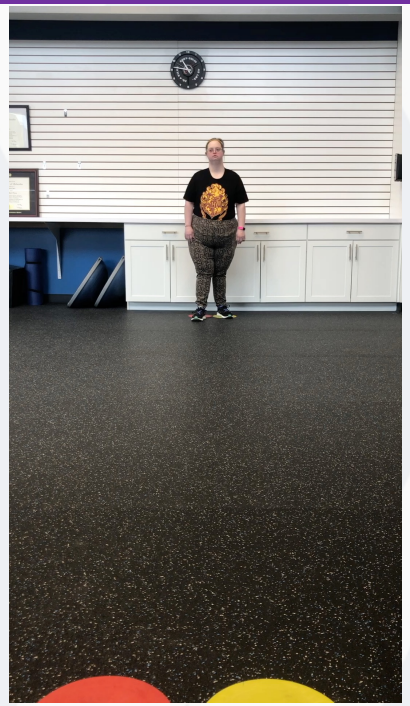
What does gait tell us?

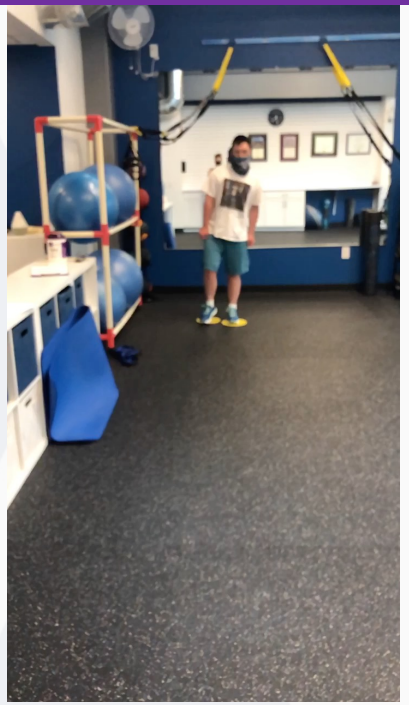


- How feet affect walking
- Muscle imbalance
- Hip and knee instability
- Balance concerns
- Difficulty with weight shift
- Tight muscles (hips and calves)
- Endurance

How do we get providers to listen and help?

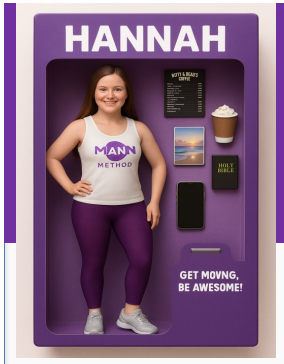






Talk to your Doctor or Pediatrician if you have concerns regarding your son or daughter's foot posture or walking pattern. They can refer you to PT or to a good podiatrist who can help!

- Start with good shoes
- Then foot support
- Then PT to help with underlying factors!



How do we get providers to listen and help?

- Most providers truly want to help
- They may not have all the information or be familiar with the details about people with Ds– especially as it relates to feet and walking!
- Bring the data to them!

Formal Gait Assessment

- Gait assessment (Rancho Los Amigos)
- Gait speed (m/s)
- Gait and functional movement (Timed Up and Go)
- Orthotics Codes

Ranchos Los Amigos Gait Assessment

Periods	Stance Period				Swing Period			
Functional Task	WA		SLS		SLA			
Phases	IC	LR	MSt	TSt	PSw	ISw	MSw	TSw
Critical Evens	Heel contact	Hip stability Controlled knee flexion Controlled plantar-flexion	Controlled tibial advancement *Pelvic stability*	Heel rise with controlled dorsiflexion Trailing limb posture	Rapid plantar-flexion Passive knee flexion to 40°	Active hip flexion Peak knee flexion 60° *Pelvic stability*	Peak hip flexion (30°) Ankle dorsiflexon to 0°	Knee extension to neutral *Ankle dorsiflexion maintains 0°*

Common Gait Compensatory Patterns: Foot and Ankle

- Flat foot initial contact
- Base of support wider than hip width
- Decreased eccentric plantarflexion control during loading response – heavy footfalls or “slapfoot”
- Increased eversion of foot during loading response
- Increased weightbearing on medial arch with navicular drop during loading response and stance
- Increased forefoot and/or great toe abduction during stance
- Decreased dorsiflexion during midstance
- Excess plantarflexion during terminal stance - early heel rise due to gastroc/soleus muscle tightness
- Toe-off forces isolated to first metatarsal
- Increased external rotation and flexion of great toe (hallux valgus) during stance and/or swing
- Decreased active dorsiflexion for foot clearance during swing
- Increased extension of great toe bilaterally during swing phase to assist with foot clearance
- Excessive plantarflexion during mid swing and terminal swing
- Increased external rotation of foot throughout gait cycle
- Excessive plantar flexion throughout gait cycle
- Increased foot progression angle (due to forefoot abduction)

Common Gait Compensatory Patterns: Knee

- Increased foot progression angle (due to tibial external rotation)
- Increased genu recurvatum in loading response, midstance, and/or terminal swing
- Increased genu valgum during midstance and/or initial swing
- Poor knee flexion control during midstance and/or pre-swing
- Use of hip external rotation and abduction for foot clearance during pre-swing and initial swing bilaterally (due to decreased passive knee flexion)

