Normal Gait

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Critical Gait Parameters

- Average walking speed = 2-3 mph (60-80 m/min)
- Average cadence = 80-110 steps/min
- Average step length = 30 cm
- Average stride length = 60 cm
- Stance/swing (1 leg) = 60/40
- Single/double limb support = 80/20
- Running has no double limb support
Step or Stride?

R step + L step = stride
Phases of the Gait Cycle (1 leg)

Stance Phase – 60%

Swing Phase – 40%
### Table 5-2. Summary of Gait Phases

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<th>0–10%</th>
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**Key:**
- **Swing**
- **Stance**
Three Important Gait Factors

- Forward Progression
- Stance Stability
- Conservation of Energy
Methods of Analyzing Gait

- **Kinematics** = observing or measuring the position of joints and segments through each phase of gait (visual gait analysis)

- **Kinetics** = measuring the Ground Reaction Force at each joint and then calculating the muscle activity or soft tissue resistance present to stabilize the joint
Gait Analysis Basic Training

- Assess only one joint at a time
- Look at early stance, late stance, then swing
- Separate kinetics from kinematics
- KEEP IT SIMPLE!
Normal Human Locomotion: Sagittal Plane Gait Kinematics
STANCE PHASE

HEEL STRIKE
LOADING RESPONSE
MID-STANCE
TERMINAL STANCE
PRESWING
Swing Phase

Initial Swing
Midswing
Terminal Swing
Rockers or Pivot Points in Stance

A Heel rocker  B Ankle rocker  C Forefoot rocker
Initial Contact:

• Double Support

• Hip = Flexed 30°

• Knee = Extended

• Ankle = Neutral

• Goal = Begin Stance
Loading Response:

- Double Support
- Hip = Flexed
- Knee = Flexing 5-10°
- Ankle = Plantarflexing to 20°
- Goals = Weight Acceptance, Shock Absorption, Advance body over Heel Rocker
Mid Stance:

- **Single Support**
- **Hip = Extending**
- **Knee = Flexed 5-10°**
- **Ankle = Dorsiflexing**
- **Goal = Advance body over stationary foot, ankle rocker**
Terminal Stance:

- **Single Support**
- **Hip** = Extending 15-30°
- **Knee** = Extend, then Flex
- **Ankle** = 15° DF to Neutral
- **Goal** = Advance body over forefoot rocker
Pre Swing:

• Double Support

• Hip = Flexing

• Knee = Flexing 30-40*

• Ankle = Plantarflexing 20-30*

• Goal = Prepare for Swing, transfer load to other limb
Initial Swing:

- **Single Support**
- Hip = Flexing
- Knee = Flexing up to 65°
- Ankle = Dorsiflexing to 0°
- **Goal** = Clear foot and advance limb
Mid Swing:

- Single Support
- Hip = Flexing to 30°
- Knee = Extending
- Ankle = Dorsiflexing to 0°
- Goal = Advance limb and clear foot
Terminal Swing:

• Single Support

• Hip = Flexed 30°

• Knee = Extending

• Ankle = Neutral

• Goal = Advance limb
Initial Contact:

- Double Support
- Hip = Flexed 30°
- Knee = Extended
- Ankle = Neutral
- Goal = Begin Stance
Kinetics of Stance Phase

Diagram showing various phases of the stance phase with labels for different moments and angles such as flexion moment, extension moment, GRFV, and COP.
Activity of All Major Muscles
Activity of All Major Muscles
Hip Abductor Activity
Determinants of Gait
Stick Figure Model
1. Pelvic Rotation
Lengthens Limb at IC and PS
2. Pelvic Tilt
Shortens Limb at MS
3. Knee Flexion in Stance Shortens Limb at MS
4&5. Foot and Ankle Motion
Lengthens and Shortens Limb
Sinusoidal Motion of the COG
6. Narrow Base of Support to Minimize Horizontal Motion
Effect of Incline on Energy
Effect of Ankle Immobilization on Gait
Effect of Knee Immobilization

![Diagram showing energy expenditure during walking at different angles of knee flexion for two speeds: 2.9 km/h and 4.4 km/h.](image)
Up and Down Stairs

Diagram showing the angle of knee flexion during walking cycles for both up and down stairs. The graphs illustrate the changes in knee angle at different stages of walking, comparing upstair (left) and downstairs (right) movements.
Center of Gravity Line

Figure 5-24. Location of the COG. In the average adult, the COG lies anterior to S2.
Base of Support

Figure 5-26. Base of support. The size of the base of support varies with a change in foot position.
Figure 5-27. Base of support. The size of the base of support varies with the use of a cane or crutches and with placement of the assistive device.
Thank You