Common Compensatory Patterns: Pelvis and Hip

- Starts with base of support wider than hip width
- Lead step with left/right foot
- Decreased passive hip extension during terminal stance bilaterally
- Use of hip external rotation and abduction for foot clearance during pre swing and initial swing bilaterally (decreased passive knee flexion)
- Increased hip or foot external rotation during swing, stance or throughout gait cycle
- Pelvic obliquity on stance leg (“hip drop”) due to gluteus medius muscle weakness
- Pelvic obliquity on swing leg (“hip hike”) to clear foot due to decreased ankle dorsiflexion
- Increased foot progression angle

Common Gait Compensatory Patterns: Eyes, Head, Neck, Trunk

- Excessive forward trunk lean for momentum
- Excessive posterior trunk lean for limb advancement due to hip flexor weakness
- Excessive lateral trunk flexion during stance due to decreased hip stability
- Decreased lateral weight shift during stance resulting in short step length
- Asymmetrical torso posture
- Rounded shoulders with excessive protraction bilaterally
- Preference for head turned to one side
- Preference for head tilted to one side
- Downward gaze, looking at one's feet
- Decreased trunk rotation with decreased arm swing and diminished shoulder-on-hip dissociation

Ranchos Los Amigos Gait Assessment vs. Common Compensatory Patterns

Periods	Stance Period				Swing Period			
Functional Task	WA		SLS		SLA			
Phases	IC	LR	MSt	TSt	PSw	ISw	MSw	TSw
Critical Events	Heel-first contact	Hip stability Controlled knee flexion Controlled plantarflexion	Controlled tibial advancement	Heel rise with controlled dorsiflexion Trailing limb posture	Rapid plantar-flexion Passive knee flexion to 40°	Peak knee flexion 60°	Peak hip flexion (30°) Ankle dorsiflexon to 0°	Knee extension to neutral
Common Compensatory patterns	Flat foot contact Hip or tibial external rotation	External or internal hip rotation Knee hyper-extension Uncontrolled plantarflexion (“foot slap”) Excessive forefoot abduction, eversion	Poor control of ankle rockers Forefoot abduction with excessive pronation Genu valgum Excessive lateral trunk flexion Hip external rotation	Early heel rise Decreased hip extension Excessive lateral trunk flexion	Decreased concentric plantar-flexion Toe-off forces isolated to first metatarsal	Hip external rotation Hip abduction Forefoot abduction	Decreased hip flexion Excessive genu valgum Hip external rotation Forefoot abduction with slight plantarflexion Excessive great toe extension	Knee hyper-extension Hip external rotation Increased foot progression angle Wide step (foot lateral to hip)

Hopefully that will help you and your person with Down syndrome!

Today we covered:

- Anatomy and physiology
- The muscle and bone system
- Common foot posture
- Orthotics and footwear recommendations
- Common walking patterns
- Ideas to share with your providers
- Now, what questions can we answer for you?

Strength, Balance, Gait Resources

Review > Int J Environ Res Public Health. 2023 Feb 18;20(4):3667. doi: 10.3390/ijerph20043667.

Development of a Physical Therapy–Based Exercise Program for Adults with Down Syndrome

Sarah Mann [1], Jennifer Spiric [1], Cailin Mitchell [2], Thessa Irena Maria Hilgenkamp [2]

Affiliations + expand

PMID: 36834362 PMCID: PMC9960831 DOI: 10.3390/ijerph20043667

> J Appl Res Intellect Disabil. 2025 Jun 10;38(3):e70080. doi: 10.1111/jar.70080

Successful Online Exercise Intervention Studies for Individuals With Intellectual Disabilities Including Down Syndrome: Best Practices and Recommendations

Thessa Hilgenkamp [1,✉], Amy Bodde [2], Sarah Mann [3], Brain Helsel [4], Joseph Sherman [2], Jessica Danon [2], Lauren Ptomey [2]

Clinical Trial > J Appl Res Intellect Disabil. 2023 Mar;36(2):385-393. doi: 10.1111/jar.13068. Epub 2022 Dec 30.

The effect of a telehealth exercise intervention on balance in adults with Down syndrome

Kristina Guerrero [1], Alexandria Umagat [1], Mark Barton [1], Andrew Martinez [1], Kai-Yu Ho [1], Sarah Mann [2], Thessa Hilgenkamp [1]

Affiliations + expand

PMID: 36585748 PMCID: PMC11646388 DOI: 10.1111/jar.13068

Under Review: **Journal of Applied Research in Intellectual Disabilities**

Effects of a 12-week physical therapy-based exercise intervention on gait in adults with Down syndrome: a randomized clinical trial

Paige Lucero, Samantha Betts, Stephen Király, James Malabanan, Kai-Yu Ho, Sarah Mann, Thessa Hilgenkamp

> J Intellect Disabil Res. 2024 Jun;68(6):598-609. doi: 10.1111/jir.13132. Epub 2024 Mar 13.

Effects of a 12-week telehealth exercise intervention on gait speed and gait deviations in adults with Down syndrome

T Hilgenkamp [1], R Lum [1], C Roys [1], T Souza [1], D Stopka [1], S Mann [2], K-Y Ho [1]

Affiliations + expand

PMID: 38481070 PMCID: PMC11653813 (available on 2025-06-01) DOI: 10.1111/jir.13132

Under Review: **Footwear Science**

Better gait quality and speed were observed in adults with down syndrome when wearing supportive shoes

Bailey Gosse, Kimberly Nguyen, Zoe Zelensky, Sarah Mann, Kai Yu Ho, Thessa Hilgenkamp

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